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Saturday, March 22, 1952

only a guide and friend for the undergraduate, but it can also remain a stimulating companion in mature experience.

It is rather remarkable, but no doubt deliberate, that the conventional vector diagram of A.C. circuit theory is not utilized at all in the work even to illustrate skin effect phenomena to which this representation is well adapted. At least one group of minor misprints has been transmitted from the first edition, namely, the omission of '*dx*' from several of the equations on p. 241. JAMES GREIG

SPECTROCHEMICAL ANALYSIS

Metal Spectroscopy

By F. Twyman. Pp. ix+569. (London: Charles Griffin and Co., Ltd., 1951.) 50*s*. net.

THE development of spectroscopy proceeds with ever-increasing pace: from the discovery of the spectrum by Newton in 1672, the use of flame spectra to distinguish between lithium and strontium by Talbot in 1834, the spectroscopic discovery of cæsium and rubidium by Kirchhoff and Bunsen in 1861, and the first serious attempts at spectrochemical analysis by Hartley and de Gramont at the turn of the century, to the present, when the all-pervading science of electronics is being applied to spectrochemistry. The historical side is most readably presented in the opening chapter, but the importance of this book is in its complete and up-to date treatment of recent developments in a rapidly expanding field. These rapid developments have led to the replacement of Mr. Twyman's "Spectrochemical Analysis of Metals and Alloys", which was written during the difficult early war years and published in 1941.

Mr. Twyman has been outstanding in the development of spectroscopic equipment and technique, and his experience in the field extends back half a century. Although he has been so closely associated with Messrs. Adam Hilger, Ltd., this book is not tied to the instruments of this firm, and the important contributions to spectrochemistry from Germany, the United States and other countries are given full weight, and the instruments of other firms are fully covered.

Practically every aspect of spectrochemical analysis is dealt with in more than five hundred closely written pages. There is a short chapter dealing with the fundamental principles of the theory of atomic spectra (the unusual notation of writing the upper state of a transition to the left may be noted), but thereafter the emphasis is on the instruments and experimental technique; this practical aspect may be illustrated by the section on shielding of sparks to prevent radio interference. Chapters on light sources, electrodes, X-ray spectrochemistry, and the present trend of developments are contributed respectively by A. Walsh, M. Millbourn, F. Brech and F. Holmes.

For the analysis of metals, especially in routine testing of numerous samples, or in detecting trace elements in soils, spectroscopic analysis obviously has many advantages; but it is not only for metals that it can be used, and the book also covers analysis of gases and of some non-metals such as sulphur, selenium, carbon and boron. Colorimetry and spectrophotometry, microphotometers, the infra-red region, and the use of spectrochemical analysis combined with chromatography are also dealt with. An interesting suggestion is the possible extension to shorter wave-lengths, perhaps by the use of fluorite prisms, to reach more sensitive lines such as those of sulphur and selenium. Types of instruments are compared, and, while Mr. Twyman admits that gratings have some real advantages, the limitations due to overlapping orders, astigmatism and ghosts are pointed out.

This book is by far the most comprehensive and authoritative treatment of the subject available, and is strongly recommended. If there is a weakness it probably lies in the presentation: the table of contents only gives chapter headings, and as these are in general terms it is not always easy to find the section of interest—thus Raman spectra come under "Electronic Methods". There is a good bibliography, and the book is well produced. A. G. GAYDON

RHODODENDRON LEAVES

The Rhododendron Leaf

A Study of the Epidermal Appendages. By Dr. John Macqueen Cowan. Pp. xi+120+18 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1950.) 21*s*. net.

THE study of the rhododendrons has long been pursued in the Royal Botanic Gardens, Edinburgh, blessed by an ever growing wealth of living plants and by unswerving interest in taxonomy. Throughout this time a widespread view has come that, while specific status or generic rank may well be proved by form and stature of papillæ or of hairs or scales retained on mature leaves, in other respects the forms and groupings of the hairs or scales may point to true relationships, the seekers of which have hitherto all assumed that species bearing scaly leaves are of distinct descent from all those that have hairy leaves or lack such dermal organs.

This broad assumed distinction was employed throughout "The Species of Rhododendron" (1930), both in the seriation of the plants described and often, too, as if it can denote for new-found or for doubtful plants some special series which already hold their nearer kith and kin. Although this standard book allowed that certain series then proposed embrace confusing plant assemblages, its plan again implied that plants with hairs or scales are rightly viewed as of distinct descent.

The present handsome book relates how, though so often contrasting in their forms and states, the hairs and scales which many species bear alike arise from single superficial cells, and how their products must be held of unit kind, though built on diverse plans. Since it shows, too, how dermal organs borne by hybrid plants may stand in all respects between hairs and scales, how certain species vary much in types of hair-display, and how, in others, hairs and scales are formed on every leaf, it seems the old assumption must be set aside until it is known what hair- and scale-formation mean to living plants themselves.

No matter how these findings bear on taxonomic problems, this book has interest far beyond the field of systematics or that of horticulture. It first relates how needful lines of study grew from those already traced, and how through simple technique knowledge came of many trichome-forms which had not always drawn comment or were misunderstood. Each one of these is then described and faithfully portrayed before it is shown what founded species-series are still justified, and which must be revised.

Throughout its length, this book impresses one by the author's sense of plants as living things, each posing many problems still but slightly grasped and which must duly be essayed if one should hope to picture near relationships.

Although the major chapters brim with novel observations, they rather seek to urge research than to suggest conclusions. Perhaps the final chapter will serve the most to quicken new inquiry; for, vividly, it turns the mind from plants in cultivation to an understanding of, in part, their fitness to their native habitats and their sustained survival.

This simply written book reflects a long and arduous effort. Its illustration merits special praise, as does its composition. J. McLean Thompson

A POPULAR NATURE STUDY

Nature through the Year

By Frances Pitt. Pp. vii+300. (London: Macmillan and Co., Ltd., 1951.) 18s. net.

FRANCES PITT'S literary excursions in natural history are now so well known that there can be few with love of Nature who have not met her in person or print. In her latest work this popular writer presents a colourful account of natural events throughout the year. As always, the book is written in a delightful narrative style which is accompanied by evidence of acute powers of observation stemming from keen interest in and love of living things.

In some ways the title of the book is a misnomer. Although other aspects of Nature are referred to, Miss Pitt is mainly concerned with birds and mammals, and these, not unexpectedly, sometimes include those well-loved pets with which the author has had long acquaintance and studied so carefully. The book, in fact, would serve as an admirable supplement to the popular "In Britain" series by the same publishers, particularly if these in turn were strengthened by a work dealing with insects in Britain.

The arrangement of the book is on a weekly basis. Beginning on January 1 and continuing for each successive week throughout the year, the author has recorded significant impressions which she has observed, and has used these as starting points for gentle dissertations on biological principles or practices. An encounter with a hare, for example, leads naturally to discourse about animal camouflage, while genetic principles are introduced after a mild detective story in which a Manx cat is the chief suspect.

In these voyagings Miss Pitt does not hesitate to roam wherever fancy takes her, and one of her weekly episodes begins with an account of a squirrel's reaction to the sting of a wasp, continues with the description of a squirrel which had "bilious" attacks which may have been brought on by eating Brazil nuts, and finishes with possible explanations of old legends about spectral horsemen and ghostly hounds running equally ghostly quarry through the night; these vagaries do not detract from the charm of the book. Nor do some minor errors, although, when another edition of the book is called for, Miss Pitt should not—on p. 73—begin a sentence by saying that she "could not give a *definite* answer", and end it with "the reason is *undoubtedly* one of light and lighting". So, too, with other parts of the text which appear to have been hastily written and have become so loosely constructed that, as on p. 289, the author has exposed herself to the charge of anthropomorphism.

The book is generously provided with black-and-white illustrations, the photographs for which were taken by Miss Pitt; the majority of these are clear but a few are well below the standard associated with the publishers.

In a world where the search for truth has become so objectively impersonal that much present-day writing lacks the warmth and colour of human emotion, Miss Pitt's book makes refreshing and interesting reading mainly because the author has nowhere tried to conceal her feelings and idiosyncrasies.

Besides British readers, "Nature through the Year" would be an admirable guide for visitors from overseas who have come to examine Britain as she really is in Festival year. T. H. Hawkins

ATOMIC REMINISCENCES

New Atoms

Progress and some Memories. By Otto Hahn. A collection of Papers, edited by Dr. W. Gaade. Pp. 184. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1950.) 12s. 6d.

THOUGH there has been a number of books purporting to expound the scientific facts about 'atomic energy' to the non-technical reader, this little volume should hold its own. It is a collection of four lectures, each complete in itself; hence some overlap is unavoidable. The first is the Nobel Lecture given by the author in 1946, and is an account of the work which led up to the discovery of nuclear fission. The occasions on which the other three lectures are given are not stated; the second is largely physical, centred around the nuclear chain reaction which followed soon after the discovery of fission. In the third, the author is at home again in his beloved chemistry, zestfully describing the new elements (no less than ten) which recent nuclear research (not all of it directly connected with fission) has given the chemists to play with. The last brings reminiscences of the early years of radioactivity; less technical and often humorous, it paints a lively canvas of those heroic days when radium was new and anything might happen.

The style is very straightforward, indeed rather subtle in its simplicity. It avoids the long-winded explanations which are apt to stress rather than resolve difficulties, and it is also refreshingly free from that hectic verbiage by which some popular writers lash the flagging attention of their jaded readers. Much of the information given, particularly in the third lecture, is fairly technical; but it is always presented in simple language. Perhaps the most valuable feature is the sense of historical unity, connecting early radioactivity and modern atomic energy, a unity of which the author is a living symbol and which he succeeds very well in communicating.

On the whole, this is a most likeable little book, written by a man who took a leading part in the development of radioactivity and who enjoys telling us about his work and the scientific scenery in which it took place. The translation is good; a few minor slips are easily spotted and do no harm.

O. R. Frisch

Solvents

By Dr. Thos. H. Durrans. (Monographs on Applied Chemistry, Vol. 4.) Sixth edition, revised and enlarged. Pp. xv+242. (London: Chapman and Hall, Ltd., 1950.) 21*s.* net.

THIS well-known and useful monograph was first published in 1930 to provide a scientific exposition of the technical application of solvents, more particularly in connexion with the cellulose-lacquer industry. The considerable advances in the production of solvents and plasticizers during the past twenty years made it necessary to subject the book to frequent revision if it was to retain its usefulness as an up-to-date manual, and it has now reached its sixth edition, which fully maintains the standard of its predecessors.

The general arrangement of the previous editions has been retained, the first part of the book discussing the more theoretical aspects of the subject, and the second part dealing with the characteristics and uses of individual solvents and plasticizers. The chapter on toxicity has undergone considerable revision and extension in the light of recent discoveries and opinions. Appendixes give a very useful and comprehensive list of trade names with probable compositions (now extended to some 576 entries), solubility tables and plasticizer proportions. The solubility tables give information on the solubility of twenty-seven different substances, such as cellulose acetate, rubber, gums, oils, etc., in more than a hundred different solvents.

The present edition may be accepted as containing the most recent information and experience in its particular field, and can be recommended with confidence to all who have to deal with solvents and plasticizers. E. H. NURSE

British Journal of Applied Physics

Edited by Dr. H. R. Lang. Vol. 1, 1950. Pp. iv+340. (London: Institute of Physics, 1950.) £4.

THE monthly periodical, *British Journal of Applied Physics*, was launched in January 1950 by the Institute of Physics in order to provide the steadily increasing number of physicists employed in industry with a medium for the publication of new applications of physics, especially in industry, and for the description of developments of older applications. The completion of Vol. 1 provides a welcome opportunity to direct attention again to the excellence of the *Journal*, and to commend the editor, Dr. H. R. Lang, and the advisory committee for their continued meritorious efforts.

All but one of the twelve monthly issues have contained one or more special articles or special reports, in addition to the several original contributions, reviews of new books and notes and comments. Scientific education, environmental warmth and human comfort, the 1948 revision of the international temperature scale, and electrical conduction in glass are the subjects of the four special articles, and the special reports consist of summaries of the proceedings of various conferences and discussions held by branches of the Institute during the past two years. It is impossible to summarize adequately the various original contributions. They range over a wide field covering electronics, vacuum technology, photoelasticity, rheology and glass technology. Only one of the contributions, "An Electromagnetic Problem", by Dr. G. F. C. Searle (p. 268), seems to be out of place in a periodical devoted solely to applied physics, but the editor may be excused for this apparent lapse because the problem discussed is of considerable fundamental interest. It arose when preparations for the celebration of the centenary of Heaviside's birth reminded that veteran of experimental physics, Dr. Searle, that, in 1916, he sent an electromagnetic problem to Heaviside for solution but which, apparently, Heaviside either could not solve or merely ignored. The original problem presents great mathematical difficulties; but, in his article, Dr. Searle considers a simplified case which he then proceeds to solve in an elegant manner. Perhaps some physicist may now be prompted to tackle the more difficult problem submitted to Heaviside.

The illustrations, index and binding of this first volume are of a high standard, and the large clear type is particularly welcome. It is to be hoped that proper and adequate support will be forthcoming from members of the Institute, industrial organizations and professional societies for the *Journal* to continue as a medium for bridging the gap between applied physics in the laboratory and its eventual translation into industrial practice. S. WEINTROUB

Light and Sound

By M. Nelkon. Pp. viii+342+2 plates. (London: William Heinemann, Ltd., 1950.) 11*s.* 6*d.*

IN view of the number of text-books of intermediate standard already in existence, the value of yet another is rather doubtful, and it could only be justified by some particularly original treatment and ideas. In this book, however, the treatment throughout is conventional.

University teachers will also note with regret that the author uses the 'real-is-positive' sign convention in light, thus helping further to establish its hold at the school level of teaching. This convention, since it is not easily extended to non-axial points, is of little use in degree courses, and thus a definite cleavage now exists between the teaching of optics in the schools and the universities. The author admits this difficulty, and gives an introduction to the 'new Cartesian' convention in an appendix. Since this convention was recommended in 1934 by a committee appointed by the Physical Society, it is a matter for regret that it is not more widely adopted.

Applied Mycology and Bacteriology

Originally compiled by L. D. Galloway and Dr. R. Burgess. (Modern Chemical Industries Series.) Third edition, revised by L. D. Galloway. Pp. viii+184+8 plates. (London: Leonard Hill, Ltd., 1950.) 12*s.* net.

MANY workers in mycology and bacteriology will already know this book from earlier editions. It is perhaps most valuable as a general introduction to methods of work and to the techniques of handling and control of micro-organisms. Part 1 deals with such questions, and includes several modern contributions. Part 2 is a wide review of the ways in which fungi and bacteria are connected with industry, medicine and food. There is here not sufficient detail for the specialist, who may, nevertheless, be able to glean one or two ideas from other fields of action. The section serves as a very good introduction for the student or laboratory worker, and it makes interesting reading. Mr. L. D. Galloway has considerably re-written the text for this third edition, and the ten illustrations are so good that more would be acceptable. JOHN GRAINGER

INFLUENCES OF TIDAL STREAMS ON OCEANOGRAPHIC AND CLIMATIC CONDITIONS IN THE SEA AS EXEMPLIFIED BY THE ENGLISH CHANNEL

By DR. G. DIETRICH
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IN so far as a periodically recurring wave process is linked up with friction and eddy viscosity, it can well exercise permanent influences in the sea. In the case of tidal streams, various effects of this kind can be observed. Being closely associated with tidal waves which are very long compared with the depth of the water, the tidal streams reach right down to the bottom of the sea, where they are diminished by frictional influences. From hydrodynamics it is well known that, with increasing vertical change of velocity, the eddy viscosity will be intensified if the stability of the layering of the water remains below a certain critical value. Since, in the sea, this limitation is mostly fulfilled, the density stratification will be diminished in the presence of tidal streams. In the case of low speeds, destruction of the density stratification will be confined to the neighbourhood of the sea bottom; at higher velocities, however, the destruction will be intensified until the tidal streams have succeeded in mixing the whole water column from bottom to surface. The occurrence of strong tidal streams is confined to limited parts of the marginal seas where topography favours the development of high tidal waves. Hence, in this type of area, water masses which are in a considerably differentiated stage of mixing may be found within a short distance from each other; this situation facilitates the comparison of the physical effects.

The English Channel is particularly suited for demonstrating the influences of tidal streams. The velocity of these currents reaches high values in this area, and its distribution is well known from a recent paper by W. Hansen[1] summarizing the observations. In addition, the oceanographical and meteorological factors are supported by an abundant and very diversified mass of observational material. References to the material and methods of elaboration of it have been dealt with in another paper[2].

Fig. 1 shows several oceanographical and climatic factors presented for a line which follows the axis of greatest depths and is more or less coincident with the orthodrome from 48° N., 8° W., to 51° N., 1½° E. This line runs from the continental slope in the Bay of Biscay as far as the Straits of Dover. *B* indicates the topography of the bottom along this line. Some of the factors indicated do not take into consideration the small depression of the Hurd Deep, in order to avoid a one-sided representation. In winter, the whole water column is homogeneous from the surface down to the bottom of the sea, while in summer, in the Bay of Biscay, a characteristic stratification develops. This consists of a homogeneous top layer with high temperatures, and a cool homogeneous subsurface layer. The line *T* indicates the mean depth of the temperature discontinuity between these two layers in August. The temperature difference Δt between these two layers, corresponding to the temperature difference between the surface and the sea bottom, gives an idea of the magnitude of the temperature discontinuity. In the western entrance of the Channel, abreast of Ouessant, the discontinuity layer rises remarkably from a depth of 45 m. to 20 m. and in the same region Δt falls from about 6° to less than 2° C.

This phenomenon demonstrates the immediate effect of the mixing process caused by tidal streams. Fig. 1 shows that the velocity of the tidal streams *V* rises from 1 to 2 sea miles/h. (knots) in the same area. Consequent upon the greater vertical turbulence caused by the increased frictional influences near the bottom, the discontinuity layer is carried off from below and hence, as a whole, becomes shallower and less powerful. Towards the central part of the English Channel the tidal streams increase to such an extent as to cause the summer discontinuity to be completely destroyed. Hence, it is not only in winter, but also in summer, that the central and eastern parts of the Channel are thoroughly mixed from the surface down to the bottom. Owing to the shallow depths in the area extending from the Isle of Wight to Dover, the local falling-off of tidal stream speeds does not suffice for the formation of a summer layering there.

As a result of the mixing process enforced by the tidal streams, the quantity of heat available at the sea surface from the heat balance will be imparted to a far thicker water layer than would be the case if there were no tidal mixing process. The heat balance at the surface being limited, the annual variation of the surface temperature will be damped. The annual mean variation of the surface temperature, $t_{Wh}-t_{Wl}$, which in the latitudes concerned normally rises with approach to the Continent, can be seen from Fig. 1 to show a noteworthy decrease abreast of Ouessant in that the maximum annual temperature t_{Wh} falls and the minimum temperature t_{Wl} rises. At the surface, this damping is imparted to the air temperature and, unlike the conditions in the Bay of Biscay and the eastern Channel, there is observed a decrease in the annual variation $t_{Ah}-t_{Al}$ in the western Channel. In taking the annual variation as a measure of continentality—as is customary in climatology—one arrives at the apparently paradoxical conclusion that the open Bay of Biscay has a greater continentality than the adjacent western Channel. This phenomenon is due to the effect of the mixing process caused by tidal streams.

The damping will be manifested not only in a diminution of the mean annual variation of water and air temperatures but will also reveal itself in the mean retardation of phases of the annual variations. To express this in a more illustrative way, it will become evident in the retardation of the setting-in of the annual maxima P_W and P_A. Because of this, the premature occurrence of the maxima normally found in approaching the Continent is decisively disturbed. In the central Channel abreast of Guernsey, the P_W values are delayed until September 11, the corresponding date in the Bay of Biscay being August 20. The maxima of the air temperatures are much less delayed, namely, by five days. The maximum is retarded until August 17, as compared with August 12 in the western approaches to the Channel. The noticeable increase in the phase difference between the annual variations of water and air temperatures, as shown in Fig. 1, contributes to the development of extraordinary values of temperature gradient in the air layer near the water

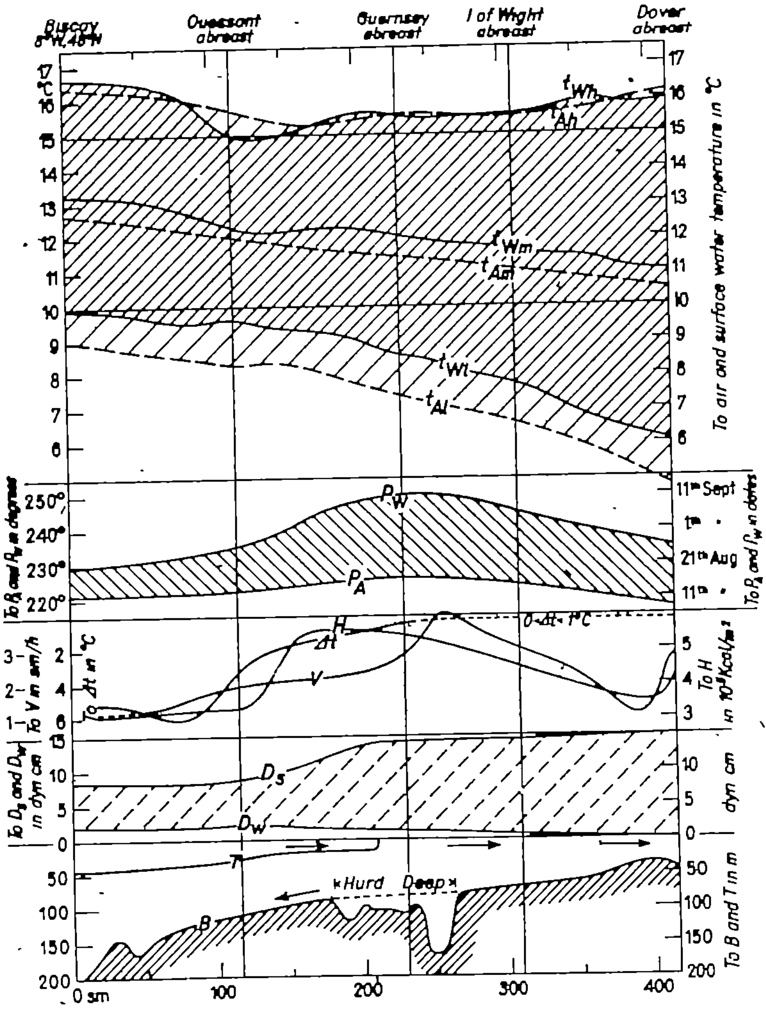

Fig. 1. Some oceanographic and climatic elements in the English Channel along the line following the axis of greatest depth (nearly the line 48° N., 8° W.–51° N., 1½° E.)

B, Bottom topography in metres.
T, Depths of the thermal discontinuity layer in summer in metres.
Δ*t*, Difference of water temperature surface minus bottom in summer in °C. (intensity of discontinuity layer).
→, Observed main direction of sea currents.
D_s, Mean geopotential topography of the sea-surface relative to the 100-decibar surface in dyn. cm. in summer.
D_w, Mean geopotential topography of the sea-surface relative to the 100-decibar surface in dyn. cm. in winter.
//////, Mean annual variation of geopotential topography D_s–D_w.
H, Annual variation of heat content in 10^5 k.cal./m.².
V, Mean maximal spring velocity of tidal streams in sm./h. (knots).
P_A, Phase in degrees of cosine wave or in dates of setting-in of max. temperature of the mean annual variation of air temperature.
P_W, Phase in degrees of cosine wave or in dates of setting-in of max. temperature of the mean annual variation of surface water temperature.
\\\\\\, Phase difference P_W–P_A in degrees or days.
t_{Am}, Annual mean air temperature in °C.
t_{Ah}, Maximal mean air temperature in °C.
t_{Al}, Minimal mean air temperature in °C.
t_{Wm}, Annual mean surface water temperature in °C.
t_{Wh}, Maximal mean surface water temperature in °C.
t_{Wl}, Minimal mean surface water temperature in °C.
////, Annual variation of air temperature in °C.
//////, Annual variation of surface water temperature in °C.

surface. In early summer, at the time of the greatest rise in temperature, the water in the central part of the Channel is considerably cooler than the air, whereas in late autumn, at the time of the greatest fall in temperature, the water is considerably warmer than the air. In consequence, the meteorological conditions essential for the formation of fog and mist are produced in early summer, while, on the other hand, the formation of fog and mist will be rendered more difficult in late autumn. From the observations recorded in Fig. 2, this is impressively confirmed. The lighthouses Les Hanois and Casquets are at open places in the central part of the Channel, Les Hanois west of Guernsey, and Casquets west of Alderney. In order to establish a comparison, reference has been made to the hours of fog at the Seven Stones light-vessel near the Scilly Isles. Unlike the observations in the central part of the Channel, they show an unimportant annual variation. In the Channel there is an unusual abundance of fog in June/July—involving various dangers for shipping—and an extraordinary absence of fog in October/December. This climatic peculiarity of the Channel is seen to be attributable to the influence of the mixing process of the tidal streams.

The effect brought about by the tidal mixing process, however, accounts for a part only of the anomalous conditions. This becomes particularly evident when the annual variation of heat content in the sea is considered. Curve *H* in Fig. 1 indicates the quantity of heat in 10^5 k.cal./m.² stored up from the time of minimum heat content in winter until the time of maximum heat content in summer, and relates to the compensated bottom topography *B* without taking account of the Hurd Deep. In the western part of the English Channel, this curve rises from 3 to 5·5 × 10^5 k.cal./m.², and over most of the Channel it maintains a value of more than 4 × 10^5 k.cal./m.². These values are not confined to the longitudinal direction indicated in the diagram but extend over the major part of the width of the Channel.

That the situation is unusual will become evident when the components of the heat balance are studied. In Fig. 3 their complete annual variation at the western entrance and in the central part of the Channel is represented; the appropriate calculations were based on methods developed by H. U. Sverdrup[3] and F. Albrecht[4]. The expression is $Q_s = Q_r - Q_b - Q_e - Q_s$ (the legend of Fig. 3 explains these symbols). At the western end of the Channel the quantity of heat which is needed to explain the observed course of temperature throughout the water column down to a depth of 140 m. (Q_t) attains a comparatively close approximation to the local heat balance between ocean and atmosphere (Q_s). The differences between Q_t and Q_s may be conditioned by both the horizontal turbulence of heat and the annual variation of the course of the current. In the central Channel, on the other hand, where Q_t refers to 0–80 m., it is considerably greater than Q_s. The paradox thus occurs that the increase in heat content Q_t is greater than permitted by the radiation of the sun and the sky Q_r. Furthermore, a comparison between the two diagrams in Fig. 3 shows that the values of the vertical heat balance Q_s differ markedly between the

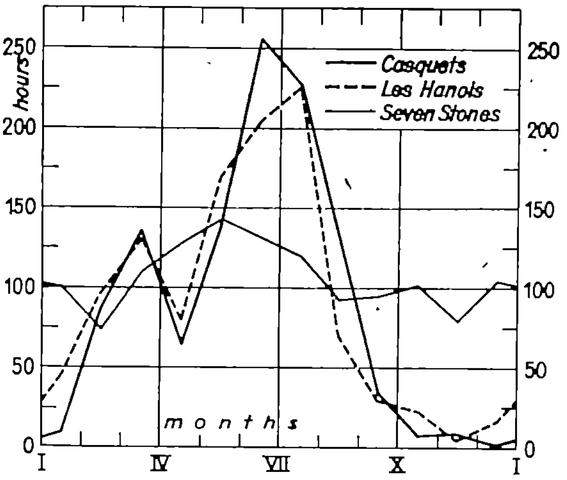

Fig. 2. Mean hours of fog per month in the central part (Casquets and Les Hanois) and in the western entrance (Seven Stones) of the English Channel
(Casquets Lighthouse, 49° 43′ N., 2° 33′ W.; Les Hanois Lighthouse, 49° 26′ N., 2° 45′ W.; Seven Stones Light Vessel, 50° 04′ N., 6° 05′ W.)

two areas. In the central part of the Channel the water receives more heat from the atmosphere in spring and summer than it does at the western end of the Channel, which is, above all, due to the fact that the evaporation heat Q_e remains small. The evaporation heat saved helps to increase Q_s. The unimportant degree of evaporation in the central Channel, as well as the frequent occurrence of fog, are conditioned by the negative difference between water temperature and air temperature. This, as has already been shown, is closely related to the mixing process of the tidal streams. These high values of Q_s cannot, however, sufficiently explain the observed variation of temperature as shown by Q_t; also, the horizontal eddy conductivity of heat is of little avail in this connexion. The horizontal temperature differences remain unimportant, and there are no extensive areas of shallow water as in the Irish Sea. There the shallows contribute very warm water in summer and cool water in winter by way of a horizontal eddy conductivity; in so doing they further the heat exchange in the Irish Sea; as has been shown by K. F. Bowden[5].

The combined effect of water balance and tidal mixing in the Channel is expected to help greatly in unveiling the causes of the anomalous value Q_t in Fig. 3, and of curve H in Fig. 1. From numerous current observations by J. N. Carruthers[6], it is well known that a current flows in a west–easterly direction through the upper layers of the Channel. Yet only a small proportion of the water entering the Channel passes the Straits of Dover; the major portion of it leaves again at the western end. Observations made by J. N. Carruthers[7] and H. W. Harvey[8] with a system of drift bottles on the sea bottom support these views. The arrows in Fig. 1 show this circulation system.

In winter, this type of water balance does not exert any essential influence on the heat balance. The water is then isothermal from the surface down to the bottom, and the inflowing water has equal or similar temperatures to the outflowing water. Hence the amount of heat conveyed into the Channel approximates to that carried out of it. In summer, however, the very warm water of the surface layer flowing into the Channel from the Bay of Biscay is mixed by strong tidal streams with the whole water column. The relatively cool mixed water which flows back again out of the Channel carries less heat with it than was carried in by the inflowing water. As a result, there occurs a horizontal current of heat with an annual period that is effective only in spring and summer, when there exists a thermal layering outside the western entrance of the Channel. This heat current provides the Channel with approximately 2×10^{18} k.cal., which sufficiently explains the anomalies of H and Q_t.

It need scarcely be said that this combined effect of the water balance and tidal mixing process also plays a part in the oceanographical and meteorological factors mentioned at the beginning of this article, but it is difficult to make a quantitative separation. Another phenomenon represented in Fig. 1 is elucidated now that the horizontal supply of heat has been taken into account, namely, the curve of the annual mean temperature of the surface water, t_{Wm}. This falls from the Bay of Biscay to the area abreast of Ouessant, which is in good agreement with the conditions normally ruling in the neighbourhood of the Continent. Next follows an unimportant rise in temperature with, finally, farther to the east, another decrease, though less marked than at the beginning. The course of the air temperature t_{Am} reflects the water-temperature curve but shows a less modulated fall with progress to the eastern Channel. This behaviour of the annual mean values may be regarded as the effect of the heat supply, which, as was explained before, is the result of the conjoint effects of the tidal mixing process and the water balance. Damping of the annual variation, delay in the setting-in of the annual extreme values, and increase in the annual means of the air temperatures, are the phenomena which entirely determine the favourable climatic conditions in the Channel. These could not possibly occur in this form did not the mixing caused by the tidal streams exercise its influence.

In addition, the high annual variation of the heat content in the Channel exercises influences of an especially oceanographic character, as a result of which the specific volume of the whole water column

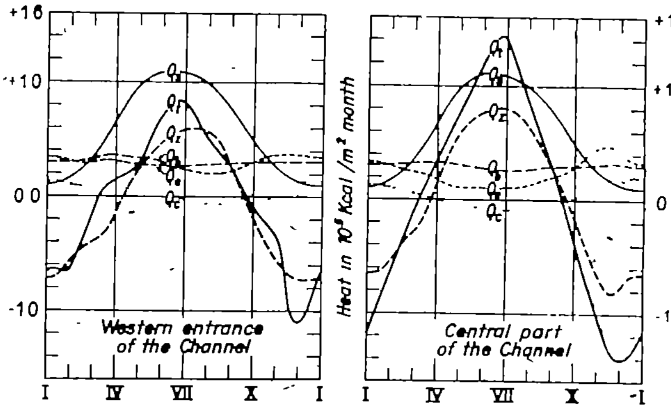

Fig. 3. Mean heat budget of the water of the English Channel in two examples. Q_s, heat absorbed from incoming radiation from sun and sky; Q_b, heat lost by back radiation from the sea surface; Q_h, heat lost by convection of sensible heat to the atmosphere; Q_e, heat lost by evaporation; Q_v, heat balance in vertical direction: $Q_v = Q_s - Q_b - Q_h - Q_e$; Q_t, heat used for explaining the observed annual temperature variation of the water from surface to bottom

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inside the Channel has a higher annual variation than that of the area outside. It follows that the geopotential topography of the sea surface is subject to greater changes in the course of a year. D_S in Fig. 1 indicates its situation in summer, and D_W in winter. Both are referred to the 100-decibar surface. D_S–D_W, which amounts to 6 dyn. cm. outside the western end of the Channel, reaches 13 dyn. cm. in the central part of the Channel. From this it follows that there is a change in the gradient of the geopotential topography, especially in the section Ouessant/Guernsey, as can be seen in Fig. 1. The increase of D_S and the concurrence of the Coriolis forces provoke a cyclonic component of motion superimposed on the general drift current and driving the inflow towards Brittany, and the outflow towards Cornwall. In winter, the situation is reversed; then, the decrease of D_W contributes to the formation of an anticyclonic component of motion, which drives the inflow towards Cornwall and the outflow towards Brittany. Observation confirms this annual change in the circulation system of the water masses. According to the monthly charts of surface salinity by J. R. Lumby[9], the tongue of water of high salinity and reaching from the Bay of Biscay to the western Channel advances as far as Brittany in summer and as far as Cornwall in winter. The low-salinity water of the Bay of St. Malo, urged by the anticyclonic component of motion, advances in winter to the west beyond Ouessant; in summer, on the other hand, the cyclonic component of motion drives it back into the inner part of the Bay of St. Malo.

A series of causal relations could be quoted which, in the end, could all be traced back to the effect of the tidal mixing process. This may be expected to prevail similarly in other areas having pronounced tidal streams, such as the Irish Sea, the Minch Channel, the waters north of Scotland, and the southern North Sea, where the effect of the tidal mixing process on the layering of the water has been proved[10]. Thanks to the large and varied mass of observations available, the English Channel appeared to be particularly well suited for demonstrating the influences which tidal streams exert on oceanographic and climatic conditions.

[1] Hansen, W., *Deutsch. Hydr. Z.*, 3, 169 (1950).
[2] Dietrich, G., *Deutsch. Hydr. Z.*, 3, 184 (1950).
[3] Sverdrup, H. U., *Ann. Hydr. Marit. Met.*, 64, 41 (1936).
[4] Albrecht, F., *Reichsamt Wetterd. Wiss. Abh.*, 8 (Berlin, 1940).
[5] Bowden, K. F., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, 5, 270 (1948).
[6] Carruthers, J. N., *J. Mar. Biol. Assoc.*, N.S., 17 (1930); *Fish Invest.*, (II), 11 (1928); 14 (1936).
[7] Carruthers, J. N., *J. Mar. Biol. Assoc.*, N.S., 14 (1927).
[8] Harvey, H. W., *Cons. Int. Exp. Mer, Rapp. Proc. verb.*, 37 (1925).
[9] Lumby, J. R., *Fish. Invest.*, (II), 14 (1935).
[10] Dietrich, G., *Kiel Meeresf.*, 7, 85 (1950).

STRUCTURE OF CLATHRATE COMPOUNDS*

By H. M. POWELL

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THAT certain of the chemical elements will unite together to form new substances, their chemical compounds, is well known and to some extent explained. It is also known that a compound capable of a separate existence of its own may combine with an element and that two such compounds may unite by simple addition: $L + M \rightarrow LM$.

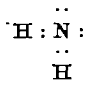
Some time ago, the conviction formed that the ordinary manifestations of these interactions between old substances to form new are the outward signs of inner rearrangements of atoms that make up the invisibly small units of both old and new. Since it became apparent that atoms are not the indivisible units that their name states them to be, the explanation for the bonding of one with another has been sought in the interaction of their component parts. The essentially electrical structure of the atom with some of the pieces positively or negatively charged has been demonstrated, and, since similar charges repel each other and dissimilar charges are mutually attracting, the supposition arose that these interactions could cause atoms to hold together.

Although the law of force between charges is simple, its application to the whole complex system of electrical charges in uniting atoms is difficult, and the problem is for the most part treated by approximate methods. The linkage of atoms is related to the disturbances of a few of their negatively charged electrons, which are sometimes spoken of as being farther than others from the centre of the atom. These electrons are less firmly bound to the positive nucleus than some of the inner ones which partly screen them from the nuclear charge, and in a complex atom they form only a small part of the whole. Their rearrangements by transference from one atom to another or sharing between them provide the binding forces.

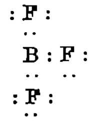
Certain groupings of electrons, notably a completed outer group of eight, are particularly stable. This is illustrated by the known sequence of atoms according to the number of electrons surrounding the nucleus. Atoms, which in the uncombined state already have the stable configurations, have no chemistry; they are the so-called inert gases, helium, neon, argon, krypton, xenon and emanation, and they are commonly stated to form no compounds; their electrons do not need any rearrangement. Much of the simpler chemistry of the neighbouring atoms in the atomic number sequence is interpreted as the rearranging of their electrons to form similar stable groups around atoms which in their uncombined state do not have them.

When transference of an electron takes place, the atoms become positively or negatively charged, according to their loss or gain of electrons, and the resulting ions are mutually attracted, as are other oppositely charged bodies. Atoms may complete the desired stable groups by sharing what they have when one or both are deficient in electrons.

When a particular atom has a stated set of electrons, and some of the outer ones are shared to form two or more bonds, the directions in space of the bonds relative to each other are fixed. They adopt one or other of a number of known patterns, and from this they vary little, whatever may be the nature of the groups that they bind to the atoms concerned. Electron sharing usually results in the build-up of some familiar stable group; but even when the more urgent electronic requirements of combining atoms have been satisfied, and a stable compound formed, there remain further possibilities of combination. For example, of the molecules of ammonia (NH_3) and boron trifluoride (BF_3),



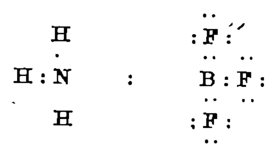
$$\begin{array}{ccc} & \mathrm{H} & \\ & \cdot\cdot & \\ \mathrm{H}: & \mathrm{N} & : \\ & \cdot\cdot & \\ & \mathrm{H} & \end{array}$$



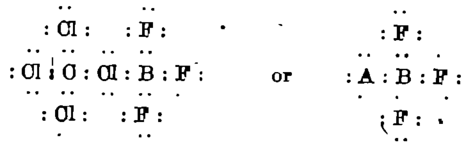
$$\begin{array}{ccc} & \dot{} & \\ : & \mathrm{F} & : \\ & \cdot\cdot & \\ & \mathrm{B} & : \mathrm{F} : \\ & \cdot\cdot & \cdot\cdot \\ : & \mathrm{F} & : \\ & \cdot\cdot & \end{array}$$

* Substance of a Friday Evening Discourse entitled "Atoms Encaged—A New Type of Compound" delivered on April 28.

the former has for all atoms an inert gas electronic arrangement which is helium-like for hydrogen, neon-like for nitrogen; in the latter, the group of six electrons around the boron atom is stable, but it can be increased to eight by addition of NH_3 to give:



If the paper drawings of electronic dots alone were needed, this process could be extended: for example,



But these atomic linkages do not take place. Such compounds of argon and boron trifluoride were reported, but their existence has been disproved. This form of sharing does not happen because too much energy is required to make argon or even xenon give up a share of its electrons.

A further type of linking, which causes the union of molecules, is known as the hydrogen bond. For the present purpose it is sufficient to say that it forms only between a few groups, commonly between hydroxyl (OH) groups, and although not so precisely limited in space arrangements, the directions of hydrogen bonds are restricted in a manner analogous to that of the electron-pair bonds.

For some substances formed by the addition process $L + M \rightarrow L.M$, it is inevitable that for a time there should be a meaningless full stop inserted between L and M; it must be emphasized that this does not represent an electron. Although many addition compounds are eventually fitted into the known scheme of interatomic bonding, there exist many crystalline molecular compounds for which no formulation is apparent, and the suspicion arises that between the molecules there is no chemical binding of any of the kinds already described.

These associations of molecules are attributable to parts of the total interatomic forces so far neglected. Between all molecules, additional, usually much weaker, forces come into play. They arise because the centres of positive and negative charges do not at all times coincide. Some molecules have permanent, some transient, dipoles or multipoles. There is a more restricted use of the term, but for convenience, all these residual attractions may be grouped together and called van der Waals forces. As a result of their operation, a multitude of substances draw their electrically neutral molecules together into crystalline forms. These forces are strong enough to hold atoms of the non-combining inert gases in crystal structures that exist at suitable low temperatures.

In a mixture of molecules, it happens, fortunately, that all those of one kind will often gather together. From an assortment of different molecules, stable regular patterns are built by the segregation of identical shapes. Sometimes, however, two substances do not crystallize separately in this way, but together make a crystalline molecular compound. In these structures, which often bear little resemblance to those of the components when they crystallize in the pure state, there are no links between the two kinds of molecules. This is shown by the observed interatomic distances, which are much greater than those commonly found between linked atoms. As an example, there is a molecular compound of *p*-iodoaniline with *s*-trinitrobenzene, one molecule of each. The two kinds of molecules pack together according to a regular repeating space pattern similar to those formed by single pure substances.

In other molecular compounds there is the same co-operation of the two components, but in some series the structural arrangements of one component dominate the whole. Thus if a paraffin is added to a saturated solution of urea in methanol, a crystalline compound is formed immediately. It consists of urea molecules arranged so as to form a structure resembling a honeycomb. In the long channels of the honeycomb the paraffin molecules are located, and if molecules of different lengths are used, different ratios of urea to paraffin are found. In general, they are not whole-number ratios and the formula is $n\text{Urea}.H$, where n is proportional to the length of the hydrocarbon molecule H.

In these uniting pairs, one partner at least is a solid when pure at ordinary temperature, at which the molecular compounds are prepared. The other is a solid or liquid. Sometimes, especially if one participant is a very volatile liquid, the molecular compound decomposes when allowed to stand in the open. A substance with van der Waals forces between its molecules so weak that it is normally a gas is therefore not likely to form similar compounds.

But a hundred and two years ago Wöhler prepared an addition compound of quinol and sulphur dioxide. He gave the composition as $3C_6H_4(OH)_2.SO_2$, and reported that it did not lose the normally gaseous sulphur dioxide on standing, but that on solution the sulphur dioxide was lost and quinol recovered. During the next sixty years, similar compounds were obtained with quinol, and a second substance such as hydrogen sulphide, hydrogen chloride, hydrogen bromide, hydrogen cyanide or formic acid. In some, the ratio of the second substance to quinol is less than 1 : 3. This is also the case with some recently added members of the series (acetylene and carbon dioxide); but others (for example, methanol and methyl cyanide) reach the 1 : 3 ratio, which is never exceeded.

There being none of the bonds mentioned earlier and, for the most volatile of these second components, no great van der Waals attractions between the components, how can these crystalline compounds exist? Why at ordinary temperatures have they no significant dissociation? What accounts for the unusual 1 : 3 ratio and its variations, and on what basis does quinol choose certain companion molecules and reject others? How, in the series that starts with water (HOH) and passes through methanol (CH_3OH), ethanol (C_2H_5OH) to the higher alcohols, is methanol alone singled out for such combination?

Application of the very penetrating method of X-ray crystal structure analysis has provided the answers. By this method the positions of all atoms in the crystal array are accurately found. Quinol molecules of the shape and size expected are revealed in the structure sufficiently separated from the other component to show that there is no chemical bonding to it. A set of these molecules link together through hydrogen bonds between their hydroxyl groups. Six oxygen atoms of six different quinol molecules form a plane hexagon. Alternate quinol molecules incline upwards or downwards from this and are linked in a similar manner through their other hydroxyl group to form a structure of the giant molecule type. This structure may be likened to the steel frame of a large building. Each girder represents a quinol molecule, and the points where six such girders meet should be replaced by a hexagon to correspond with the hydrogen-bonded hexagons. Two identical frames of this kind form and interpenetrate. They are in no way linked by chemical bonds, but are inseparable without the breaking of chemical links. This arrangement may be seen as two identical steel frames, not joined, but arranged such that the junctions of girders in one are at the centres of the rooms in the other.

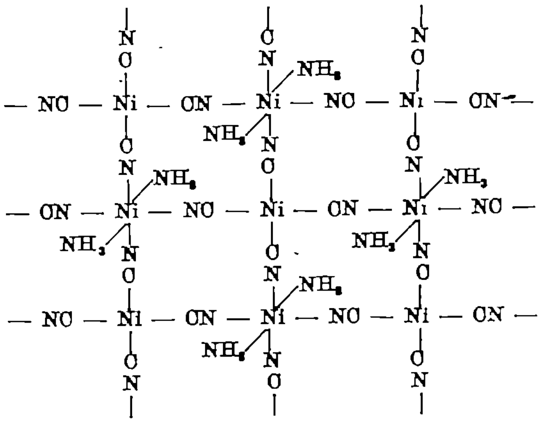
The double quinol structure is still not a very close-packed one, and between the two giant molecules there is a set of cavities, each a roughly spherical empty space of about 4 A. diameter. In these spaces reside the molecules of sulphur dioxide or other substances which form these molecular compounds. The molecule once trapped in this space cannot escape. As it approaches the walls of its cage, large forces of repulsion between it and the walls are set up. There are no holes in the surrounding structure large enough for it to escape without coming much closer than the normal van der Waals contact distance to the atoms of the quinol molecules. The structure is different from that formed by quinol itself in the absence of any molecules suitable for enclosure. Every gas molecule has one of the set of identical molecular envelopes around it. Although there will always be van der Waals forces of attraction between the cage and its occupant, these forces, which in any case are insufficient to do it, are not necessary to ensure the permanent association of the two substances. The sulphur dioxide can be released by heating, but only as a result of the breaking of the hydrogen bonds, and sublimation of quinol. Similarly, it is released when the material is dissolved in any solvent for quinol.

The chemistry of such compounds now becomes clear. There are three molecules of quinol in the material of the cage structure for every cavity formed. This explains the formula *M*.3 (quinol). It is a limiting composition, since some cages may be left empty. The selection of molecules that take part in the compound formation now loses its miscellaneous character. The enclosed molecule must be small enough to go into the space available and large enough not to escape through the available holes, the largest of which is the hexagon of oxygen atoms bound by hydrogen bonds. For this reason methyl cyanide (CH_3CN), methanol (CH_3OH), acetylene (C_2H_2) and carbon dioxide (CO_2) seemed possible participants, and proved to be so. Ethanol (C_2H_5OH) is too large; water (H_2O) is too small. The compounds with argon, krypton and xenon have been prepared by crystallizing quinol solutions in the presence of the inert gases, which are used at suitable pressures to increase the solubility. The pressures need not be very high, and if other conditions are properly controlled the argon compound can be made at 10 atmospheres or less. The products consist of crystals often a centimetre across and easily distinguishable from ordinary quinol.

Although it seems likely that many such enclosure compounds may exist, it is difficult to predict which pairs of substances will form them; but if a compound which is already known belongs to this class, there are characteristics by which it may be provisionally detected.

The series of compounds formed from ammoniacal nickel cyanide solution and a small group of organic substances provides an example. The composition is $Ni(CN)_2.NH_3.M$, where *M* is benzene, thiophene, furan, pyrrole, aniline or phenol. There is no obvious manner in which benzene may be linked to the nickel cyanide complex. The metal —C≡N— metal sequence of atoms, which may well be suspected in the cyanide complex, is a suitable cage-forming component. Homologues of benzene and of the other molecules do not form such compounds. The thiophene compound has only about a third of the thiophene indicated by the formula.

Examination by X-ray methods of the crystalline benzene compound shows that the main component of the structure is an extended two-dimensional array of groups which form a flat network:



To every other nickel atom there are attached two ammonia groups projecting above and below the network. One set of nickel atoms is surrounded by four carbon atoms in a square pattern, and the other by four nitrogen atoms of CN groups, and two ammonia groups, the six nitrogen atoms forming an octahedron.

This complex has a rigid flat structure with projecting ammonia groups which prevent the close approach of two layers. Although staggering of the projecting ammonias would make possible a closer packing, no arrangement can avoid a considerable amount of empty space. By the inclusion of a benzene molecule in each of a set of cavities left between layers, there results a structure which, as a whole, is well packed. All the molecules which are capable of combining in this way have shapes and sizes very similar to those of benzene.

The behaviour of these compounds may be applied in the chemical processes of separation, identification and quantitative analyses. They provide new and striking ways of preparing pure materials. The ordinary methods of fractionation lead to products which are likely to contain impurities of very similar physical properties to the desired substance. Further separation, for example, of two isomeric hydrocarbons of almost identical boiling point, can be extremely difficult. It is precisely at this stage of difficulty that a method of separation based on some entirely different factor is required. Two substances of such close similarity of physical properties may yet differ strikingly in the geometrical form of their molecules. Thus a paraffin may be of the straight-chain or branched-chain type. These may be separated by use of the urea compounds, because the straight chains fit into the honeycomb whereas the branched isomers cannot; but the separation of chains of different length is not a structural necessity. In clathrates, as these compounds are termed, the cage is of restricted size and, if suitable structures can be found, molecules of different lengths should be separable.

Benzene which is already of reasonable purity may be further rid of impurities, probably *cyclo*hexane, by formation of its nickel cyanide ammonia complex, which is later decomposed. A single crystallization of this kind gave a large yield of benzene, which contained 99·992 ± 0·004 molecules per cent. The ideal in this type of chemical work should be to 'tailor a suit' for any desired molecule, which could then be obtained as a molecular compound; this compound could then be removed as unwanted or used as a source of the required material.

The purification process is further illustrated by some experiments in the separation of the inert gases. No ordinary chemical componds of these elements are available for a separation, and the usual method takes advantage of their different boiling points in a fractional distillation process. Argon may be separated from neon by adjusting the pressure conditions such that the argon forms the compound with quinol but neon does not. The gases krypton and xenon, which both form compounds with quinol, may be separated in a different manner. Since the solubility is higher for xenon, there is a greater chance for xenon to become enclosed. A mixture containing krypton and xenon in the proportions of 3 : 1 was used in the standard method of preparation; the gas liberated from the crystals contained about one part by volume of krypton to three parts of xenon.

ENGINEERING EDUCATION AND TRAINING

THERE has been much controversy in recent years on the education of the engineer. An unusual feature of the discussions is that engineers have taken relatively little part. That this is not due to lack of interest in the subject is shown by the fact that during the Joint Engineering Conference held during June 4–15 in London, a whole day was devoted to papers dealing with the education and training of the engineer.

During the morning of June 13, at the Institution of Civil Engineers, Prof. J. F. Baker read a paper on "The Development and Trend of University Education in Engineering", and this was followed by "The Contribution of the British Technical Colleges to Engineering Education", by Dr. H. L. Haslegrave. As was to be expected at a Conference having as one of its objectives the recording of the contributions made during the past century by engineers to the advancement of civilization, both authors devoted considerable attention to the history of technical education in Great Britain.

While the origins of the technical colleges in Great Britain go farther back than a hundred years, to a welfare movement for working men and neglected youths and to the founding of the Society of Arts in 1754, the universities, in all but one of which there are now flourishing engineering schools, came into the field much later. It was not until a third of the nineteenth century had passed that courses of lectures, described as "Civil Engineering", were given in the University of Durham and in University College and King's College, London, and not until 1840 was any real attempt made to establish a balanced course of fundamental science and practical application.

In 1851 there existed only five university schools of engineering in Britain, chairs having been established at Glasgow, Dublin and Belfast, while the courses at Durham had been wound up. In the next twenty-five years four more were added, Owens College, Manchester, and Armstrong College, Newcastle upon Tyne, being founded, while the Universities of Edinburgh and Cambridge established chairs of engineering. It was shortly after this, between 1878 and 1890, that the most striking blossoming of advanced educational facilities occurred; no less than nine chairs of engineering being established in this period. In almost all cases the colleges owed these foundations to the generosity and ideals of local men; but they all had financial difficulties. More serious was the dual part all but Cambridge were called upon to play; the Government Department of Science and Arts instituted in 1858 having provided by means of grants a great stimulus for skilled craftsmen to attend evening classes, all other schools were centres of evening as well as day work. While the evening class students undoubtedly brought in that enthusiasm which is still so marked in the technical colleges, the dual responsibilities inevitably had repercussions on research and scholarship in the universities. Only gradually were the two activities separated and, in fact, in several cases this separation has still to be effected.

During 1900–14 the story of engineering in the universities is one of continuous and steady development, although hampered by lack of funds in spite of State aid. As in other fields, the First World War had appreciable repercussions. Apart from the sharp rise in numbers, the main effect seems to have been indirectly through changes in industry, which at last realized the advantages to be gained from the application of science to production and design problems. More universities stiffened their courses to three years post-intermediate and delayed specialization until the final year; but only Oxford and Cambridge persisted in giving an all-embracing course to a high level in the firm belief that their products possess a versatility and balance of mind which enable them to strike out with equal facility along any line they may be called upon to pursue.

The most striking change brought about by the Second World War was the doubling of the number of students, an expansion which must at least be maintained if the universities are to shoulder the responsibility of supplying the 'engineer-scientists' and development engineers needed by industry. There is evidence that the universities are alive to their responsibilities and are responding to them with a flexibility which a study of the last thirty years would scarcely lead one to expect. A number of universities are questioning the value of the formal experiments in the laboratory courses and are introducing small investigations and projects in the final year as a means of encouraging initiative and a methodical approach to new problems. Alarm at the inability of students to think and write logically has led in some colleges to formal instruction in the presentation of technical information, and in others to the use of discussion-groups; and there are other healthy signs of encouragement to undergraduates to achieve a better general education.

While all this development was taking place in Great Britain in the universities, where students get their education in the relatively easy way, the determination of the workers in industry to improve their knowledge of their work brought about an even more striking increase in the number of technical colleges. These were created from the earlier mechanics institutes from 1870 onwards, first by means of voluntary effort and later with government financial help. Evening classes were not the only activity; by 1914 there was a considerable volume of part-time day release of engineering apprentices throughout Great Britain, and this was increased after the First World War when the National Certificate scheme was born. One of the values of this scheme is its flexibility, and the syllabuses, subjects and standards have since been kept constantly under review by the Ministry of Education, the professional engineering institutions and the staffs of the colleges. Teaching of a high order has been assured for part-time students, resulting in the securing of recognized qualifications and through them of membership of the professional institutions. When the output of engineering graduates in Britain is compared unfavourably with those of other countries, the products of our senior technical colleges, which have no parallel abroad, are too often forgotten.

Since 1931 many new colleges have been erected; but this expansion has always lagged well behind the needs of industry. Since the War, two of the Percy Committee recommendations have been adopted, namely, the formation of national colleges, four of which are now in existence, and the setting up of regional advisory councils for further education. These councils have had little time to make any impression other than the production of the controversial scheme for the creation of a Royal College of Technologists. What is likely to have a greater effect upon the progress of technical colleges is the revision of salary scales which came into effect on April 1 last. Up to now the staffs of the colleges have worked with a surprising devotion and resourcefulness for woefully inadequate salaries.

In introducing his paper, Prof. Baker directed attention to a most important recent development in university education, namely, the establishment of postgraduate courses of instruction which generous help from the University Grants Committee has made possible at Birmingham, Cambridge, Edinburgh, Glasgow, the Imperial College of Science and Technology, Leeds and Sheffield. These courses have been designed for engineers whose experience in industry has concentrated their attention on relatively narrow fields. The student will choose that university which has organized a course in the particular field of his interest, and there he will return, not to do research but to attend advanced lectures, to read under supervision and to engage in laboratory work under conditions not generally available in industry and, above all, to learn how to apply science. This scheme should have far-reaching effects, integrating as it does teaching and research activities. Primarily in the interests of the undergraduate courses, the teachers engage in research or consulting work. When that makes them leaders in their particular field, they obtain extra facilities to enable them to organize postgraduate courses of instruction. The students attending these will be mature men coming straight from industry. They will contribute quite as much as they receive, so that the departments' research and undergraduate teaching will both benefit; neither will become too academic and a healthy balanced state will develop.

In the discussion that followed, in which engineers from Holland, Belgium, Australia and New Zealand joined, this scheme was applauded. Its economy over the possible alternative of extending the undergraduate course for a fourth year was stressed, and it was welcomed for its encouragement to make the undergraduate course more general. The opinion of the Conference, expressed particularly by Colonel B. H. Leeson, who opened the discussion, and Dr. Livingstone Smith, was solidly in favour of the universities making their undergraduate courses general and fundamental on the present Cambridge pattern. Prof. R. L. Lickley, while in favour of the postgraduate courses, gave the serious warning that, judging from the experience of the National College of Aeronautics, industry would not avail itself of the new opportunities. Others taking part in the discussion urged the need for a study of teaching methods, for more attention to the education of those destined to become managers, for more places in university engineering departments for the good all-round man who is in danger of extinction, and finally a strong plea was made for the granting of greater academic freedom for technical colleges.

The teaching of engineering presents peculiar difficulties compared with other subjects, because it is essentially an applied science, and practice can never be ignored. This side of the problem was dealt with in two more papers, "Practical Training of Civil Engineers" by Mr. H. J. B. Harding, and "Practical Training of Mechanical and Electrical Engineers" by Sir Arthur Fleming. Both authors gave interesting accounts of the evolution of practical training and of the schemes which are now available. Because engineering employment is diverse, no one single scheme can cover adequately the general needs of the whole profession, nor can a single scheme cover the individual needs because the entrance levels to the profession are different. It was interesting that both authors advocated an increase in the facilities for 'sandwich' courses based on works training. Certain institutions, notably the University of Glasgow, so arrange their courses that the students can spend five months at a stretch in or on works. Mr. Harding has had such men working for him. At the end of the five-months period, they leave an unexpected vacuum behind them in the organization. Mr. Harding suggested that selected colleges should establish double-sandwich courses of, say, five and a half months each. The employer could then engage students in pairs, and as each half-year's course ends they could change places so that one is always available. He then somewhat ingenuously stated that, as the total number of students would not increase, no great increase in teaching staff would be required. No university teacher could go on indefinitely teaching for eleven months in the year; but there is something in the scheme where an institution wishes to double the number of students turned out. It would mean doubling the teaching staff—no easy task to-day—but would entail no addition to its buildings, equipment or appreciably to its laboratory staff.

Though Capt. A. M. Holbein, in opening the discussion, was able to say that he detected an awakening of interest among industrial companies as well as among individuals, and a sense of responsibility for giving an all-round training as was done by the ancient trade guilds, this was not supported by the other contributors to a somewhat disappointing discussion.

The impression left by the papers and their reception was that Great Britain can deal successfully with the education and training of the technician and the general run of professional engineer, the classes who form the backbone of industry. There is a strong partnership between the technical colleges and the engineering industry, and, though there is plenty of room for better equipment and more generous treatment of teachers in the colleges, they are doing good work and will continue to do this and even better so long as they have the determination to develop their own methods and do not ape the universities. The problem industry has not solved is how best to treat the product of the university. No one denies the urgent need for a steady supply of these highly educated men, and everyone at the Conference agreed that the universities in their undergraduate courses should concentrate on the fundamentals of general engineering science; but this is less than half-way to making the men engineers able to use all their talents. Something more is needed than a two-year graduate apprenticeship followed by the usual haphazard and extravagant method of obtaining experience. The only certain way a young man now has of being given a real chance to develop fully is to be born the son of an engineering magnate. This is a restricted class, and unless leaders of industry and the professions are prepared to 'adopt' more young men from the universities rather than just to use them, then fewer and fewer of the best products will turn devotedly to engineering, ignoring the easier paths open to other scientific workers and the attractions of other professions where the training is better organized and the rewards and social standing are higher.

OBITUARIES

Mr. László J. Havas

László Jenő Havas died on June 9 at Colmar, in Alsace, after an operation. He was born in 1885, of Hungarian nationality, and studied at Budapest and at several other universities; he also worked at Rothamsted Experimental Station. He was a man of wide culture, and an excellent linguist. The problem which primarily interested him was the relationship between plant and animal cancer; and many of his publications testify to his interest in tumours and other plant abnormalities induced by *Bacterium tumefaciens* and chemical agents. It is not widely realized that Havas was the first to apply colchicine in such investigations (*Nature*, 139, 371; 1937); and it was while he was in Brussels in A. P. Dustin's laboratory that he discovered the effect of colchicine on cell-division that has had wide repercussions in genetical work. This was announced at the Congress of Anatomists held at Marseilles in March 1937. (An account of early researches with colchicine has been given by J. M. Krythe and S. J. Wellensiek, *Bibliographia Genetica*, 14, No. 1, 1; 1942).

Havas regarded as his principal paper that on the gradual evolution of polyploidy and other changes in *Pelargonium zonale* (*Bull. Acad. Roy. Belgique*, (5), 28, 318; 1942); but with this also he was unfortunate. Published during the German occupation of Belgium, it attracted little notice except from the Nazis, who destroyed all reprints. Havas suffered under two despotisms, and lost all his belongings in Brussels and Budapest, including his library. After the War he found asylum in France and existed precariously on grants; but his Belgian-born widow is left unprovided for. There were no children.

Hugh Nicol

Dr. I. E. Balaban

Isidore Elkanah Balaban, head of the Pharmaceutical Research Department of the Geigy Company, Ltd., Manchester, was killed on May 23 when he fell between a train and the platform on alighting at London Road Station, Manchester.

Dr. Balaban showed an early aptitude for scientific work. During the First World War, he served with the Manchester Regiment and later the Special Brigade, Royal Engineers. He then returned to the College of Technology, Manchester, and after graduation, became research assistant to Dr. F. L. Pyman. He worked on glyoxalines and took his M.Sc. and Ph.D. degrees. On Pyman's recommendation he secured a temporary post at the National Institute for Medical Research, Hampstead, where he collaborated with Dr. Harold King in problems of chemotherapy involving the preparation of analogues of Bayer 205 and a study of their substantive properties, glyoxalines containing arsenic and gold compounds.

Balaban then entered on an industrial career, joining first of all the staff of May and Baker, Ltd., under Dr. A. J. Ewins, and ten years later he left to take up a post in the research department of Imperial Chemical Industries, Ltd., at Blackley, thus fulfilling a desire to return to his native city. While in Manchester he was awarded the degree of D.Sc., and he joined the Geigy Company, Ltd., in 1941 to develop the pharmaceutical side of the firm's activities. During these years in commercial firms, Balaban published a number of scientific papers, all having a bearing on chemicals of potential use in pharmacy or medicine.

Balaban was a keen worker in the field of medicinal chemistry and avidly kept in touch with all the latest developments. Of unassuming nature, he surprised his most intimate friends by his love of ornithology and horticulture; thus he thought nothing of paying a visit to St. Kilda to see the sea-birds in their natural surroundings. He will long be remembered by his friends and colleagues for his enthusiasm and honesty of purpose, and many will mourn his untimely end.

We regret to announce the following deaths:

Prof. R. St. A. Heathcote, formerly professor of pharmacology in the Welsh National School of Medicine, on May 19, aged sixty-two.

Prof. F. Marguet, *correspondant* for the Section of Geography and Navigation of the Paris Academy of Sciences, and formerly professor of astronomy in the Naval School of Brest, at Villeneuve-Loubet, on June 2, aged seventy-six.

Mr. G. Udny Yule, C.B.E., F.R.S., formerly University lecturer and reader in statistics, University of Cambridge, on June 26, aged eighty.

NEWS and VIEWS

Radio-Astronomy at Manchester:
Prof. A. C. B. Lovell, O.B.E.

Dr. Alfred Charles Bernard Lovell has been appointed to a newly created chair of radio-astronomy in the University of Manchester. Dr. Lovell was born in 1913 and entered the University of Bristol in 1931. In 1936 he was appointed assistant lecturer in the Physics Department at Manchester; he was made lecturer in 1945 and reader in 1948. During the war years, Lovell was occupied with radar research in the Telecommunications Research Establishment, and accompanied this famous institution in its war-time wanderings from Bawdsay via Dundee and Swanage to Malvern. He was particularly concerned with the development and installation of airborne radar in the air force, and his services were recognized by the award of an O.B.E.

Soon after returning to Manchester in 1945, Lovell set up a radar set, on loan from Anti-Aircraft Command, in the courtyard of the University and began an investigation of radar echoes from meteor trails. Soon driven out of the city area by electrical interference, the radar set was transferred to a field at Jodrell Bank in Cheshire, near the University Botanical Station. Five years later, aided by generous financial support from the University and the Department of Scientific and Industrial Research, there has come into being a large and well-equipped research station, with some eighteen research workers engaged in many branches of the new subject of radio-astronomy. The Jodrell Bank Research Station is now, and will remain, an integral part of the Physical Laboratories of the University, of which the director is Prof. P. M. S. Blackett. Together with the pioneer work of J. S. Hey, of the Ministry of Supply Operational Research Station, and of Martin Ryle at Cambridge, radio-astronomy is now in a very flourishing state in Britain. Among the important contributions from Jodrell Bank has been a detailed survey of meteor activity, which led to the discovery of very intense summer showers occurring in daylight and so unobservable by visual means. This work has greatly changed our present picture of meteor activity. The first radar echoes from the aurora borealis stream were made at Jodrell Bank in 1949. Quite recently, radio noise from the Andromeda Nebula has been detected and shown to be of the same order of magnitude compared with visual light as for our galaxy.

Textile Chemistry at Manchester:
Mr. F. Scholefield

Mr. F. Scholefield is retiring from his position as head of the Department of Textile Chemistry in the Manchester College of Technology on reaching the age limit. He was first appointed, as lecturer in textile chemistry, in 1926. Prior to that he had been one of Prof. A. G. Green's first students in the Department of Colour Chemistry and Dyeing at what was then the Yorkshire College, Leeds. After a short period in Read Holliday and Sons, Ltd.'s dyehouse at Turnbridge, he became chemist to Francis Hinde and Sons, Ltd., at Norwich, and then, successively, chief chemist to Henry Ashwell and Co., Ltd., Nottingham, R. P. Lawson and Sons, of Manchester, and in 1912 to Burgess Ledward and Co., and later manager of their dyehouse. At the Manchester College of Technology he initiated the comprehensive work on the action of light on cotton dyed with vat dyes, for which he was awarded the Research Medal for 1928–29 of the Worshipful Company of Dyers. This work has become classical, and his research work was further recognized in 1947 by the award of the Gold Medal of the Society of Dyers and Colourists, of which he is now president, in recognition of his "Exceptional Services to the Society in the advancement of Tinctorial Technology both in theory and practice". Still more recently he has been awarded at the Brighton Conference of the Textile Institute last May the Institute's Medal for distinguished services to the textile industry. Under Mr. Scholefield the Department of Textile Chemistry in the College of Technology has risen to the front rank in both teaching and research, and he leaves it with a reputation in industrial circles that fully justifies its position in the Faculty of Technology of the University of Manchester.

Gold Coast College of Arts, Science and Technology:
Appointments

The Secretary of State for the Colonies (Mr. James Griffiths) has announced the following appointments in the new Gold Coast College of Arts, Science and Technology: Prof. J. P. Andrews, vice-president and professor of physics in University College, Ibadan, Nigeria, to be principal-designate; Mr. R. Pattison, head of the Department of Engineering and Building, South-East Essex Technical College, to be head of the Engineering Department. The Gold Coast College of Arts, Science and Technology is being established at Kumasi, and work is in progress on the permanent buildings. The College is to be an autonomous institution, complementary to the Gold Coast University College, and will provide courses of higher technical education (including engineering) and teacher-training. Two hundred students of the Achimota Teacher Training College and a hundred other students are expected to move to Kumasi to start the new College this month. A sum of £350,000 has been allocated under the Colonial Development and Welfare Acts for capital expenditure on the College—which is likely to be in the region of £2,000,000.

Prof. Andrews, who is forty-nine, was educated at Leyton County High School and Queen Mary College, University of London, where he obtained his B.Sc. in 1921 and D.Sc. in 1931. He has been professor of physics at Ceylon University College and has carried out research on problems of the ionosphere. During 1939–44 Prof. Andrews was head of the Physics Department in Bradford Technical College, and among other duties was responsible for organizing a scheme for training Service personnel in radio. He then became assistant professor of physics in Queen Mary College, University of London, and in 1949 was appointed to University College, Ibadan. Mr. Pattison has been head of the Department of Engineering and Building at the South-East Essex Technical College since 1943. After holding lectureships in mechanical engineering at Birmingham and Leicester Technical Colleges, he was appointed head of the Engineering Department at Burnley Municipal College in 1938, and superintendent of classes to the Board of Industrial Training, Trinidad, in 1940.

Spotlight on Science

Thirty or more years ago the means of promoting the layman's interest in science took the form of articles containing details of simple experiments which the layman could carry out at home. To-day, increasing awareness of the social impact of science has changed the nature of popular science journals and now they usually seek to explain not only the mechanics of important scientific discoveries but also their significance for man and society. This is well brought out in a new journal called *Spotlight on Science*, which has been written by Dr. J. Gordon Cook for "the man in the street and his family". The first issue of this journal consists of notes and articles on such topics as bee behaviour, prospecting in Antarctica, high-frequency radio, fluorine, computing machines, mono-sodium glutamate, meteorology, the extraction of elements from sea-water, and the effects of environmental conditions on human beings. Each article is well written and shows that the author has taken considerable pains over the details of his information and the means of making it clear. Nine useful photographs add to the attractiveness of the journal; but these would have been more effective if spread throughout the whole journal rather than concentrated in the first half. Details of the journal may be obtained from the Merrow Publishing Co., Ltd., 23 Ganghill, Guildford, Surrey.

Bollettino dell'Istituto di Alimentazione e Dietologia

THE first number of the bulletin of the Institute of Nutrition and Dietetics, Rome, was issued in August 1950 and includes a description of the work that the Institute proposes to undertake (*Bollettino dell'Istituto di Alimentazione e Dietologia*, 1, No. 1, August 1950; pp. 56. 1, No. 2, October 1950; pp. 64. Rome: Editore 'Il Pensiero Scientifico). It appears that the founders of the Institute were fully alive to the ramifications of the subject of nutrition, for the work envisaged ranges from experimental food production to fundamental laboratory studies in physiology and biochemistry, and includes food technology, catering and dietetics in health and disease. The Institute is also to offer courses in nutrition at various levels, intended for medical officers, nurses, teachers, administrators, economists, agriculturalists, catering officers and cooks, and also non-technical courses for the man-in-the-street and the housewife. All these plans are in concordance with the resolutions adopted by the United Nations Food and Agriculture Conference at Hot Springs in 1943 and repeatedly re-emphasized by the Food and Agriculture Organization ever since. If these plans can be adequately carried through, Italy should be able to evolve and maintain a scientific food policy from which her people would derive great benefit. But to what extent this Institute will be able to influence government policy remains to be seen. The first two issues of the bulletin present reports of work already in progress (for example, on protein levels and albumin/globulin ratios in cases of gastric or duodenal ulcers or carcinoma of the digestive tract) and also diet sheets and recipes for therapeutic use. The second issue also includes very full extracts of the publication by the Food and Agriculture Organization on calorie requirements.

Blight-resistance in Potato

DR. WILLIAM BLACK, working at the Scottish Plant Breeding Station, Edinburgh, has produced several potato varieties resistant to attack by blight, *Phytophthora infestans*. He describes, in a recent paper (*Proc. Roy. Soc. Edinburgh*, B, 64, Part 2, No. 10; 1950), the occurrence of three strains, A B and C, of the fungus. Strains B and C are more virulent than the common strain A, from which they probably arose by mutation. Specialized strains of blight may, under test conditions, alter in virulence; but each can be maintained in continuous culture on a host plant to which it is specially adapted, without appreciable change. This mutability of pathogenic fungi is an incubus to the plant breeder; but Dr. Black now reports breeding experiments for resistance to all three strains. The existence of three genes is postulated: *Rb*, conferring resistance to strains A and B; *Rc*, resisting A and C; and *Rbc*, giving resistance to all three. Each gene is independent of the other in producing its effect, and is inherited independently in simple Mendelian fashion, though there is an excess of recessive individuals. The wild species *Solanum demissum* provides the source of resistant genes.

University Education and Subsequent Careers

AN excellent pamphlet, "Introduction to a University" (pp. 47; 1951), has been issued by the University of Birmingham and is designed to assist some of those who now have the chance of a university education but have had little opportunity of finding out what are the essentials of such an education. The greater part deals with the various careers open to university graduates in science and the humanities; but the pamphlet starts with a brief account of the main ideas about universities in general at the present time, especially as they relate to the undergraduate. This is followed by some account of the University of Birmingham itself and of undergraduate life at that University. There is a section on qualifications for admission to the University of Birmingham, and some information on salary scales in various careers is appended.

1950 Conference of British Universities

A REPORT of proceedings at the Conference of the Home Universities, held at the University of London during December 15–16, 1950, has now been published (pp. 119; London: Association of Universities of the British Commonwealth, 1951; 1*s*.). It includes the text of addresses by Profs. W. Fisher Cassie, T. S. Simey, Sir Lionel Whitby and R. D. Waller at the session on "The University as a Regional Focus", by C. E. Escritt and T. R. Henn at the session on "National Service and the Universities", and by Dr. G. V. Allen and Sir Ronald Adam at that on "Overseas Students in British Universities", as well as summaries of the discussions.

University of London: Appointments

DR. BERNHARD KATZ, reader in experimental physiology in University College, has been appointed to the University chair of biophysics tenable in University College from January 1, 1952. The following titles have been conferred in respect of posts held at the places mentioned: professor of applied mechanics in the University on Dr. Hugh Ford (Imperial College of Science and Technology); professor of technical optics in the University on Dr. W. D. Wright (Imperial College of Science and Technology); professor of veterinary physiology in the University on Dr. E. C. Amoroso (Royal Veterinary College); professor of veterinary pathology in the University on Mr. T. J. Bosworth (Royal Veterinary College).

Leverhulme Research Fellowships, 1951

THE following awards for research, tenable for periods up to two years, and for the subjects mentioned, have been made by the trustees of the Leverhulme Fellowships: *Fellowships:* T. J. Dunbabin, fellow and reader in classical archæology, All Souls College, Oxford (Greece and the Orient in the eighth and seventh centuries, B.C.); Dr. R. F. Fortune, senior lecturer in anthropology, University of Cambridge (investigation of change in central New Guinea highlands societies since pre-conquest observations in 1935); Miss P. M. Kemp, formerly lecturer, University of Allahabad (household economy and technology of some tribal communities, Punjab); M. C. K. Tweedie, Laboratory of Human Nutrition, University of Oxford (statistical estimation problems in non-Gaussian distributions). *Research Grants:* Miss B. de Cardi, assistant secretary, Council for British Archæology (an exploratory survey of prehistoric sites on the eastern borders of Baluchistan); Mrs. S. Davis, Extra-Mural Department, University of Manchester (agriculture in Cheshire, 1750–1850, in relation to contemporary industry); R. C. Ellis, education officer and headmaster, Basutoland High School, Maseru (Basotho indigenous songs and verse); J. M. Hartog, joint reader, Oxford and Cambridge Spitsbergen Expedition, 1951 (photographic and cartographic work in connexion with the Expedition); E. M. Jope, Department of Archæology, Queen's University, Belfast (economic geography of the Oxford region in the Middle Ages); Dr. W. G. Keyworth, East Malling Research Station (hop diseases in the United States and current research on *Verticillium* wilts); Miss J. M. Lambert, Leverhulme Research Fellow (ecological investigations into the vegetation in the region of the Norfolk Broads); G. F. Mitchell, fellow and tutor in geology, Trinity College, Dublin (plant fossils from late-glacial and post-glacial deposits in the British Isles); T. B. Mitford, lecturer in humanity, University of St. Andrews (continuation of archæological research in Cyprus); Dr. J. Needham, Caius College, Cambridge (completion of a study of science, scientific thought and technology in the Far East). Further information can be obtained from the Secretary, Leverhulme Research Fellowships, 3–5 Salisbury Square, London, E.C.4.

Kalinga Prize for Scientific Popularization

AN international annual prize of £1,000 sterling for the best works of scientific popularization has been established by Mr. M. B. Patnaik, an Indian industrialist, and will be awarded under the auspices of Unesco. The prize will bear the name of Kalinga, the empire which covered part of India and Indonesia three centuries before the Christian era, and which was conquered by the Emperor Asoka, who resolved, on the occasion of his conversion to Buddhism, never again to resort to the use of armed force. In co-operation with the International Council of Scientific Unions, Unesco will draw up and publish the rules for competition for the prize; and the first award will be made in 1952. Further information can be obtained from Unesco, 19 Avenue Kleber, Paris XVI^e.

Announcements

PROF. A. A. HALL, Zaharoff professor of aviation in the University of London and head of the Department of Aeronautics, Imperial College of Science and Technology, has been appointed director of the Royal Aircraft Establishment, Farnborough, in succession to the late Mr. W. G. A. Perring. Prof. Hall worked at Farnborough during 1938–45, before going to the Imperial College (see *Nature*, August 19, 1944, p. 234).

THE honorary degree of D.Sc. of the University of Birmingham has been conferred on Sir James Chadwick, master of Gonville and Caius College, Cambridge, Sir Robert Davis, inventor of the Davis submarine escape apparatus, and Sir John Simonsen, director of research, Colonial Products Research Council.

DR. G. L. S. SHACKLE, reader in economic theory in the University of Leeds, has been appointed to the Brunner chair of economic science in the University of Liverpool.

THE following appointments have recently been made in the University of Sheffield: Dr. M. A. G. Kaye to be lecturer in biochemistry; Dr. W. S. Bullough to be honorary lecturer in zoology.

DR. A. M. MACBEATH has recently been appointed lecturer in mathematics in the University College of North Staffordshire. The following have been appointed assistant lecturers in the subjects shown: E. M. Yates and Dr. Monica M. Cole (geography), Dr. D. E. Davies and A. A. Shepherd (physics), T. H. White and H. Spedding (chemistry), Ruth M. Badcock (biology), F. Moseley and R. Barrass (geology).

THE Adams Prize for 1949–50 of the University of Cambridge has been awarded jointly to the following, for essays on the subjects mentioned: Dr. G. K. Batchelor ("The Theory of Homogeneous Turbulence"); Mr. W. R. Dean ("Problems in the Motion of an Incompressible Viscous Fluid"); Dr. L. Howarth ("Some Aspects of Boundary Layer Theory").

THE British Welding Research Association announces the following appointments: Dr. Nicol Gross, to be assistant director of research, while remaining in charge of the Association's research station at Abington; Dr. K. Winterton and H. E. Dixon, to be chief metallurgists, the former for ferrous metals, and the latter for non-ferrous metals; C. L. M. Cottrell and P. T. Houldcroft, to be assistant chief metallurgists for ferrous and non-ferrous metals respectively.

SIR WILLIAM TAYLOR, a member of the Nature Conservancy and formerly director-general of the Forestry Commission, has been appointed a member of the National Parks Commission to fill the vacancy created by the resignation of Mr. E. W. Wimble.

THE first two volumes of the proceedings of the polarographic congress, held in Prague during February (see *Nature*, March 24, p. 464), are now ready. Volume 1 contains forty-four communications, in English, German, French or Italian, sent as contributions to be published in honour of Prof. J. Heyrovský's sixtieth birthday (about 550 pp.), and abbreviated papers presented at the Congress in Russian, German, English or French (about 200 pp.). Volume 2 presents a full bibliography of polarography (1922–50), revised by Prof. Heyrovský and his collaborators (about 250 pp.); Russian polarographic publications are quoted in Russian characters. Inquiries about these volumes should be sent to Orbis-Export-Import, Prague I., Národní 37, Czechoslovakia.

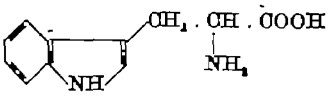
INTERMEDIARY METABOLISM OF TRYPTOPHAN

By Dr. C. E. DALGLIESH, Dr. W. E. KNOX* and Dr. A. NEUBERGER, F.R.S.
National Institute for Medical Research, Mill Hill, London, N.W.7

CONSIDERABLE advances have been made in recent years in our knowledge of the metabolism of tryptophan, and the experimental results suggest a general similarity of the enzymic reactions concerned in mammals, insects, fungi and bacteria. From the cumulative evidence obtained in studies with these widely different organisms, it would appear that the following represents one major pathway of tryptophan metabolism: tryptophan → formylkynurenine → kynurenine → 3-hydroxykynurenine 3-hydroxyanthranilic acid → nicotinic acid. In spite of the large volume of work in this field, much remains to be done on the elucidation of the enzyme systems involved, on the identification of postulated and as yet unknown intermediates, and on the study of alternative pathways. The work to be described was undertaken to fill some of these gaps.

First Step in the Oxidation of Tryptophan

It has generally been assumed that tryptophan (I) is first oxidised to α-hydroxytryptophan (oxindolylalanine, II) and that this compound is then transformed with uptake of one further atom of oxygen to kynurenine (III). Support for this hypothesis was provided by the isolation[1] of oxindolylalanine from the hydrolysate of phalloidine, a toxic peptide present in the deathcap (*Amanita phalloides*), and also by the observation of Butenandt *et al.*[2], that (II) had some activity as precursor of the eye-pigment in mutants of *Drosophila melanogaster*. Various attempts to prepare oxindolylalanine have been made, but it was not until recently that this amino-acid has become available. Two independent syntheses[3,4] have been reported, and it has thus become possible to test this hypothesis.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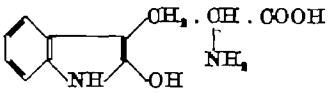
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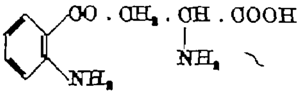
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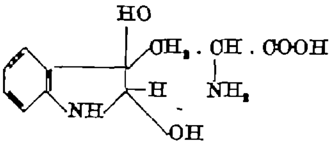
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The results obtained in this laboratory indicate clearly that oxindolylalanine is certainly not a normal intermediate in tryptophan metabolism. Thus, it has been found that the patterns obtained on paper-chromatographic examination of urines from normal or pyridoxine-deficient rats after feeding oxindolylalanine are quite different from those obtained after feeding supplementary tryptophan. After feeding tryptophan no oxindolylalanine can be detected, and after feeding oxindolylalanine none of the usual intermediates of tryptophan metabolism (see below) can be detected. Moreover, the liver tryptophan peroxidase–oxidase system of Knox and Mehler[5] was found to be quite inactive towards oxindolylalanine. Japanese workers[6] have shown that oxindolyalanine is not metabolized by *Pseudomonas* which had been adapted to tryptophan and kynurenine. Recently, Mason and Berg[7], using liver and kidney slices, have also suggested that oxindolylalanine is not a tryptophan metabolite.

There is also some doubt as to whether oxindolylalanine is, in fact, a natural product. Cornforth, Dalgliesh and Neuberger[8] have pointed out that the ultra-violet absorption of phalloidine indicates strongly that the oxindole structure is not preformed in the intact molecule, and it was suggested that the oxindolylalanine obtained on hydrolysis may be a degradation product of a 2-substituted indole. The low activity of oxindolylalanine observed by Butenandt *et al.*[2] in the eye-pigment test may still be due to an enzyme oxidizing oxindolylalanine to kynurenine in the larvæ; but it appears to us more probable that the results can be explained by the observation that oxindolylalanine, after standing in solution for some days, is largely decomposed, and among the decomposition products kynurenine may be detected.

The finding that formylkynurenine may be formed enzymically from tryptophan *in vitro* suggests that the indole ring is split oxidatively between C^2 and C^3. This may proceed by a hydroxylation mechanism giving as the first product of tryptophan oxidation 2 : 3-dihydroxy-2 : 3-dihydrotryptophan (IV)[5], which could then be further oxidized to formylkynurenine. No direct evidence for (IV) has, however, yet been encountered.

Excretion of Tryptophan Metabolites by Pyridoxine-deficient Rats

The urine of pyridoxine-deficient rats fed supplementary L-tryptophan, which has previously been shown to contain xanthurenic acid[9], is particularly rich in tryptophan metabolites. The urine obtained from pyridoxine-deficient rats fed 0·1 gm. L-tryptophan per day for one or two days was treated, after acidification and removal of insoluble material, with mercuric acetate. The precipitate was decomposed with hydrogen sulphide and the solution chromatographed on paper using (mainly) butanol-acetic acid. Under ultra-violet illumination at least nine strongly fluorescent spots appear (Fig. 1; under the conditions used tryptophan itself does not fluoresce). Strips of the chromatograms were also treated with ninhydrin, and with the reagents of Ehrlich, Hellmann[10] and Pauly. In addition, the spots were extracted into buffer (*M*/5 phosphate, *p*H 7·0, diluted 1 : 10) and the solutions examined spectroscopically. Samples of the urine were also hydrolysed with 5*N* hydrochloric acid in a sealed tube at 100° for one hour, and the hydrolysates re-examined.

Not all the spots have as yet been identified; but various conclusions can be drawn. None of the spots is given by the urines of normal rats fed similar amounts of tryptophan, or by the urines of pyrid-

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* Special Research Fellow of the United States Public Health Service

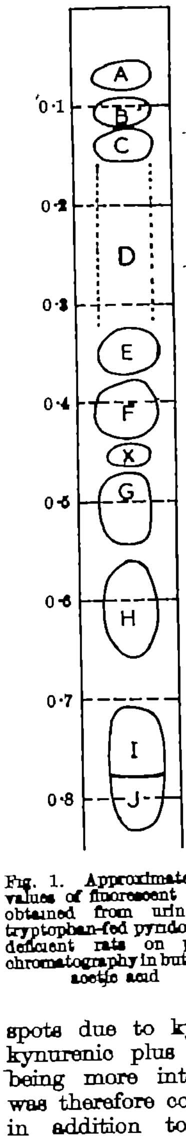

Fig. 1. Approximate R_F values of fluorescent spots obtained from urine of tryptophan-fed pyridoxine-deficient rats on paper chromatography in butanol-acetic acid

oxine-deficient rats not receiving tryptophan supplement. The conclusion is thus justified that these spots represent products of tryptophan metabolism accumulated or excreted as a result of pyridoxine deficiency.

Spot *F* is due to kynurenine, and spot *E* to 3-hydroxykynurenine. The presence of hydroxykynurenine is worthy of note. It has been found in *Calliphora*[11] and *Bombyx mori*[12]; but so far as we are aware has not previously been reported in the excretion of mammals. Its recognition in the urine of pyridoxine-deficient rats supports the concept that 3-hydroxykynurenine is an intermediate in the tryptophan metabolism of vertebrates. Spot *H* is due to a mixture of kynurenic and xanthurenic acids.

Spots *A*, *C*, *I* and *J* gave ultra-violet spectra identical in type with those of kynurenine and hydroxykynurenine. The spectrum of spot *X* resembles that of spot *H* closely, while the spectrum of *B* is somewhat similar. The assumption that *A*, *B*, *C*, *X*, *I* and *J* represent derivatives of the two kynurenines and of the two quinoline-carboxylic acids is supported by the fact that after hydrolysis only the spots due to kynurenine, hydroxykynurenine and kynurenic plus xanthurenic acids remained, these being more intense than before hydrolysis. It was therefore concluded that the urine contained, in addition to kynurenine, hydroxykynurenine, kynurenic and xanthurenic acids, comparable quantities of conjugation products of these substances. *D* is a region of weak general fluorescent and ninhydrin-positive background without outstanding spots, and *G* has as yet been little investigated but is probably also a conjugated metabolite.

The identity of spot *J* was definitely established, and the identity of spot *I* can be postulated with high probability. Spot *J* agreed in chromatographic and chemical behaviour in all respects with synthetic N^{α}-acetyl-DL-kynurenine, and the identification was strongly supported by the following experiment: A pyridoxine-deficient rat was fed at the same time 0·2 gm. L-tryptophan and 3·0 mgm. sodium acetate labelled in the methyl group with carbon-14 (36·6 μC.). A chromatogram was obtained in the usual way and the relative radioactivities of the spots were determined by a mechanical scanning technique[13]. Fig. 2 shows that the greatest radioactivity corresponds to spots *I* and *J*. It is suggested that spot *I* corresponds to N^{α}-acetyl-3-hydroxykynurenine. This is based on a comparison of the R_F values, colour reactions, and absorption spectra of spots *F* and *J* (kynurenine and its acetyl derivative) and spots *E* (hydroxykynurenine) and *I* (its postulated acetyl derivative) and is supported by the result of the above experiment (Fig. 2).

N^{α}-Acetylkynurenine has been previously isolated from a mutant strain of Neurospora[14]. The presence in urine of acetyl derivatives of normal metabolites is of some interest; but the significance of the finding cannot as yet be readily assessed.

The identity of the remaining unknown spots is at present being investigated. The following could not be detected on the chromatograms: oxindolylalanine, N^{α}-acetyltryptophan, anthranilic acid, 3-hydroxyanthranilic acid, acetylanthranilic acid, indole, skatole, indole acetic acid, indole propionic acid, indole pyruvic acid, tryptamine, *o*-aminoacetophenone, nicotinic acid, nicotinamide, nicotinamide methochloride, or quinolinic acid. Treatment of the urine preparations with formylase[5] showed no increase in kynurenine, and therefore the absence of formylkynurenine; this is to be expected owing to the ready hydrolysis of the formyl group.

Kynureninase and Pyridoxine in Tryptophan Metabolism

An enzyme in liver, kynureninase, was described by Kotake and Nakayama[15] and further studied by Wiss[16], who showed that the reaction was specific for L-kynurenine, and formed anthranilic acid and alanine. The work of Braunshtein *et al.*[17] demonstrated that the kynureninase activity was decreased in pyridoxine deficiency, and that the enzyme required pyridoxal phosphate. The possibility that the interruption of this reaction in pyridoxine-deficiency produced the abnormal accumulation of tryptophan metabolites prompted us to investigate it further.

The activity of kynureninase in liver is low, comparable to that of the tryptophan peroxidase[5], and only about 10 μmol. of kynurenine react per gm. liver (dry wt.) per hr. The long (20 hr.) reaction periods mostly used by previous investigators can be replaced

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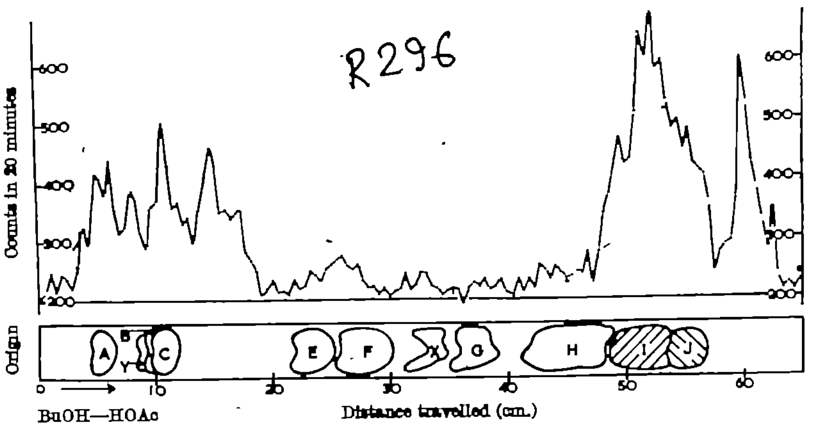

Fig. 2. Comparison of radioactivity and location of fluorescent spots on a chromatogram obtained after simultaneous feeding of tryptophan and ^{14}C-labelled acetate to a pyridoxine-deficient rat. Spot *Y* is a 'pigment' spot, not derived from tryptophan

TABLE 1. EFFECT OF PYRIDOXINE ON KYNURENINASE ACTIVITY *in vivo* AND *in vitro*

0·5 ml. of rat liver enzyme preparation plus 1·0 μmol. L-kynurenine and 0·1 ml. 0·2 *M*-borate, *p*H 8·0, in a total volume of 1·2 ml. Pyridoxal phosphate added as indicated. Deproteinized with 4 ml. of ethanol after 40 min., incubation at 38°. Initial and final determinations of kynurenine in the reaction mixtures were calculated from the absorptions at 365 mμ minus the absorptions of controls containing no kynurenine

Enzyme preparation	Pyridoxal phosphate added μgm.	Kynurenine μmol./gm. dry wt.	Disappearance μmol./ml.
Homogenates, normal rats	0	9·6 (12 animals)	
,, pyridoxine-deficient rats	0	2·7 (2 animals)	
Supernatant, dialysed (normal rats)	0		0·37
Supernatant, dialysed (normal rats)	10		0·49
Ethanol precipitated	0		0·46
,, ,,	10		0·60
Precipitated with ethanol and ammon. sulphate	0		0·18
Precipitated with ethanol and ammon. sulphate	10		0·44

by short-term experiments using more sensitive methods. We have measured the disappearance of kynurenine by the decrease in absorption at 365 mμ. Under our conditions (Table 1), the amount of kynurenine disappearing is proportional to time and to the amount of enzyme present. From the increased absorption at 310 and 330 mμ, in the same solution, can be calculated the amount of anthranilic acid and the small amount of kynurenic acid formed by the reaction. The products, alanine, anthranilic acid and kynurenic acid, have been identified by paper chromatography. Approximately twenty-fold purification of the enzyme in a liver homogenate has been obtained by the removal of insoluble material at *p*H 5, followed by ethanol and by ammonium sulphate fractionations. The enzyme from normal rats has been partially resolved by treatment with ammonium sulphate and shown to require pyridoxal phosphate as coenzyme (Table 1). The kynureninase activity was markedly decreased in pyridoxine-deficient rats. These findings confirm those of Braunshtein *et al.*

The purified kynureninase preparation also splits hydroxykynurenine to analogous products and at roughly the same rate as L-kynurenine (compare ref. 18). Acetylkynurenine, however, is acted upon only after it is hydrolysed to kynurenine by a deacetylase present in liver and still not completely separated from our best preparations of kynureninase.

These actions of kynureninase, dependent upon pyridoxine, could account for the accumulation of kynurenine and hydroxykynurenine in pyridoxine-deficient rats given tryptophan. Of additional interest is the persistent formation of small amounts of the quinoline carboxylic acids, apparently by the same reaction. Approximately the same proportion of total degraded kynurenine goes to form kynurenic acid by the action of either crude or purified enzyme. Furthermore, it was found that the amount of kynurenic acid formed could be increased by the addition of excess pyruvate to the reaction, without a comparable increase in the total kynurenine disappearing. The degree of increase possible in this way was similar in both crude and purified enzymes (Table 2). The lack of summation and the parallelism with crude and purified enzymes in yields of the two aromatic products derived from kynurenine suggest that kynurenic acid is a by-product of the same set of reactions which form anthranilic acid and alanine from kynurenine.

TABLE 2. KYNURENIC ACID FORMATION AS A BY-PRODUCT IN THE KYNURENINASE REACTION

Experimental conditions as in Table 1, with the addition of 10 μmol. of lithium pyruvate as indicated

Enzyme preparation	Kynurenine disappearance μmol.	Kynurenic acid formed μmol.
1. Crude liver supernate	0·49	0·06
,, ,, ,, +pyruvate	0·53	0·13
2. Ammon. sulphate fraction	0·57	0·01
,, ,, +pyruvate	0·62	0·16
3. Ethanol and ammon. sulphate fraction	0·90	0·33
,, ,, ,, +pyruvate	0·88	0·67

The mechanism of the kynureninase reaction has not yet been elucidated. The possibility that alanine is formed from kynurenine by two transamination reactions, in the way that alanine arises during tyrosine metabolism[19], is excluded by the finding that neither the addition of α-ketoglutarate nor of pyruvate is necessary for the reaction, even in the most purified preparations. These experiments did, however, reveal the effect of pyruvate, and to a lesser extent that of α-ketoglutarate, in increasing the proportion of kynurenine going to kynurenic acid. If kynurenic acid is formed as a by-product of the main kynurenine reaction this would be indirect evidence for an intermediate deamination of kynurenine to an α-keto acid, as opposed to the direct fission of kynurenine. The mechanism would involve the formation of the α-keto acid corresponding to kynurenine and its hydrolysis to anthranilic acid and pyruvate. The deamination of kynurenine to its keto acid, and the reamination of the pyruvyl fragment to form alanine, could occur through a cyclic transamination of the coenzyme for the reaction, pyridoxal phosphate. Excess pyruvate would then hasten the regeneration of pyridoxal phosphate, and increase the deamination of kynurenine. Some of the unstable keto acid accumulating under these conditions would form kynurenic acid by ring closure before it could be hydrolysed.

We are greatly indebted to Prof. A. Butenandt for a specimen of synthetic hydroxykynurenine and for making available to us prior to publication the paper by Dr. H. Hellmann, and to Dr. W. W. Umbreit for a gift of pyridoxal phosphate.

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REDUCTION OF FERROUS OXIDE

By O. H. GELLNER and Dr. F. D. RICHARDSON

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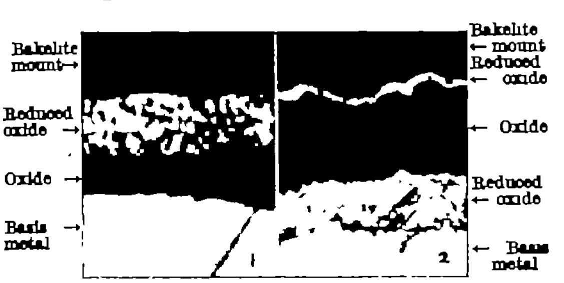
SINCE most of the previous research on the reduction of iron oxides has been carried out on ores and other poorly controlled and impure materials, we started some time ago on a systematic investigation of the reduction of the oxides of iron. So far the investigation has only properly covered the reduction of polycrystalline layers of wüstite—the non-stoichiometric ferrous oxide approximating to the composition $Fe_{0.95}O$ when in equilibrium with iron. These were prepared on polycrystalline strips of Swedish iron. The impurities in this metal totalled 0·3 per cent, of which 0·15 per cent was manganese and 0·04 per cent tungsten. Although not complete, the results so far obtained are of considerable interest. The work is being continued and it is intended to publish a full report elsewhere at a later date.

Layers of wüstite approximately 10^{-2} mm. thick were prepared by passing controlled mixtures of hydrogen and water vapour over strips of the iron at 900° and 950° C. The layers were then reduced in hydrogen at temperatures ranging from 600° to 1,000° C. The kinetics of the reduction were studied by collecting and weighing the water produced, and the mechanisms followed by microscopic examination. Reduction of the specimens could be arrested at any desired stage by drawing them into a cool part of the furnace, where they were rapidly quenched to room temperature.



Wüstite layer on iron partially reduced at (1) 700° C. (× 850) (2) 950° C. (× 650)

Photomicrographs of cross-sections of two typical specimens after partial reduction are shown. At 700° C. (Fig. 1) reduction of the wustite layer proceeds, as would be expected, from the surface inwards, a spongy layer of iron being produced. At 900° C. and above (Fig. 2) a very thin film of iron first forms on the oxide surface; but its growth soon ceases. Virtually all the reduction then proceeds outwards from the interface where the basis metal meets the oxide layer. At intermediate temperatures reduction proceeds simultaneously inwards from the surface and outwards from the metal. The results with different specimens at each temperature were consistent and reproducible.

One would have expected that reduction at all temperatures would have proceeded from the surface inwards. The fact that it proceeds outwards at the higher temperatures indicates that layers of wüstite grown under our conditions have some unexpected properties.

It appears to us that the most simple explanation consistent with all the facts is that the oxide in the immediate neighbourhood of the basis metal is less stable than the oxide on the surface and that there is a gradation of stability across the layer. This might be due, for example, to strain, which has commonly been shown to occur in oxide films[1], and which might be expected to decrease gradually with distance from the metal. On this hypothesis the course of reduction would be as follows: (1) removal of oxygen by hydrogen from the surface of the oxide with resultant supersaturation of the oxide with iron; (2) nucleation of this excess iron to form a thin layer of massive metal on the surface; (3) retardation of further reduction by the surface metal, which restricts access of hydrogen to the oxide and the diffusion of water vapour away from it; (4) diffusion of the excess iron, produced in the outermost layers of oxide by the continuing reduction, into the body of the oxide; (5) when the temperature is high enough and the diffusion rapid enough, preferential growth of massive iron outwards from the basis metal, where the oxide is least stable.

Steps (1)–(3) inclusive are clearly operative at all temperatures and their mechanisms do not need further discussion here. Step (4) might take place both by movement of excess iron atoms towards the basis metal via the vacant iron lattice sites normally present in wüstite (about 5 per cent in equilibrium with massive iron) and by movement of oxygen atoms towards the surface to fill the vacant oxygen sites produced at the surface by the reduction.

Either diffusion process would be expected to have a high activation energy and hence a high temperature coefficient. For an activation energy of 50 k.cal., for example, the diffusion coefficient could increase 85-fold between 700° and 900° C. Diffusion could therefore bring about concentration gradients of excess iron across the oxide layer which change markedly with temperature, and might reasonably have the forms represented diagrammatically in Fig. 3. The more stable oxide should require a greater supersaturation with excess iron than the less stable, before massive iron can grow continuously from it. If these supersaturation limits (c_1 and c_2) are as illustrated in Fig. 3 relative to the concentration gradients of the excess iron, the results obtained in practice would automatically follow.

In conformity with this theory we found that the course of reduction was independent of whether the oxide layers were prepared and reduced above or below the α–γ transformation temperature in iron (910° C.), or whether the substrate metal was oxidized completely away. In addition, we have found that if a completely oxidized specimen is annealed for a sufficiently long period to produce recrystallization,

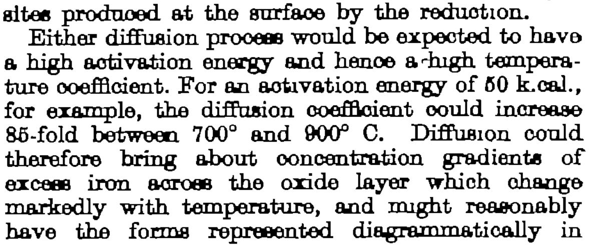


Fig. 3. Schematic representation of concentration gradients (full lines) of excess iron across the oxide layer at (a) 700° C., (b) 800° C. and (c) 900° C. c_1 and c_2 represent the super-saturation limits required for growth of massive iron at the oxide surface and the oxide–basis metal interface respectively. The broken lines suggest how these limits may vary across the layer

the grains of oxide are then reduced more or less uniformly over their entire surfaces and there is no difference in behaviour between the material near the surface and that near the centre of the strip.

Since the first layers of wüstite formed initially on iron appear to be less stable than the massive oxide, their formation must require a higher oxygen potential than equilibrium between bulk phases of metal and oxide would indicate. The phenomenon represents a new type of passivity which may well vitiate equilibrium measurements involving formation of very small quantities of a new phase on a bulk substrate. It may account for the discrepancies reported in studies of the equilibria between solid iron and liquid and solid wüstite, in carbon monoxide–dioxide and hydrogen–steam gas mixtures[2-4]. These equilibria have been studied under conditions where solid iron is just oxidized, so that in cases where the oxide formed is solid the oxygen pressure will be higher than that for the bulk phase. When the product is liquid, no such passivity should occur, so that the equilibrium oxygen pressure will be lower than the solid results would indicate, when allowance is made for the change in state. This effect may also account for the unexpected passivity reported by Chipman and Marshall[2] when treating solid iron specimens under conditions which were just oxidizing.

The work reported here was done in the Chemistry Laboratories of the British Iron and Steel Research Association while we were members of the staff of that Association. [Jan. 9.

[1] Mehl, R. F., and McCandless, E. L., *J. Amer. Inst. Min. Met. Eng.*, 125, 531 (1937).

[2] Chipman, J., and Marshall, S., *J. Amer. Chem. Soc.*, 62, 299 (1940).

[3] Darken, L. S., and Gurry, R. W., *J. Amer. Chem. Soc.*, 67, 1398 (1945).

[4] Darken, L. S., and Gurry, R. W., *J. Amer. Chem. Soc.*, 68, 798 (1946).

X-RAY SHADOW MICROSCOPE

By DR. V. E. COSSLETT and W. C. NIXON

Cavendish Laboratory, Cambridge

THE advantages of the short wave-length of X-rays may be exploited for microscopy by projecting shadowgraphs from a point source[1], the resolving power being then limited primarily by the size of the source. Electron lenses can be used for focusing the exciting beam so as to produce a point source of X-rays of very small dimensions[2]. The specimen may be kept in atmospheric conditions, and yet brought close enough to the source to give a high working magnification, if the target is in the form of a Lenard window and the transmitted X-rays are utilized[3]. The system is shown schematically in Fig. 1, where an electron lens L focuses the beam issuing from a cathode C on to the target T. An enlarged shadow of an object O is thrown on to a fluorescent screen or photographic plate S. Such an arrangement is capable of much higher magnification and resolution than the procedure adopted by Goby, Dauvillier, Engström and others[4], in which the specimen is almost in contact with the recording plate and is illuminated by a distant source of X-rays of normal size. In that case the limiting factor is the grain of the photographic emulsion, and a resolution of better than 10 microns is difficult to obtain. On the other hand, the point source is in principle limited in size only by the aberrations of the electron lens and could be made smaller than 100 A.; the exposure-time would then become in practice the limiting factor.

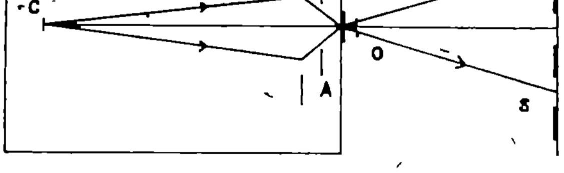


Fig. 1. Principle of X-ray shadow microscope

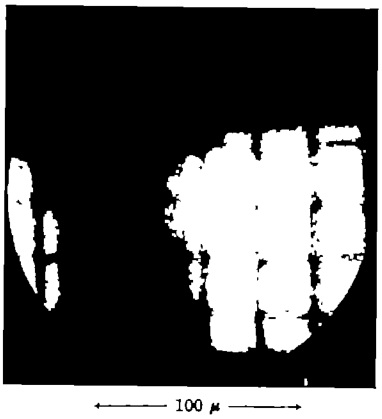


Fig. 2. X-ray shadowgraph of silver grid (1,000 mesh/in.) overlapping copper grid (200 mesh/in.) Original magnification, ×95; final magnification, ×285

An X-ray shadow microscope has now been developed, using a magnetic lens to demagnify the electron beam. The size of the spot obtained is of the order of 1 micron, when an aperture A is placed before the target to limit the electron beam and thus reduce the effect of lens aberrations. Accelerating voltages between 3 and 12 kV. have been employed, corresponding to X-ray wave-lengths of 1–4 A. The camera length is variable from 2 to 5 cm. or longer. Test results are shown in Figs. 2 and 3, taken at 10 kV. Fig. 2 shows a silver grid of 1,000 meshes to the inch carried on a 200-mesh/inch copper grid, the wires of the former being 5 microns in width; exposure time was 20 sec., primary magnification ×95. Fig. 3 shows a book louse (*Liposcelis granicola*) and part of a 1,500-mesh grid; exposure time 5 min., primary magnification ×25. As the 1,500-mesh grid is made of wires of 3 microns in diameter, the resolving power can be estimated to be of the order of 1 micron. The fine structures in the leg running across the bottom of Fig. 3 appear to be still thinner.

It appears that the resolution obtainable with a single stage of demagnification of the electron spot cannot, with existing electron lenses, much exceed 1 micron. The employment of two stages of demagnification raises no practical difficulty, but would seem to lack suitable biological specimens, owing to their low absorption of X-rays; it might be of more value for metallurgical investigations. In order to increase absorption, a lower accelerating voltage and correspondingly longer X-ray wave-length could be employed; but a vacuum camera would then be

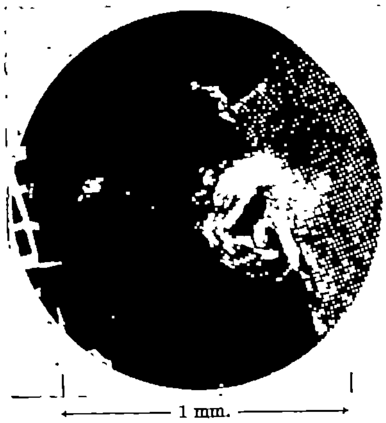


Fig. 3. X-ray shadowgraph of book louse (*Liposcelis granicola*) and silver grid of 1,500 mesh/in. Original magnification, ×25. final magnification, ×37

needed and the advantage of the specimen being in air would be lost.

The apparatus described, a fuller account of which will appear elsewhere, can also be used as a fine-focus tube for X-ray analysis. Indeed, the use of a magnetic lens is similar to that in the diffraction tubes devised by Goldsztaub[5] and by Witty and Wood[6]. It gives a much smaller spot than the fine-focus diffraction tube of Ehrenberg and Spear[7], which makes the maximum use of the electrostatic focusing action of the electron gun but employs no subsequent lens.

Thanks are due to D. A. Taylor and S. S. D. Jones, who assisted in the preliminary experiments. One of us (V. E. C.) has been supported by a Keddey Fletcher-Warr Research Studentship of the University of London (at the Electrical Laboratory, Oxford, 1939–41) and by an I.C.I. Research Fellowship (at Cambridge, 1946–49), and the other (W. C. N.) by a Scholarship of the Research Council of Ontario.

[May 3.

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[1] Sievert, R., *Acta Radiol.*, 17, 299 (1936).

[2] von Ardenne, M., *Naturwiss.*, 27, 485 (1939).

[3] Cosslett, V. E., "The Electron Microscope", pp. 72, 116 (Sigma Press, London, 1947).

[4] See Crowther, J. A., "Handbook of Industrial Radiology", pp. 151–182 (Institute of Physics, London, 1946); and Engstrom, A., "Progress in Biophysics", pp. 164–196 (Butterworth, London, 1950).

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[6] Witty, R., and Wood, P., *Brit. J. App. Phys.*, 1, 305 (1950).

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EMPIRE COTTON GROWING CORPORATION, 1921–50

A SHORT history of the Empire Cotton Growing Corporation, 1921–50, originally published in the *Empire Cotton Growing Review* of January 1951, is now available as a pamphlet. It includes a number of matters of scientific interest. The Corporation was incorporated by Royal Charter on November 1, 1921, as a result of the report of the Board of Trade's Empire Cotton Growing Committee in 1920, and was financed partly by a capital grant from the Imperial Government and partly by a levy on all raw cotton spun into yarn in the United Kingdom. Since the repeal of the Cotton Industry Act on March 31, 1948, the Corporation has received an annual grant of £18,000 from the Cotton Board.

Resembling in many ways a research association, the Corporation has concentrated mainly upon production, with its relevant agricultural and scientific problems and requirements. A first step was the training and enlistment of a scientific staff, and in this, since 1922, the Corporation has been in close association with the Imperial College of Tropical Agriculture in Trinidad. Relations established with the Shirley Institute at Manchester, by enabling plant-breeders to test new cottons at a much earlier stage, have led to a great saving of time, land and labour. Another early step was to enlist the help of scientific experts in general agriculture, soil science, genetics and plant breeding, plant physiology, entomology and plant pathology, and particular tribute is paid to the services of the late Sir John Farmer.

The agricultural and scientific policy of the Corporation has fully recognized that cotton-growing, to be permanent, must be associated with other crops in the general system of agriculture of the countries concerned. A Research Station was established in Trinidad in 1926 and closed at the end of 1944, when it was decided that the next phase of the work could more advantageously be carried out in a country producing a commercial cotton crop. A site for the new Station was found at Namulonge, Uganda, and of the estimated capital cost of £206,500 half was provided from Colonial Development and Welfare Funds, £78,250 from the Corporation's invested resources, and £25,000 from the Cotton Industry War Memorial Trust. The Corporation is to find £170,000 of the recurrent expenditure, estimated at £400,000 over the ten years from October 1, 1947, Colonial Development and Welfare Funds are providing £100,000 and the Governments of Uganda, Tanganyika, Nigeria, Kenya and Nyasaland, jointly, have promised £130,000. The Uganda climate has necessitated stationing the Cytogenetics Section at Shambat, near Khartoum. Figures are quoted to demonstrate, on the basis of record crops, the capacity of the Empire to grow more than a million bales of cotton per annum; and three-year averages show that production in the Anglo-Egyptian Sudan has increased from 23,225 bales in 1918–21 to 299,872 in 1946–49; in Uganda from 55,196 to 262,929; in Kenya from 233 to 6,574 bales; and in Tanganyika from 2,442 to 48,345 bales, for the same periods.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS

AT the invitation of the Camberley and District Natural History Society, the South-Eastern Union of Scientific Societies held its fifty-sixth annual congress at Camberley during April 26–29 under the presidency of David Seth-Smith. The local committee for the congress was under the chairmanship of Major Maxwell Knight, with Miss Jean Armitage as local secretary.

At the 'young naturalists' evening', Dr. W. E. Swinton, of the British Museum (Natural History), lectured on "Prehistoric Reptiles", illustrating his remarks with lantern slides and films. A Nature quiz competition took place between teams from the junior section of the Natural History Society and the local schools. The junior section also largely contributed to the success of an excellent nature-study exhibition by displaying specimens, examples of their field-work, notebooks and drawings.

The presidential address to the Zoological Section was given by Sir Philip Manson-Bahr, who spoke on "The Contribution of Zoology to Medicine". He dealt with the early investigations into the causes of elephantiasis and malaria and with subsequent work upon the life-cycles of the insects responsible for these and other diseases. A. J. Low gave the presidential address to the Geological Section and conducted an excursion to the Jealott's Hill Research Station of Imperial Chemical Industries, Ltd., where he demonstrated some of the points of his address dealing with soil fertility, the influence of leys, microlysimeters and soil profiles,

Mr. Seth-Smith's presidential address to the Union was on "Man's Control of Wild Animals". He commenced by saying that there are people who think that zoological gardens should not be allowed to exist, as it is cruel to confine any wild animal. Such people invariably say they do not visit the zoo because they do not approve of it. Mr. Seth-Smith said that he has always been fond of animals and so of zoos, for there one can see animals which one could never hope to see in a wild state, can study their forms and actions, and know them individually and intimately. All domesticated animals were derived from wild species, and the world is now dependent upon them for its very existence. The camel was domesticated so long ago that it is not known where its wild home was. Job possessed six thousand of them, so that they were domesticated before his time. In England the first real zoological gardens was established by Henry I at Woodstock in Oxfordshire; it was removed to the Tower of London by Henry III and was transferred to Regent's Park, London, on the formation of the Zoological Society in 1829. Zoos are of the greatest educational value, for though the student can read about animals and see their stuffed skins in museums, it is not until he observes them in the wild or in captivity that he acquires a true idea of their living form.

Dealing with the problem of how do animals feel about being in a zoo, Mr. Seth-Smith said his thirty years of experience as curator led him to think that the majority, if capable of choosing, would vote for a safe and comfortable home in captivity. Most animals in a zoo are born there or are brought in from the wilds when quite small babies. Most wild animals have their own areas in which they live, and in captivity they regard their enclosures as their territories and apparently are not particular as to their size. Scientific experts are employed to ensure the health and happiness of the animals. As an example, almost every wild animal suffers from internal parasites. The very first thing at a zoo with a new arrival is thorough examination for, and treatment of, these pests. Very few wild animals die of old age or sickness. The majority are preyed upon, while the predators when old or infirm either die of starvation or are themselves killed. In zoos they live their full lives, the span of which is longer than their chances in a native haunt. Man is the greatest enemy of all wild life; his greed, cruelty and ignorance are leading to its extermination even to-day. Wild animals are afraid of man when taken under his control; but when well treated, well fed and safe from enemies, they soon become reconciled and regard man as their protector. Some animals have been saved from total extinction by being taken into zoos and collections. Were it not for zoological gardens we should have a poor idea of the wonderful animals that share the earth with us and should have to rely chiefly upon the stories of hunters, whose chief idea was perhaps to magnify the danger in their destruction.

Other events that took place at the meeting are, briefly, as follows. Prof. F. W. Jane, as president of the Botanical Section, spoke on "Trees and Scenery", and H. H. Coghlan chose for his presidential address to the Archæological Section the theme "Aspects of Prehistoric Metallurgy in Southern England". Excursions were conducted to Frensham Pond and Haslemere Museum with Major Maxwell Knight and Francis Rose as leaders. C. D. Ovey described aspects of weather and weather forecasting, showing 'Kodachrome' slides of features of meteorological interest. He stressed the importance of relating scientific observations with those of the field naturalist and the farmer. At the general assembly the methods of developing the usefulness of the Union to its affiliated societies was discussed at length and a sub-committee appointed to formulate schemes for that purpose.

SOUTH-WESTERN NATURALISTS' UNION

ANNUAL CONFERENCE

THE South-Western Naturalists' Union held its 1951 annual Whitsuntide conference (the twenty-fourth) during May 11–14 at Taunton as guests of the Somerset Archæological and Natural History Society. It was to this Society, and particularly to the hard work of the local secretary, A. D. Hallam, in planning the programme, that the success of the conference was largely due.

A reception was held by the Mayor, Councillor W. F. Heywood, at the Municipal Buildings on the evening of May 11, and then on the following day nearly sixty members visited the Blackdown Hills under the leadership of Mr. and Mrs. Hallam. Halts were made at Priors Park Wood, Britty Common, Castle Neroche and Ashill Church. At Priors Park Wood, where many birds, including the nightingale, were heard and where several badger setts were seen, the attention of the botanists was directed to the marked influence that changes in the geological formation had upon the vegetation. On Britty Common exposures of the Upper Greensand and overlying gravels were examined by the party. H. St. George Gray conducted the party over the earthworks of Norman date known as Castle Neroche, and the interesting features of Ashill Church were explained by Mr. Hallam. In the evening, W. A. Seaby lectured on Ham Hill, where many important finds of late Iron Age and Roman date have been made; the talk was amply illustrated by lantern slides.

Most of May 13 was taken up by an excursion to the region around Minehead. In the morning, Porlock Marsh was explored, under the guidance of H. G. Hadden, for plants and animal life; and members visited the village of Bossington, after which they drove to Horner Woods and from there to Minehead. After tea the party divided; one half visited Cleeve

Abbey, which was described by Mr. Seaby, and the other half, the cliffs at Watchet, where the Keuper and Lower Lias are well exposed. The geology was explained by Mr. Hallam and Dr. Stanley Smith. In he evening Peter Scott, president of the Union, delivered his address; he explained two coloured films, one of bird life in northern Europe taken during his visit to Scandinavia in 1950, and the other illustrating experiments in netting wild geese for the purpose of ringing. In this work, nets are carried over the flock after it has settled, by means of rockets electrically exploded.

The final morning was occupied by the council and general meetings, with A. O. Rowden presiding over both. In the course of his remarks at the general meeting, Mr. Rowden alluded to the recent public enquiry into the use by the military of Braunton Burrows and to the matter of footpaths. The secretary reported that the South Western Naturalists' Union embraces at the present time twenty-one affiliated societies or sections of societies.

SILTING IN BRITISH RESERVOIRS

By R. M. PROTHERO

ARTICLES in previous issues of *Nature*[1] have stressed the need for the proper study of the relationship between rainfall and run-off in Britain, since its influence in promoting soil erosion, dependent on the vegetation cover and on the soil cover itself, may be more considerable than we imagine. There is the danger that because of the lack of spectacular examples of soil erosion such as occur in other parts of the world, we may ignore it and fail to realize its presence. As a result of this attitude, precise information is practically non-existent and it is necessary to rely on evidence which is fragmentary in nature and which has often been collected only incidentally.

Important evidence relating to the removal of soil by heavy rainfall is provided by information on the silting, caused by the deposition of this material, of British reservoirs. A survey, covering twenty-eight of the major water-undertakings in Britain, revealed in the first place an absence of any co-ordinated information. An attempt to survey the floor of a reservoir in the Tâf Fawr valley, Breconshire, during the drought of 1949 was unfortunately unsuccessful owing to the onset of rain. This would undoubtedly have provided important and precise evidence as to the rate of silting in that area.

It is possible to prevent the transport of material of large size into reservoirs by the construction of catch-pits and wreck-lodges in the tributary streams. To prevent the entry of finer material, carried in suspension during periods of high stream flow, is a more difficult problem. Such material, deposited on the floor of a reservoir, may accumulate in a short time and seriously reduce its capacity. In Great Britain examples are not so outstanding as in the United States, where in 1934 the Soil Conservation Service reported that in a survey of fifty-six reservoirs, it was found that thirteen major dams, with an average height of 30 ft., had silted up completely during an average life of twenty-nine years.

The most outstanding example in Britain known to me, of nearly a 50 per cent reduction in capacity in seventy-eight years, has already been quoted in a previous article[2]. Rates of silting vary considerably: from an accumulation during a hundred years of 6 ft. of silt on the floor of a reservoir with an area of 40 acres and an average depth of 25 ft. at the time of construction; to 6 in. accumulated over a 44-year period. In many of the reservoirs there is no marked silting at all, but in eleven out of the twenty-eight undertakings for which information was received it will become serious within the next hundred years. But even if the rate of silting is slow, we must take a long-term view of our facilities for providing water, remembering that demands on available supplies are steadily increasing. In four reservoirs built in 1798, 1830, 1876 and 1880, capacity has been reduced by 12, 12, 5·5 and 8 per cent respectively; but the situation will become serious only if an increased demand exceeds the surplus available at the present time. In such circumstances the engineer reported that it would be more practical to increase capacity by raising the top-water-level of the reservoirs rather than to attempt to remove the silt. In only one instance was there an actual reference to allowance being made for reduction in capacity by silting at the time of the construction of the undertaking. The allowance was for a 20-million gallon reduction in the case of one reservoir and of 10 million gallons each for the other two. But though allowance had been made for reduction in total capacity, several hundred tons of silt had to be removed from around the draw-off tunnel of one of the reservoirs in 1933.

The problem of silting does not appear to have been allowed for in the calculated capacities of the reservoirs now being constructed as an integral part of the hydro-electric power schemes in the Scottish Highlands. In fact, the possibility of the problem arising does not seem to have been considered. A recent article on the developments taking place[3] stated that, in addition to the influence they would exert on flood control, "The reservoirs will also act as traps for sand and silt which at the present time are washed down to the sea and in many places, particularly on the north-east coast, have filled up estuaries and harbours".

While acknowledging the benefit to Scottish harbours, it must be pointed out that this will only be attained at the expense of creating a problem in the reservoirs themselves. The dredging of a harbour would appear to be a much simpler operation than the removal of silt from a reservoir, quite apart from the interference with water supply to the turbines entailed in carrying it out.

Silting is most marked where erosion, particularly by gullying in the beds of the streams feeding the reservoirs, takes place in deposits of sand and peat. It is also a feature where glacial till, widespread in the north and west of Britain, is being eroded. In being complementary to erosion, silting is the most significant evidence available of the existence of the former. Even if silting may not become a serious problem for a hundred years or more, the time to take action to prevent it is at the present. The remedial measures necessary have been stated in previous articles; but in order that they may be planned to produce the maximum effect it is essential that a considerable body of accurate information be accumulated on the related factors of rainfall, run-off, erosion and silting.

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[2] *Nature*, 166, 584 (1950).

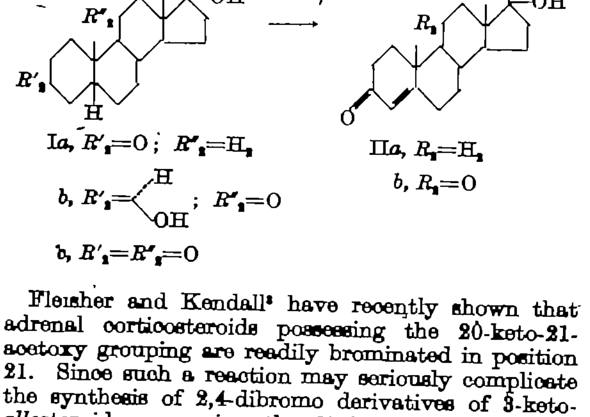
[3] *Scot. Geog. Mag.* 66, No. 2, 74 (1950).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Cortical Hormones from *allo*Steroids: Synthesis of Cortisone from Reichstein's Compound *D*

Cortisone acetate (II*b*) has so far only been synthesized[1] from bile acids which possess the 'normal' configuration at C-5 (rings *A*/*B* *cis*). Since the potentially most abundant sources, such as the steroidal sapogenins, belong to the *allo* series (rings *A*/*B* *trans*) or are readily convertible to the latter, it is important to accomplish the transformation of an *allo*steroid to cortisone. We have recently described[2] a method for the conversion of 3-keto-*allo*steroids into Δ^4-3-ketones, which involved dibromination to a 2,4-dibromo derivative, treatment of the latter with sodium iodide in acetone solution to yield a 2-iodo-Δ^4-3-ketone and subsequent de-iodination with chromous chloride, collidine or zinc. This procedure was applied successfully in the androstane, etio*allo*cholanic acid and *allo*pregnane series. The usefulness of this method for the important 17,21-dihydroxy-20-keto steroids remained to be demonstrated.



I*a*, $R'_3{=}O$; $R''_{11}{=}H_2$

b, $R'_3{=}{<}^{H}_{OH}$; $R''_{11}{=}O$

b, $R'_3{=}R''_{11}{=}O$

II*a*, $R_{11}{=}H_2$

b, $R_{11}{=}O$

Fleisher and Kendall[3] have recently shown that adrenal corticosteroids possessing the 20-keto-21-acetoxy grouping are readily brominated in position 21. Since such a reaction may seriously complicate the synthesis of 2,4-dibromo derivatives of 3-keto-*allo*steroids possessing the 17,21-dihydroxy-20-keto side-chain, we have examined the sodium iodide method[2] in the case of *allo*pregnane-3,20-dione-17α,21-diol 21-acetate (I*a*)[4]. The ketone I*a* was treated at 16° in chloroform – acetic acid solution with two moles of bromine, a small amount of anhydrous hydrogen bromide in acetic acid was added to facilitate the rearrangement of the presumable[5] initial 2,2-dibromo compound to the 2,4-isomer, and after twenty hours the chloroform solution was washed free of acid and evaporated to dryness *in vacuo*. The crude 2,4-dibromo derivative was not crystallized, but was refluxed immediately with an excess of sodium iodide in acetone solution for twenty hours. After concentrating, extracting with ether, washing with thiosulphate solution and evaporating to dryness, the residue was refluxed for half an hour in dioxane solution with 5 per cent sodium bisulphite solution. This latter de-iodination procedure proved particularly suitable for adrenal hormones of type II.

Dilution with water, filtration and recrystallization from acetone afforded Δ^4-pregnene-3,20-dione-17α,21-diol 21-acetate (II*a*) (Reichstein's compound *S* acetate) of melting point 233–235° (all melting points are uncorrected), $[\alpha]_D^{20}$ + 109° (acetone), ultra-violet absorption maximum (95 per cent ethanol) at 240 mμ (log ε, 4·36). This represents the third synthesis of Reichstein's compound *S* from readily available pregnane derivatives[6].

The synthesis of *allo*pregnane-3β,17α,21-triol-11,20-dione 21-acetate (I*b*) (Reichstein's compound *D* mono-acetate) was recently accomplished in this laboratory[7] from *allo*pregnane-11,20-dione-3β-ol, which in turn was obtained from a number of steroidal sapogenins. I*b* had a melting point of 235–237°, $[\alpha]_D^{20}$ + 66° (acetone) (calc. for $C_{23}H_{34}O_6$: C, 67·95; H, 8·43; found: C, 68·22; H, 8·73), and was correlated with Reichstein's compound *D*[8] via the 3,21-diacetate (m.p. 220°)[9]. Oxidation of I*b* with N-bromoacetamide in pyridine solution afforded *allo*pregnane-3,11,20-trione-17α,21-diol 21-acetate (I*c*), of melting point 235–237°, $[\alpha]_D^{20}$ + 78° (acetone), + 89° (chloroform) (calc. for $C_{23}H_{32}O_6$: C, 68·29; H, 7·98; found: C, 68·13; H, 7·63). Dibromination in acetic acid solution (without chloroform), as described above for I*a*, followed by dilution with water, produced a solid dibromo derivative (m.p. 150–153° (dec.); calc. for $C_{23}H_{30}O_6Br_2$: Br, 28·42; found: Br, 28·67) which without purification was carried through the sodium iodide and sodium bisulphite steps as described above. Passage of the final product through a short column of ethyl acetate-washed alumina and two recrystallizations from acetone of the benzene–ether eluates yielded colourless needles of Δ^4-pregnene-3,11,20-trione-17α,21-diol 21-acetate (II*b*) (cortisone acetate), of melting point 236–238°, $[\alpha]_D^{20}$ + 181° (acetone), ultra-violet absorption maximum at 238 mμ (log ε, 4·35). The infra-red spectrum (chloroform) was identical with that of an authentic specimen.

While the overall yield in the conversion of the ketones I*a* and I*c* to the adrenal hormones II was somewhat lower than observed earlier[2] in the androstane series, the present results clearly demonstrate the feasibility of synthesizing cortisone and other adrenal hormones from *allo*steroids of plant origin.

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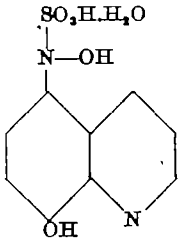
Antitubercular Activity of some 8-Hydroxyquinoline Derivatives

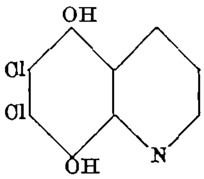
THE well-known antiseptic properties of 8-hydroxyquinoline, and particularly experiments on the use of this compound as an antitubercular agent[1], led one of us (T. U.) to prepare a few derivatives of 8-hydroxyquinoline, in order to examine their activity against *Mycobacterium tuberculosis*.

One of the products tested, *T* 28, proved to be particularly interesting due to its activity both *in vitro* and *in vivo* and to its low toxicity. The product was prepared by the action of sodium hydrogen sulphite on 5-nitroso-8-hydroxyquinoline. It proved to be monohydrate of N-sulpho-N-[5-quinolyl-8-hydroxy]-hydroxylamine (I), so far unknown in the literature.

A detailed description of the method of preparation and the proof of the structure will be reported elsewhere[2]. On boiling with concentrated hydrochloric acid, (I) was hydrolysed and, surprisingly enough, chlorinated, to yield the hydrochloride of 6.7-dichloro-5.8-dihydroxyquinoline (II).



I



II

The substance (II) also possesses strong antitubercular action *in vitro*, but experiments *in vivo* have not been carried out because of its high toxicity.

The other 8-hydroxyquinoline derivatives tested were: 5-amino-(III)- and 5.7-diamino-(IV)-quinoline. They were prepared in a new way—by reduction with sodium hydrosulphite of 5-nitroso- and 5.7-dinitro-8-hydroxyquinoline respectively. 5-Sulpho-8-hydroxyquinoline (sodium salt) (V) and 8-hydroxyquinoline sulphate (VI) were also tested and used as a standard.

The bacteriostatic concentrations were determined *in vitro* in Youmans's medium against six strains of saprophytic mycobacteria. Limits obtained for different strains are shown in Table 1.

Table 1

Substance	*T* 28 (I)	(II)	(III)	(IV)	(V)	(VI)
Bacteriostatic concentrations (mgm per 100 ml.)	5–30	2	2·5–5	2·5–15	125–250	2·5–5

Table 2 shows the toxicity to rats of substances (I)–(V).

Table 2. LETHAL DOSE (GM. PER KGM. BODY-WEIGHT)

Substance	Intravenous injection	Subcutaneous injection	*per os*
T 28 (I)	1·0	1·5	*c.* 3·0
(II)	0·02	—	—
(III)	0·06	0 11	*c.* 0·5
(IV)	0·02	0·03	0·5
(V)	1·2	2 0	*c* 5 0

The experiments carried out with Langendorf's rat's heart preparation showed that *T* 28 has no influence on the heart and coronary flow when 0·1 ml. of 5 per cent solution was administered. When given intravenously to a rabbit in doses of 50 mgm. per kgm. body-weight it caused only a small and temporary increase of the blood pressure. An injection of 50 mgm. per kgm. body-weight produced a fall of the sugar level by *c.* 20 per cent, lasting for 4 hr. Also only a very insignificant influence was observed on the peristaltic concentrations of the isolated rabbit's small intestine in a 0·1 per cent solution. No hæmolysis of rabbit red cells *in vitro* was observed.

Experiments *in vivo* were carried out by using guinea pigs (*c.* 500 gm.) inoculated intraperitoneally with 0·1 mgm. of *Mycobacterium tuberculosis* ($H_{37}Rv$ strain). The results are shown in Table 3.

Table 3

	No. of animals	Daily dose (mgm per animal, subcut.)	Mortality (per cent)	Average tuber. index	Average survival time (days)
Streptomycin	20	8	10	57	84·4
T 28	20	10	40	64	76·1
Control	20	—	90	100	47·2

Treatment with *T* 28 and streptomycin started one week after inoculation.

The animals were treated for 42 days. They were then observed for a further 36 days; all survivors were killed, and the extent of tuberculous involvement was noted and rated.

Experiments on the clinical use of *T* 28 are being commenced.

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Preparation of the Optical Forms of Tris-Acetylacetone Cobalt III

IN an earlier communication[1], a number of experiments were described leading to the conclusion that the activities of enantiomeric ions could be changed to a different extent by the addition of an electrolyte containing an optically active anion or cation. In order to demonstrate the general applicability of this principle, we have sought to resolve a typical non-electrolytic complex salt without salt-forming groups The peripheral atoms in the tris-acetylacetone cobalt III complex probably carry a slight negative charge, and hence negative or anionic asymmetrical fields are associated with the antipodal forms. The maximum differential interaction in solution is to be expected with a multiply-charged optically active cation, and for the purpose *d*- and *l*-tris-ethylenediamine cobalt III iodides were used.

In the initial experiments, the acetylacetone cobalt complex was dissolved in 20 per cent chloroform in ether and extracted ten times with 2 per cent aqueous *d*-tris-ethylenediamine cobalt iodide, saturated with ether. The small portions dissolving in the aqueous layer were extracted completely with chloroform, which was then evaporated rapidly at room temperature. The small amount of green residue, in aqueous alcohol, was found to have a slight lævorotation.

In subsequent experiments, the acetylacetone complex (0·5 gm.) in 25 per cent aqueous alcohol (100 ml.), containing tris-ethylenediamine cobalt iodide (2 gm.), was heated to 60° C. for a few minutes, cooled to room temperature and allowed to stand for three days. The material that had separated (0·25 gm.) was found to be inactive. The filtrate cooled to 4° C. was fractionally treated with solid ammonium chloride to salt out the substance. The fractions, after washing with saturated ammonium chloride solution, were found to become increasingly lævorotatory. The most soluble fraction (0·03 per cent in 20 per cent aqueous alcohol) gave $\alpha = -0{\cdot}09°$. From this value, on a material probably not optically pure, $[\alpha]^{20}_{5461}$ is $-$ 300°. Similarly, with *l*-Co(en)$_3$I$_3$ the dextro form was obtained.

The rotation in the Na$_D$ line was very small. Most of the substance had racemized in solution after twelve hours; but the solid was still active after three days.

The failure to detect both antipodes in any experiment demonstrated that the separation had been achieved through a 'first-order asymmetrical transformation'. In the presence of the *d*-Co(en)$_3^{3+}$ ion, the activity of the *l*-form of the acetylacetone complex was depressed more than the *d*-enantiomer, and the equilibrium between the antipodes moved until the activities were equal, that is, until there was an excess of the lævo form. The first-order asymmetrical transformation could be observed with difficulty as a mutarotation, but was confirmed by the addition of *d*-Co(en)$_3$I$_3$ to an aqueous solution of the complex, and, after standing for three days, extracting it completely with chloroform. The 0·047 per cent solution in chloroform had $\alpha = -0{\cdot}07°$. This result shows that, contrary to the opinion of Turner and Harris[2], first-order transformations do not require direct chemical combination between the 'activating agent' and the centre being 'activated'.

The optical forms of tris-acetylacetone chromium III, obtained in the same manner, were more stable than the cobalt compound, while the iron III compound had a very fleeting life. It is possible that the separation of the chromium III antipodes involved both a solubility difference and an asymmetrical transformation.

The work is proceeding and will be published shortly. Our thanks are due to Dr. D. P. Mellor for suggesting the acetylacetone complexes as typical non-electrolytes.

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Induction Periods in Reactions of N-Halogenimides

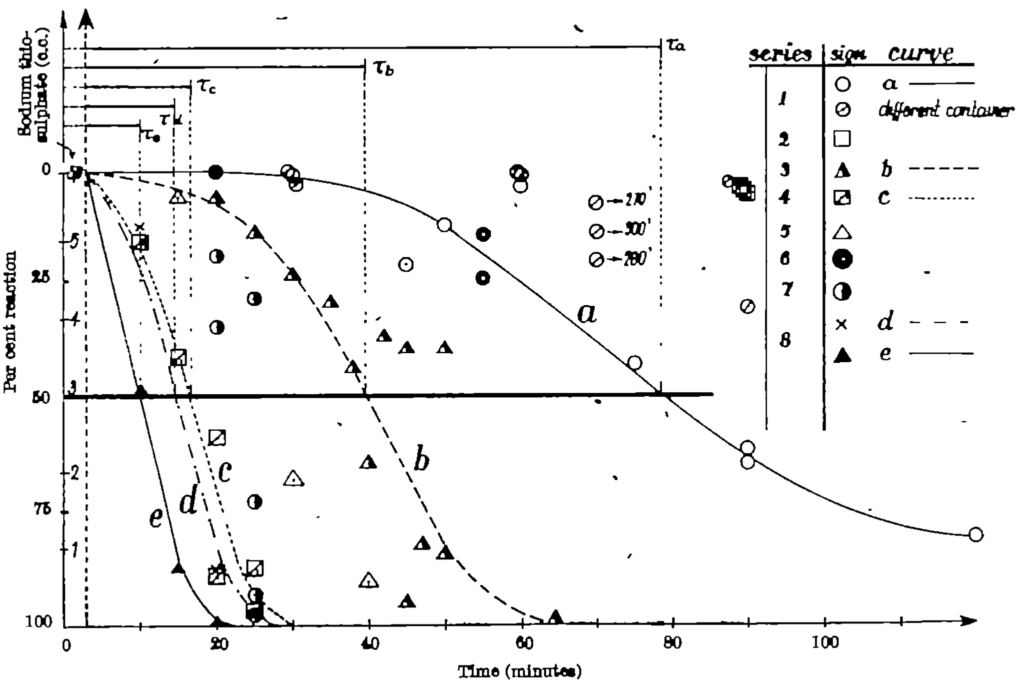
N-Halogenimides have been extensively used i preparative organic chemistry during the past fe years[1]. We have attempted to elucidate the mechanism of the reaction of N-chlorosuccinimide o toluene, in which the simplicity of the reagents an products appeared to be particularly suitable for suc a study.

On refluxing, in a quartz cell, a solution containin 0·08 mole of N-chlorosuccinimide per mole of toluen (b.p. 111°), we observed, in agreement with M Hebbelynck and R. H. Martin[2], who first studie this reaction, a rapid photochemical reaction; irradiation was carried out with a 125-watt medium-pressur mercury lamp ('Philora', Philips) at a distance o 10 cm., giving an effective intensity of about $5 \times 10^{-}$ einstein/min./sq.cm. By the use of uranyl oxalat actinometry[3], we found a quantum yield of the orde of 100 (the course of the reaction was followed by iodometry with *N*/10 sodium thiosulphate, i necessary following dilution with tetrachlorethane) At ordinary temperature, where the solubility limit the concentration to about 0·01 mole per mole o toluene, the quantum yield is of the order of unity. The photochemical reaction at ordinary temperature is of considerable interest, particularly in view o the fact that the photoactive component is toluene and not the N-chlorosuccinimide. It appeared necessary, however, to study first the *thermal reaction* at 110 ± 0·5° C. before attempting to interpret the quantum yield. Under conditions described above, but without irradiation, curve *a* shows the progress of the reaction as a function of time (series 1). Repetition of these experiments gave erratic results due to fortuitous conditions, such as the shape of the container used. But in all cases we noted induction periods at least as long as that illustrated in curve *a*, which should be considered as a limiting curve giving the maximum rate which is attainable under these conditions.

Considering the known inhibitory influence of oxygen on many halogenation reactions[4], we tried to degas the solution by passing oxygen-free nitrogen: this proved useless (series 2). We then carefully degassed the reagents under vacuum. After obtaining a gas pressure of less than 10^{-5} mm. mercury, at the temperature of liquid air, the bulbs containing about 4 c.c. of reaction mixture were sealed off under vacuum (series 3) and heated for varying times at 110° C. Under these conditions, curve *b*, which was very nicely reproducible, represents the course of the reaction. The half-reaction time falls from about 80 min. (τ_a) to 40 min. (τ_b).

Series 3 confirms the inhibitory effect of traces of oxygen, consumed during the initial phase of the reaction (induction period), and explains the erratic results obtained in the presence of air (series 1). Curve *b* still shows an induction period, even though its duration is markedly reduced.

We succeeded in nearly suppressing this induction period by means of a pre-treatment[5] (series 4, curve *c*, τ_c 17 min.). Bulbs containing N-chlorosuccinimide and toluene (prepared as for series 3) were heated during 180 min. and then broken under vacuum and their volatile constituents condensed on N-chlorosuccinimide in new bulbs. These new bulbs were then sealed off under vacuum and treated again as in series 3. Particular care was taken to eliminate all gases not condensed at liquid-air temperature.



The induction period in the experiments of series 3 could be due either to traces of impurities which are eliminated by the pre-treatment (series 4), or to the slow formation of a stable intermediate essential to the rapid progress of the reaction.

We confirmed the latter hypothesis by the following experiments :

(i) The effect of pre-treatment disappeared, at least partially (series 5), if the volatile constituents from pre-treatment are condensed by liquid air and then liquefied several times on a sodium mirror. Simultaneously we noted on the sodium the evolution of bubbles of a non-condensible gas equivalent to about 0·001–0·01 mole per mole of the N-chlorosuccinimide (pressure 10^{-1} to 10^{-3} mm. mercury in 1 litre). We assumed that it was most likely hydrogen and that the stable intermediate was hydrochloric acid.

(ii) Although the addition of dry hydrogen chloride gas in the presence of air is without effect (series 6), the addition of small amounts of anhydrous hydrogen chloride, carefully degassed by several sublimations in vacuum, shows a marked acceleration (series 7), in spite of the fact that chlorine is liberated in both cases.

Using amounts of hydrogen chloride measured with a gas pipette, the effect of the concentration (series 8, curve *d*, 0·003 moles hydrogen chloride/mole N-chlorosuccinimide ; curve *e*, 0·009 mole hydrogen chloride/mole N-chlorosuccinimide) could be demonstrated ; the induction period was thus reduced below the value obtained by the pre-treatment and probably practically abolished.

All these results seem to support the following mechanism :

(1) A small quantity of hydrogen chloride is formed probably by the reactions :

$$\mathrm{SNCl} \rightleftharpoons \mathrm{SN}\cdot + \mathrm{Cl}\cdot \quad [\mathrm{SNCl} = \text{N-chlorosuccinimide}]$$
$$\mathrm{Cl}\cdot + \mathrm{H_3C{-}C_6H_5} \rightarrow \mathrm{ClH} + \cdot\mathrm{H_2C{-}C_6H_5}.$$

(2) It is known that :

$$\mathrm{ClH} + \mathrm{SNCl} \rightarrow \mathrm{Cl_2} + \mathrm{SNH}.$$

(This equation is not meant to represent the mechanism of a reaction step but merely the known facts.)

$$\mathrm{Cl_2} \rightleftharpoons 2\mathrm{Cl}\cdot$$

(3) Finally, the chlorine atoms favour a chain reaction by one or both of the following steps :

$$(a) \quad \mathrm{C_6H_5{-}CH_2}\cdot + \mathrm{Cl_2} \rightarrow \mathrm{C_6H_5CH_2Cl} + \mathrm{Cl}\cdot$$
$$(b) \quad \mathrm{C_6H_5{-}CH_2}\cdot + \mathrm{SNCl} \rightarrow \mathrm{C_6H_5CH_2Cl} + \mathrm{SN}\cdot$$

One is thus led to a degenerate branching-chain mechanism of the type described by Semenoff[6] ; such systems show long induction periods, followed by a reaction which may become explosive (bell-shaped rate curve).

It is known that reactions of this type are occasionally initiated with suddenness, and may sometimes result in accidents (see following letter). The effect of light would thus consist in the direct or indirect formation of chlorine atoms which, after having used up the oxygen, would initiate the branching chain. It appears, however, that several different phenomena remain to be elucidated before giving a concrete meaning to the 'mean chain-length' (quantum yield) which we have measured.

It would naturally be premature to generalize our results to all free-radical reactions of N-halogenimides. We do not believe, however, that we are dealing here with an exceptional case. Indeed, preliminary tests on the thermal reaction of N-bromosuccinimide on toluene show that this reaction is similar in nature (see, however, the experiments of Buu-Hoï[7] and Karrer[8] carried out in carbon tetrachloride solution). Furthermore, we observed in this case the transitory appearance of the coloration due to molecular bromine. This is obviously the reaction stage corresponding to step 2 in the above scheme.

We are following up the study of these thermal and photochemical reactions and hope to extend them, on one hand to true allylic systems, and on the other, to different sources of atomic halogens[9].

One of us (P. A. G.) desires to express his thanks to the Institute of Applied Scientific Research (I.R.S.I.A.), Brussels, for a fellowship, which has enabled him to do this work.

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[3] Cf. Noyes, jun., W. A., and Leighton, Ph. A., "The Photochemistry of Gases", 84 (A.C.S. Monograph 86, N.Y., 1941).

[4] Cf., for example, the recent results of Ritchie, M., and Winning, W. I. H., *J. Chem. Soc.*, 3579 (1950).

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[9] The detailed results of this investigation will be published in the *Bull. Soc. Belg.* and in a thesis to be presented by one of us (P. A. G.) at the University of Brussels.

Dangers Attendant on the Use of N-Halogenimides in Organic Reactions

It is our duty, we believe, to direct the attention of research chemists to a tragic accident which should stand as a warning to all users of N-halogenimides. Our collaborator and friend, Dr. H. De Graef, who was a man of great experience and skill, was carrying out the chlorination of xylene by means of 1,3-dichloro-5,5-dimethylhydantoin, when a violent explosion occurred. Wounded and badly burned, De Graef survived only three days.

It is essential to remember that some of the reactions of N-halogenimides can be extremely violent even in the absence of peroxide. Several such reactions have been observed in this laboratory, namely :

N-chlorosuccinimide + benzylamine
N-chlorosuccinimide + aliphatic alcohols
3-nitro-N-bromophthalimide + tetrahydrofurfuryl alcohol.

Among cases reported in the literature the following may be mentioned here :

N-bromosuccinimide + hydrazine hydrate[1].
N-bromosuccinimide + diallyl sulphide[2].
N-bromosuccinimide + aniline[3].

In some cases we have noticed a vigorous evolution of chlorine or bromine in reactions carried out with 1,3-dichloro-5,5-dimethylhydantoin and 3-nitro-N-bromophthalimide respectively.

Peroxides must, of course, be handled with great care, and attention is directed, once more, to the danger of using chloroform, as recommended in the first edition of "Organic Syntheses"[4], for the recrystallization of benzoyl peroxide.

Every possible precaution should therefore be taken when using these reagents, and reactions of this type should be done on a small scale only.

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A Colour Reaction distinguishing between Adrenaline and *nor*-Adrenaline on Paper Chromatograms

In recent studies we were concerned with the detection of traces of *nor*-adrenaline in preparations of adrenaline derived from natural sources. Colorimetric methods[1,2] proved to be of limited value with low concentrations of *nor*-adrenaline ; but excellent results were obtained with paper chromatography, using modifications of the methods described by James and others[3,4]. The adrenaline samples are dissolved in methanol containing a minimum quantity of hydrochloric acid, and then transferred to paper strips for descending chromatography, or to circular disks of filter paper for chromatography by Rutter's technique[5]. Water-saturated phenol is used as the developing solvent in an atmosphere of hydrochloric acid[4]. The paper chromatograms are then dried and sprayed with an appropriate colour reagent.

The commonly-used ferricyanide colour reagent[3] produces browns and pinks which are not very sharply defined, especially when microgram quantities of *nor*-adrenaline are being sought in the presence of milligram quantities of adrenaline. More satisfactory results can be obtained by spraying the chromatograms with a solution of 0·5 gm. sodium β-naphthoquinone-4-sulphonate dissolved in 100 ml. of 0·2 *M* borate buffer at *p*H 8·9, the reagent having a final *p*H of 8·6. The solution should be freshly prepared just before use. With this reagent *nor*-adrenaline develops an intense blue colour slowly over a period of 15–30 min. Adrenaline produces a pink colour, while dihydroxyphenylalanine gives a yellow colour which gradually changes to a blue-grey. This colour difference should be of value in distinguishing dihydroxyphenylalanine from *nor*-adrenaline, since their R_F values are quite close[1]. At lower *p*H values (8·3–7·5), the paper background becomes badly discoloured, although the *nor*-adrenaline colour develops more rapidly. Exposure of the paper chromatogram to ammonia may be necessary before spraying if excessive amounts of acid are present.

This colour reaction is highly sensitive, being capable of detecting less than one microgram of *nor*-adrenaline per square centimetre of paper.

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Lamellar Compounds of Graphite with Chromyl Chloride and Chromyl Fluoride

The ability of graphite to form lamellar compounds by occluding certain other substances (fluorine, boron, oxygen, potassium, rubidium, caesium and ferric chloride) between its layer planes has been known for a considerable time. No new compounds of this type have, however, been reported for the past fifteen years, though attempts have been made to intercalate other volatile compounds in graphite. Thus Ruedorff and Schulz[1], who studied the ferric

'38 Dept.

chloride complex, were unable to prepare graphite complexes with either the triiodides or chlorides of arsenic, antimony and bismuth, and also failed to effect the intercalation of aluminium chloride. We have recently succeeded in preparing graphite complexes by the action of chromyl chloride and chromyl fluoride on graphite.

Qualitative tests showed that graphite swelled to almost twice its original size when warmed with its own volume of chromyl chloride. Even after thorough washing with carbon tetrachloride, in which chromyl chloride is readily soluble, a substance which analysis showed to be chromyl chloride could still be liberated from this treated graphite by heating the latter to between 200° and 300° C. This evolution was accompanied by exfoliation of the graphite and at least a hundred-fold increase in the volume of the latter.

The graphite used was a highly crystalline flake graphite from Uley, South Australia, purified by flotation and subsequent chemical treatment until its ash content had been reduced to less than 1 per cent. This material was screened into two fractions, the particle size being approximately 300 µ in one fraction and 40–80 µ in the other. Portions of each fraction were heated with four times their own weight of chromyl chloride at 100° C. for 24 hr., then washed with carbon tetrachloride and dried at 110° C. The products were analysed by first fuming with concentrated sulphuric acid, then ashing. The coarser sample was found to contain 43·0 per cent chromyl chloride and the finer 36·3 per cent. These large amounts are comparable with the amounts of ferric chloride held in the graphite – ferric chloride complex as found by Rüedorff and Schulz[1] and confirmed by Croft[2].

The exfoliation which accompanied the heating of these graphite – chromyl chloride complexes is typical of the lamellar compounds of graphite. Stability to solvents including aqueous acids and alkalis, which is a feature of the graphite – ferric chloride complex, is also shown by the new complex. Confirmation of the lamellar nature of this compound was obtained from X-ray diffraction measurements which showed that, as in the case of other graphite compounds, the carbon layer planes of the graphite are moved apart, in this instance from 3·45 A. to 9 A.

Following the intercalation of chromyl chloride, preparation of the corresponding fluorine compound was attempted with equal success. In this case it was found that graphite swelled immediately when placed in contact with chromyl fluoride at room temperature. Water-washed complexes obtained from this reaction exhibited an even greater degree of exfoliation than graphite – chromyl chloride when heated.

We wish to thank Mr. A. D. Wadsley for obtaining X-ray diffraction data for the graphite – chromyl chloride complex. A more detailed account of further studies on these complexes will be published elsewhere.

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Course of the Oxidation of Olefins by Chromic Acid

A FURTHER study of the oxidation of olefins by chromium trioxide in acetic anhydride[1] has now shown that the initial phase consists of two distinct reactions: (*a*) attack at a methylene group adjacent to the double bond; (*b*) oxidation at the double bond. The last reaction has been observed with all the olefins yet examined; allylic substitution (*a*) occurs to an appreciable extent with some olefins, with others it cannot be recognized.

The evidence for (*a*) is derived chiefly from a study of the oxidation of tetramethyl ethylene (I) and octene-1 (IV). 2 : 3-Dimethyl but-2-en-1-al (II) has been identified in the products of the oxidation of (I) by chromium trioxide in acetic anhydride; acetone and the monoacetate of 2 : 3-dimethylbutan-2 : 3-diol (III) are also formed. It is difficult to imagine that (II) can arise in any way other than by the attack of the oxidizing agent on the methyl group. This conclusion is reinforced by the observation that (II) is also formed from (I) by oxidation with selenium dioxide. Further support is given by the isolation of oct-1-en-3-one from octene-1 (V) from the products of oxidation by chromium trioxide in acetic anhydride.

The interpretation of the course of the oxidation at the double bond is not entirely unambiguous from observations on these olefins, in that fission occurs to a considerable extent. Clear evidence of the nature of the initial phase of the oxidation of the double bond is afforded by an examination of the behaviour of camphene (VI) and of di*neo*pentyl ethylene (VII). From both these olefins the corresponding epoxide has been isolated and is the major product of the oxidation.

$\mathrm{Me_2C{:}CMe_2}$ I

$\mathrm{Me_2C{:}C(Me)CHO}$ II

$\mathrm{Me_2C(OAc).C(OH)Me_2}$ III

$\mathrm{CH_3(CH_2)_4.CH_2.CH{:}CH_2}$ IV

$\mathrm{CH_3(CH_2)_4.CO.CH{:}CH_2}$ V

The comparative stability of the epoxides from (VI) and (VII) no doubt permits of their survival during the reaction and the subsequent operations for isolating the products. Less resistant epoxides cannot survive, but it is possible in some cases to infer their participation in the oxidation; the presence of (III) in the products of the oxidation of tetramethyl ethylene finds a ready explanation on this basis.

$\mathrm{(CMe_3.CH_2)_2C{:}CH_2}$ VII

$\mathrm{(CMe_3.CH_2)_2CH.CO_2H}$ VIII

$\mathrm{CMe_3.CH_2.CMe{:}CH_2}$ IX

$\mathrm{CMe_3.CH_2.CHMe.CO_2H}$ X

$\mathrm{CMe_3.CH{:}CMe_2}$ XI

$\mathrm{CMe_3.CMe_2.CO_2H}$ XII

It is known that epoxides are also formed when some olefinic substances are oxidized in acetic acid by chromium trioxide[2–4], and it is a fair inference that the course of the reaction in acetic acid is the same as in acetic anhydride.

The extension of the idea of the initial formation of an epoxide to the oxidation by chromic acid in aqueous sulphuric acid has a serious difficulty; it is improbable that any epoxide is sufficiently stable to persist in aqueous sulphuric acid long enough to permit of its isolation. There are observations, however, which find a satisfactory explanation only if it is assumed that an epoxide is formed in the initial phase.

It is known that some olefins on oxidation by aqueous chromic acid in sulphuric acid give not only the expected fission products but also acids which contain the same number of carbon atoms as the original olefin. Thus, di*neo*pentyl ethylene (VII) gives a good yield of di*neo*pentyl acetic acid (VIII); 2 : 4 : 4-trimethyl pentene-1 (IX) gives the fission product *neo*pentyl methyl ketone as well as 2 : 4 : 4-trimethyl pentanoic acid (X); 2 : 4 : 4-trimethyl pentene-2 (XI) yields acetone and trimethyl acetic acid as well as 2 : 2 : 3 : 3-tetramethyl butanoic acid (XII). In all these examples it is known that the epoxide isomerizes to the aldehyde corresponding to the acid isolated; there is good qualitative agreement between the extent of this isomerization and the yield of the acid in the oxidation.

An alternative hypothesis based on the assumption that a glycol is the initial product of the oxidation is less satisfactory; the rate of oxidation of glycols is in general greater than their rate of isomerization.

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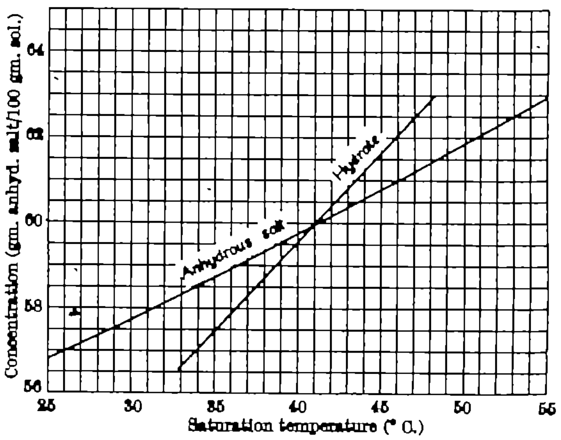
Solubility of Ethylenediamine D-Tartrate in Water

In a recent paper[1], A. C. Walker has given tables and curves for the solubility–temperature relationship in the system ethylenediamine D-tartrate (anhyd.)–ethylenediamine D-tartrate monohydrate–water. Dr. Walker shows that the salt decomposes slowly in solution, and the consequent change of composition of the solute during the time taken by the solubility determinations introduces some uncertainty in the results. Usually, when preparing a solubility curve, a considerable time must be allowed, at each observed temperature, for equilibrium between solution and solute to be attained. The change of composition of the solute during the experiments is probably responsible for the difference in level, of the order of 1° C., in two of the published curves.

In our work on growing large crystals of water-soluble substances, we have for some time been using a method for the direct estimation of the saturation temperature of solutions. The solution is circulated through a cell in which it is continuously brought into equilibrium with the solid phase being studied. Any departure from equilibrium in the cell is detected by observing a simple optical effect near the surface of a piece of crystal. The bulk of the solution is merely required to be uniform and free from solid; it is not necessary that it should at any stage be exactly at its saturation temperature.



We have used the procedure for obtaining the accompanying solubility curves of ethylenediamine D-tartrate and ethylenediamine D-tartrate hydrate. The solutions were prepared from the pure recrystallized anhydrous salt and distilled water only, so that the *p*H was approximately 6·0. The experimental conditions allowed about thirty points to be obtained in three hours for each curve. Decomposition of the solute in this period is slight, and we believe that our values are not in error by more than ± 0·1° C. It was found possible to follow the curves a considerable way into the regions where the solid phases studied are metastable only. To the extent to which they are shown in the graph, the curves are plotted from measured points and are not extrapolated.

It is intended to publish the method and results with more detail elsewhere.

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Complement Fixing Antigen in *T*5 *coli* Bacteriophage

Complement fixation with animal viruses has long been known, and Hoyle[1] by the use of the complement fixation reaction has demonstrated a soluble influenza virus antigen which appears in infected cells of the chick embryo prior to the time in the growth-cycle at which infective virus can be found. Up to the present time, so far as I am aware, complement-fixing antibody to the bacterial viruses has not been demonstrated, nor has there been sought in phage-infected cells material analogous to the soluble influenza antigen of Hoyle. However, a conversation with Sir Macfarlane Burnet prompted a search for such substances.

A rabbit serum obtained by immunization with the *coli* phage *T* 5 contained a high titre of complement-fixing antibody. The complement-fixing activity of broth preparations of *T* 5 was related directly to their titre of infective phage, reduction of the phage titre by filtration resulting in a parallel reduction in antigen titre. The phage antigen–antibody system behaved ike other large-particle complement-fixing systems. No zones of optimal antigen or antibody titre were ound. Phage inactivated by heating at 73° C. or by precipitation with acid alcohol retained its antigenic activity. The antibody was specific for T5, little or no rossing occurring with other phages of the *T* series.

One-step growth-curves of T5 in *coli B* in glucose meal broth with $0\cdot001M$ calcium chloride showed a minimum latent period of 42 min. and completion of he cycle in 70 min., the average burst size varying rom 100 to 200 particles per cell. The content of phage antigen and infective phage in the cells during the latent period was studied by the cyanide lysis technique of Doermann[2]. Cells grown in broth with aeration to a concentration of approximately 5×10^8 per ml. were infected at the rate of two phage particles per cell. 10-ml. aliquots were withdrawn at various times and unadsorbed phage removed by centrifugaion. The unadsorbed phage content of the supernatant fluid was titrated, the fluid discarded and the nfected cells resuspended in 1 ml. of broth with $0\cdot02M$ sodium cyanide. This tenfold concentration of the cells was necessary to obtain amounts of phage which could be detected serologically. After lysis, the supernatants of the cyanide lysates were tested for infective phage and for antigen.

Nine minutes after infection, phage antigen but no nfective phage could be recovered from the cells. At 12–20 min. after infection neither infective phage nor phage antigen could be detected. At 24 min. large amounts of antigen were found but no infective phage. After 25 min., infective phage and phage antigen were both found; but the titre of antigen was considerably greater than could be accounted for on the basis of infectivity. Thereafter, up to the end of the latent period, both infective phage and phage antigen increased in amount; but the quantity of antigen recovered was always greater than could be accounted for by the amount of infective phage freed by cyanide lysis.

These results may be interpreted as further evidence in favour of the hypothesis of disintegration of the invading virus particle[3]. They also demonstrate that during the early part of the latent period, not only does the virus lose its infectivity, but also its antigenic character disappears. This situation continues until half the latent period has passed, and then material can be detected in the infected cell which is not yet the complete infective virus but which has the antigenic character of the virus. In the light of our present knowledge of phage synthesis, it is significant that it is also at this stage that the deposition of significant amounts of virus deoxyribonucleic acid takes place.

This demonstration of the presence in phage-infected cells of material that can be measured by serological methods should prove of value in studies of the processes involved in chemical inhibition of phage production, and in reactivation of phage inactivated by ultra-violet light and X-rays.

A full account of the work will be published elsewhere.

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Effect of Antilymphocytic Serum on Suspensions of Lymphocytes *In vitro*

SERUM which has a powerful antilymphocytic effect *in vivo* can be prepared by immunizing an animal with injections of suspensions of heterologous lymphocytes[1,2]. The mechanism by which such a serum brings about a fall in the lymphocyte count when injected into an appropriate animal is uncertain, and it was felt that some light might be thrown on this question by studying the effect of the serum on suspensions of lymphocytes *in vitro*.

Antilymphocytic serum (rabbit-anti-rat) was prepared according to the method of Cruickshank[2], with one modification only, namely, that the immunizing injections were given subcutaneously instead of intraperitoneally. The serum was heated to 56° C. for 1 hr. to diminish anti-complementary activity. To test its efficacy, 2·0 ml. of the serum was injected intraperitoneally into a black-and-white hooded rat, total and differential leucocyte counts being made before and at intervals after the injection. A profound lymphopænia developed, the absolute lymphocyte count falling from 6,700 cells/c.mm. before, to 730 cells/c.mm. four hours after, the injection. On the other hand, no significant fall in lymphocyte count occurred in a rat which received an intraperitoneal injection of 2·0 ml. of normal rabbit serum.

For the *in vitro* test, suspensions of lymphocytes in Tyrode's solution were prepared from lymph nodes of black-and-white hooded rats, as described by Cruickshank. The cells were washed four times with Tyrode's solution and the final suspensions adjusted to a count of approximately 40,000 lymphocytes per c.mm. 0·4 ml. of suspension was placed in each of six glass ampoules (2·0 ml. capacity) and to these was added, respectively: 0·4 ml. antilymphocytic serum; 0·4 ml. antilymphocytic serum and 2 M.H.D. guinea pig complement; 0·04 ml. antilymphocytic serum, 0·36 ml. Tyrode's solution and 2 M.H.D. complement; 0·4 ml. normal rabbit serum; 0·4 ml. normal rabbit serum and 2 M.H.D. complement; and 0·04 ml. normal rabbit serum, 0·36 ml. Tyrode's solution and 2 M.H.D. complement. After samples had been removed for counting, the air in the ampoules was replaced by a mixture of 95 per cent oxygen and 5 per cent carbon dioxide and the ampoules were sealed. They were then attached to a mechanical mixer of the rotating drum type, which was placed inside the incubator (37° C.) and allowed to turn very slowly (10 r.p.m.). Further samples for counting were taken after 2 hr. and again after 18 hr. incubation.

The cell counts were made in a hæmacytometer after dilution with a solution of eosin in Tyrode's solution (1 in 2,000), as described by Schrek[3], the total count and the proportion of stained cells being recorded in each case. As the accompanying table indicates, none of the total counts showed any significant change following incubation. The proportion of stained cells—dead cells according to Schrek—increased slightly but to approximately the same extent in each case.

It thus appears that antilymphocytic serum has no effect on suspensions of lymphocytes *in vitro*. This suggests that the action of the serum *in vivo* is probably not due to direct destruction of lymphocytes in the blood stream.

Our observations are at variance with those of some other workers[4] who have reported agglutination

Type of serum	Final dilution of serum (per cent)	Whether complement added	Lymphocyte counts					
			Pre-incubation		After 2 hr. incubation		After 18 hr. incubation	
			Total count	Proportion of stained cells (per cent)	Total count	Proportion of stained cells (per cent)	Total count	Proportion of stained cells (per cent)
Normal	50	No	17,150	21	17,650	21	20,150	57
Normal	50 approx.	Yes	21,150	22	20,100	24	17,050	60
Normal	5 approx.	Yes	19,000	26	17,700	31	17,050	70
Antilymphocytic	50	No	14,850	36	13,100	41	15,000	71
Antilymphocytic	50 approx.	Yes	18,450	26	20,950	34	21,800	70
Antilymphocytic	5 approx.	Yes	21,750	35	18,900	26	18,550	54

of lymphocytes *in vitro* by antilymphocytic sera; but the tests they describe are difficult and notoriously liable to give falsely positive results. Admittedly, in our experiments continuous mixing of the suspensions occurred; but this was extremely gentle and not likely to have masked the effect of agglutinating antibodies had such been present.

It is of interest that Robertson[5] found that adrenal cortical extracts, which were markedly antilymphocytic *in vivo*, also had no apparent effect on lymphocytes *in vitro*. It is true that Robertson relied on counts of total number of cells only, and more recently Schrek[6] has claimed that some significant change in the proportion of stained cells does occur after incubation with cortical extracts; but the effect was very slight and would not seem to afford any explanation of the lymphopenia which this material produces *in vivo*.

Since antilymphocytic serum and cortical hormones both cause a marked lymphopenia on injection, but have little or no effect on lymphocytes *in vitro*, it might be suggested that the *in vivo* effect of the serum is mediated solely by an adrenal cortical mechanism. This, however, is not the case, since we have found[7] that the antilymphocytic effect of the serum, though possibly diminished, is still apparent in adrenalectomized animals.

This work was assisted by grants from the Medical Research Council, for which we wish to express our thanks.

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Vitamin B_{12} Content of Soft- and Hard-shell Clams

MICROBIOLOGICAL assays for vitamin B_{12} content were made on soft-shell clams (*Mya arenaria*) and hard-shell clams or quahaugs (*Venus mercenaria*) from the waters off the coast of Massachusetts and Rhode Island. Assays were also made on commercially canned clams, both whole and minced, and on calf, beef, and pig livers obtained through normal retail outlets.

The samples, diluted 1 : 100 with distilled water, were disintegrated in a Waring blendor and extracted under benzene at 55° C. for 24 hr. More efficient extraction of vitamin B_{12} was thus obtained than by slurrying in a Waring blendor and immediately assaying[1]. One sample of soft-shell clams was lyophilized before being extracted; the material was frozen with a mixture of solid carbon dioxide and alcohol (− 78° C.) and dried at the resulting low temperature for 15 hr. *in vacuo* (pressure, 0·2 mm. mercury).

The assay tubes were prepared in the usual manner for microbiological assay. The basal medium employed was that of Winsten and Eigen[2], except that 0·5 gm. of vitamin C was added per litre of medium. *Lactobacillus leishmanii* 313 (*ATCC* 7830) was used as the test organism. Titrimetric evaluation of the response of the test organism was made with $N/10$ sodium hydroxide, bromthymol blue being used as an internal indicator. Duplicate tubes containing 10 ml. of assay solution were used at four levels of sample material, and the results for the series were averaged. Maximum response was obtained at 0·4 μgm. of vitamin B_{12}.

All the fresh samples of soft- and hard-shell clams had higher contents of vitamin B_{12} (6·0–9·7 μgm. per gm. of dry weight) than any of the animal livers assayed (1·3, 1·1 and 2·6 μgm. per gm. of dry weight, for pig, beef and calf liver, respectively). That clams are a richer source of this vitamin than animal livers may be of some importance in pernicious anæmia therapy.

Assays for dissected portions of soft-shell clams indicated that the visceral mass contained a higher concentration of vitamin B_{12} (16·3 μgm. per gm. of dry weight) than other parts of the clam assayed (2·0 μgm. for foot and siphon and 2·1 μgm. per gm. for the remainder).

The entire vitamin B_{12} content of the dissected soft-shell clams as calculated from weighted averages of the values for the dissected portions was confirmed within experimental error by the concurrent assay of an undissected duplicate.

The drained solids of the commercially canned whole clams contained only about half as much vitamin B_{12} on the dry basis (3·8 μgm. per gm.) as the fresh clams. It is uncertain whether some of the vitamin B_{12} activity of the canned material was lost during processing, or whether the lower vitamin content was due to a difference in species or locality of collection.

Canned minced clams assayed about 50 per cent lower in vitamin B_{12} content of drained solids than did canned whole clams. This lower vitamin content may possibly be explained by the fact that the visceral mass is removed from clams before they are minced for canning and, as already pointed out, there is a higher concentration of vitamin B_{12} in the clam's digestive tract. It now appears that this discarded material might be an excellent source of vitamin B_{12} for animal-feed supplements.

The lyophilizing process had no detrimental effect n the vitamin B_{12} potency of soft-shell clams. If clams are found useful for therapeutic purposes, this fact is of interest, because large amounts can be conveniently prepared for storage in this manner.

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Use of a Sheep Abortion Virus as a Test Virus for Chemotherapy Work

A STRAIN of abortion virus, isolated by us from a local case of sheep abortion in March 1950 and apparently similar to the virus isolated by Stamp, McEwen, Watt and Nisbet[1], has been extensively used in an *in ovo* 'screening test'. It has proved so satisfactory for this purpose that it is felt its usefulness should be more generally known. The virus n infected membranes remains viable indefinitely at − 20° and for some weeks at 0°, and regularly produces well-defined lesions on the chorioallantoic membrane; in both these respects it is superior to many other large viruses. So far as is known, it is not pathogenic to man.

Drug	Inhibitory dose (mgm./egg)		* Activity in mice against Nigg virus (drug given subcutaneously from day of infection)
	Abortion	Nigg	
Chloromycetin	1·0	2·0	+ + (0·02 mgm./gm./day)
Aureomycin	0·25	0·25	+ + + (,,)
Terramycin	0·06	0·06	+ + + (,,)
Penicillin	Inact. 2,000 u.	2,000 u.	+ (4,000 u./mouse/day)
Sulphathiazole	Inact. 14·7	14·7	+ (0·2 mgm./gm./day)
p-Aminobenzoic acid	Inact. 27·4	Inact. 13·7	0 (2 mgm./gm./day, orally)

* + = prolongation of life only; + + = no deaths, but lungs involved; + + + = no deaths, lungs not involved.

Groups of 10-day chick embryos are used for the test. The drug, in 0·2 ml. diluent containing 1,000 u. penicillin and 1,000 u. streptomycin per ml., is introduced into the yolk sac; 0·2 ml. of a broth suspension of the virus is inoculated on to the chorioallantoic membrane within four hours. After a further seven days incubation, the membrane is removed and, since the lesions are very distinct, readily assessed.

To date 250 compounds have been tested, but only terramycin, aureomycin and chloromycetin have been found active.

It is probable that the abortion virus is related to the psittacosis group. To test this hypothesis an investigation into the effect of drugs on mouse pneumonitis (Nigg) virus was carried out under the same test conditions; results are given in the accompanying table. Both viruses are sensitive to terramycin, aureomycin and chloromycetin, but the abortion virus, unlike Nigg virus, is not attacked by penicillin or sulphathiazole; the implications of these results are being studied further. Full details of the work will be published elsewhere and evidence presented to justify the belief that this type of *in ovo* test will detect compounds likely to be of chemotherapeutic value. It requires smaller amounts of drug and provides indications similar to those yielded by the more laborious mouse tests (see table).

We wish to thank Sir Jack Drummond and Mr. C. E. Coulthard for their interest in this work, and Dr. A. D. McEwen for much information.

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Is Age of Parents Important in Sheep?

A SITUATION provoking speculation has been found during the course of a preliminary investigation of one-shear ($1\frac{1}{2}$-year old) rams offered for sale at the Feilding Stud Ram Fair. Stock entered in the Fair, the most important of its kind in New Zealand, come from the Manawatu and neighbouring Wairarapa and Hawke's Bay districts and are purchased by breeders throughout New Zealand, Australia and South America. Data used in these analyses were derived from the catalogues of the 1948, 1949 and 1950 sales and the 1948 Flock Book of the New Zealand Romney Marsh Breed Society.

Of the 612 rams offered for sale in the three years, 52·6 per cent were sired either by lambs or by one-shear rams. The offspring of the one-shear rams brought the highest average price and had a lower rejection-rate than any other age. Similarly, an analysis of the 1948 Flock Book involving all Romney stud sheep in the Dominion shows that 49·5 per cent of the 1,580 rams single-entered (that is, to be used as stud sires) were sons of either ram lambs or untried one shear sires. However, Goot[1] has shown that one-shear sires comprise only 27·8 per cent of the sires available for use in those flocks static in numbers and consisting of 400 or more ewes.

Selection of rams for the Stud Fair and for single-entry in the Flock Book is almost solely on phenotype and certainly without reference to age of the parents, nor does this latter point interest buyers. Because of this, it would be expected that the sires of rams chosen for single-entry and for sale would be represented in the same proportion as they are used in the flocks. In this case only 27·8 per cent of the rams single-entered or offered for sale would be the sons of one-shear rams. However, the results show that they produce almost twice this number.

An analysis of the influence of age of dam shows that progeny of the youngest ewes achieve the highest average price, though the proportion of these is not greatly different from that expected from the age composition of dams[1].

For every sire recorded in the sale catalogues there are on an average a little less than two sons offered for sale.

Further analyses are planned to throw more light on these rather perplexing problems.

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Biochemistry in the Taxonomy of Lichens

The application of biochemical methods to plant taxonomy was first made in the lichens, in 1867, when potassium hydroxide and calcium hypochlorite were found to give characteristic colour reactions when applied to the thallus of certain species. Most present-day lichenologists employ these reactions as an important character in the description of species. In a large number of lichen species the exact constitution of the lichen acids causing colour reactions is known, mainly owing to the researches of Zopf[1] and Asahina[2,3]. The latter has originated a method of microchemical analysis whereby the lichen acids can be determined by the form of the crystals which they produce under the microscope when recrystallized from various solutions[4], this method requiring the extraction of only a small portion of the thallus with acetone.

Use has been made of biochemical methods as an aid to taxonomy also in the flowering plants, and it has been found that many of the larger groupings, such as families, sections and genera, originally delimited on a purely morphological basis, are characterized also by biochemical differences[5]. The application of chemical methods in Phanerogams, however, has not yet reached the point at which species are distinguished on chemical characters. Penfold, Morrison and Smith-White, for example, class individuals of the Australian tree *Leptospermum citratum* containing different essential oils as "variety A" and "variety B" respectively[6]. In lichens, the tendency has been to regard chemically distinct individuals as distinct species, irrespective of whether morphological differences are present or not. This view, if carried to its logical conclusion, means that in many cases related species could be determined only by chemical analysis. This state of affairs has already been reached in certain lichen genera, for example, *Cladonia*. In the lichens the matter is further complicated by the fact that they are not simple organisms, but a fungus–alga consortium, and in most cases it is not known with certainty to what extent the formation of the characteristic lichen acids depends on the symbiotic union. In a few cases the fungal component has proved capable of producing the characteristic substance in pure culture without Algæ[7]. It is not unlikely that the same lichen fungus may produce distinct acids in symbiosis with different Algæ. The differentiation of 'chemical species' in the lichens therefore rests on a doubly insecure foundation.

The problem has already become acute in the taxonomy of lichens to the extent of forming a serious obstacle to the work of classification; for example, in one genus now under monographic study, it would be necessary to describe more than forty 'new species' on chemical grounds alone, without supporting morphological characters, if the present conventional treatment were adhered to. The increasing interest shown by taxonomists in other plant groups in the use of biochemical methods makes it necessary, if possible, to forestall difficulties of a similar nature which will undoubtedly arise as further use is made of biochemical criteria applied to taxonomy.

It is now suggested that morphologically indistinguishable individuals of plants (other than bacteria) which differ in their chemical characters should be included in the same species as distinct 'chemical strains', the nature of the compound present being indicated in brackets, together with quotation of tl taxonomic epithet previously used (if any) to desi nate the strain in question. The following are son examples of the treatment applied to lichen specie

Stereocaulon tomentosum Fr., Ch. str. I (stictic acid or typical strain).
" " " Ch. str. II (lobaric acid or 'sasakii'-stra (previously described as a distin species, *St. Sasakii*)
Cladonia chlorophaea (Flk.) Spreng., Ch. str. I (fumarprotocetraric ac or typical strain).
" " " " Ch. str. II (grayaninic acid 'grayi'-strain).
" " " " Ch. str III (cryptochlorophaeic ac or 'cryptochlorophaea'-strain).
" " " " Ch. str. IV (merochlorophaeic ac or 'merochlorophaea'-strain).
" " " " Ch. str. V (novochlorophaeic ac strain).
" " " " Ch. str. VI (usnic acid strain).

The strains containing grayaninic, cryptochlor phæic and merochlorophæic acids had been pr viously designated as distinct species with tl names *grayi*, *cryptochlorophæa* and *merochloropl.æ* respectively.

The application of this method registers the chen ical differences while keeping them outside the fram work of formal taxonomy, and thus avoids burdenir the latter with a mass of unnecessary epithets. I also enables the field-worker to determine his speci on a morphological basis. Continued attention shoul however, be paid to the constitution and distributio of the distinct chemical strains, for they have bee found, at any rate in some of the lichens, to b significant for distribution, occurring in separate part of the species' geographical area.

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[2] Asahina, Y., *Acta Phytochim.*, 8, 47 (1934).

[3] Asahina, Y., *Bot. Mag., Tokyo*, 51, 759 (1937).

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[5] Gibbs, R. D., *Trans. Roy. Soc. Canada*, Sect. 5, 39, 71 (1945).

[6] Penfold, A. R., Morrison, F. R., and Smith-White, S., *J. and Pr Roy. Soc. N.S. Wales*, 76, 93 (1942).

[7] Thomas, H. A., *Ber. schweiz. bot. Ges.*, 46, 191 (1936).

Permanent Preparations of Fungi Growing on Agar

The methods to be described here have been use in making preparations of predacious fungi from aga cultures, where it is important that hyphæ shoul be retained *in situ*; but they also appear to b generally applicable.

For making rapid preparations from living mater ial, a modification of the chlorazol black metho of Armitage[1] has been found satisfactory. Fron material growing in culture, agar blocks about 4 mm square are cut out with a scalpel, and the surface o the agar bearing the fungus is carefully sliced of with a razor blade to a uniform thickness of abou 200 µ. The treatment is then as follows: fix i absolute alcohol, 1 min.; stain in a saturated methy alcohol solution of chlorazol black E, 1 sec.; de hydrate in absolute alcohol, 10 min.; mount i 'Euparal' in a cavity slide, and harden by gentl heat.

This method is excellent for mycelium and thick-walled spores; but large thin-walled spores are apt to collapse as a result of the rather drastic treatment. As Armitage[1] points out, the chlorazol black stains more brilliantly if methyl alcohol is used as solvent rather than ethyl alcohol.

The thickness of the agar included in the preparation is sometimes a source of trouble in critical observation with high-aperture objectives. To avoid this, the following technique may be used which, though slower, gives beautiful preparations. Blocks of agar bearing the fungus, about 4 mm. square, are cut out and fixed in the following mixture: commercial formalin, 10 ml.; glacial acetic acid, 5 ml.; distilled water, 85 ml. For this formula we are indebted to Dr. B. Barnes. Material is fixed for at least 24 hr., but may be left in the fixative indefinitely without harm. The agar block is washed until it no longer smells of acetic acid, and then stuck, fungus downwards, on a No. 1 cover slip by means of Szombathy's gelatine, as recommended by Chamberlain[2]. The agar is allowed to dry in a warm place (not above 35° C.) until it begins to shrink; the surface bearing the fungus is prevented from shrinking by adhesion to the glass. When the agar is firmly attached to the cover slip, the block is sliced away with a sharp razor blade as close to the glass as possible. The material, still on the glass, is then stained with Heidenhain's hæmatoxylin, dehydrated by passage through a gradually ascending series of alcohols, cleared with terpineol and mounted in canada balsam. If desired, clearing may be omitted and 'Euparal' used as a mountant following absolute alcohol.

In this technique, any suitable stain may be used, but once alcohol has been applied to the preparation it is inadvisable to return to water, as swelling of the agar may cause it to become detached from the glass.

Details of these and other techniques will be given elsewhere.

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Feb. 22.

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[1] Armitage, F. D., *Trans. Brit. Mycol. Soc.*, 27, 131 (1944).

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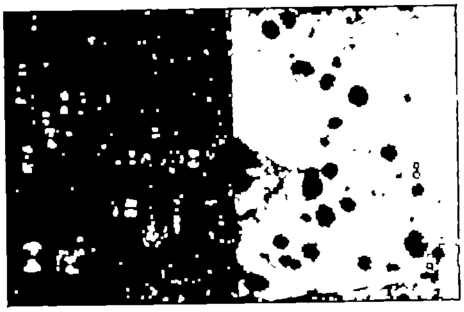
Corpora amylacea in the Central Nervous System

It has long been known that small round corpuscles may be found around the blood vessels of the central nervous system in subjects of advanced age. As the staining properties of these bodies are similar to those of starch, Virchow called them corpora amylacea. Several authors have examined them in attempts to determine their origin, but without definite result. The present contribution describes an attempt to define the morphology and some of the chemical properties of corpora amylacea, using the polarizing microscope as well as the periodic acid – leucofuchsin method[1].

Under the polarizing microscope, the round bodies show pronounced double refraction with a positive Maltese cross (Fig. 1), the path-difference being 15–20 μ in our sections. This finding does not agree with those previously given in the literature[2]. The character of the double refraction does not change in the imbibition test, suggesting that self-birefringent lipids may be considered as the principal constituents of these bodies.



Sections of corpora amylacea: (1) polarized light, crossed nicols and Senarmont compensation (× 80); (2) periodic acid – leucofuchsin method (× 80)

The myelin sheath gives a positive aldehydic reaction after treatment with periodic acid; the round bodies were treated similarly in order to obtain information about the possibility of a genetical relationship between them and the myelin sheath. Frozen or paraffin-embedded sections of corpora amylacea showed a brilliant rose-purple colour (Fig. 2); myelin sheath, however, gave a positive result only in frozen sections. In the case of corpora amylacea, the reaction was not inhibited if the bodies were extracted with solvents which would remove cerebrosides. This is probably due to the fact that the cerebrosides which are responsible for the aldehyde reaction are linked to proteins, thereby becoming unextractable[3].

Summarizing the above results, it is suggested that the principal constituents of corpora amylacea are lipids, and that their intense aldehydic reaction after treatment with periodic acid indicates that they possibly belong to the carbohydrate-containing cerebrosides. It well may be that the origin of corpora amylacea is in the cerebrosides of the degenerated myelin sheath.

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[1] McManus, J. F. A., *Nature*, 158, 202 (1946).

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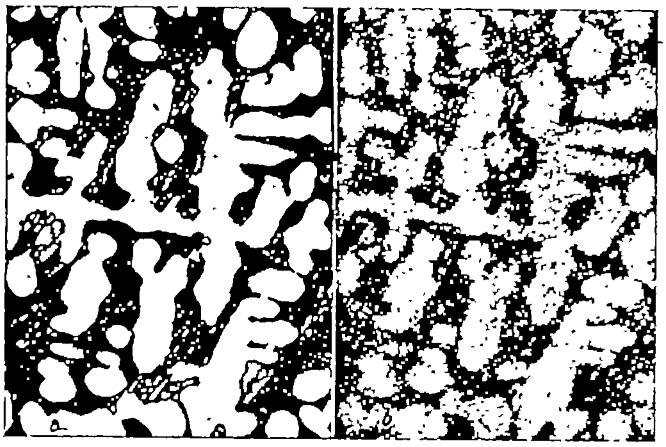
Nuclear Reaction Radiography

Autoradiography has been employed for many years for the purpose of determining the distribution of an element in a given material. The essential requirement for the use of this method is that the element in question itself should emit a radiation which can be registered, on a photographic film pressed against the surface of the sample. To make an element betray its presence in this way, one provides a certain fraction of marked atoms by adding a small amount of radioactive isotopes of the same element.



(*a*) Photomicrograph of the metal surface. Light areas: iron; darker parts: eutectic of iron and Fe_2B. × 100

(*b*) Reaction radiograph of the same surface as that shown in (*a*). Dark spots are produced by α-particles, showing position of reacting atoms of boron. × 100

I have investigated another method, which may be termed nuclear reaction radiography, since it makes use of the property of the non-radioactive element in question of reacting with an external particle radiation in such a way that a new radiation is born in the process, which is then registered on the photographic film. To use this method, the photographic film must be insensitive to the primary particle radiation used for exciting the reaction. This requirement would seem to restrict the species of available primary radiations at present to one kind, namely, neutrons. Another requirement is that the element to be detected should have a much higher probability of reacting with the primary radiation than other elements present in the material under investigation. This can be achieved in some cases by the choice of neutrons with suitable energy, making use of the fact that different reactions have different resonance energies. Finally, the radiation produced in the reaction must be of such a nature that it can be properly registered on the film.

Boron is one of those elements where the ordinary autoradiographic method fails, since no suitable radioisotope is available. Instead, conditions would seem to be favourable for the use of nuclear reaction radiography in this case. The reaction which suggests itself is:

$${}_5^{10}B + {}_0^{1}n \rightarrow {}_3^{7}Li + {}_2^{4}\alpha.$$

For thermal energy neutrons, the cross-section has the very high value of 3,000 barns. The α-particle is emitted with an energy of 1·5 MeV., which is a very favourable value for photographic trace production. The range of these particles is about 5 μ in the emulsion, and in iron it is considerably less than this. Hence, the method should be capable of yielding very high resolution. I have investigated this method, using Kodak Autoradiographic plates. These photographic plates should give very good resolution because (i) the emulsion is very fine grained, (ii) the emulsion can be stripped from the glass plate and mounted directly on the sample under investigation. A further advantage with this material is that the sensitivity to γ-radiation is very small, whereas the sensitivity to α-radiation is high.

The method has been tested on an experimental alloy made up of 98 per cent iron and 2 per cent boron. A small sample of this was ground polished and etched, and given a thin protective coating of collodion in order to keep the surface free from tarnish in the subsequent work (otherwise it will rust very readily). The collodion film was less than 1 μ thick. The freshly stripped, wet emulsion was placed on top of this and was allowed to dry in position, which made it adhere firmly to the sample. The sample was then placed in a light-tight container, where it was irradiated for 16 min. with neutrons from a cyclotron. A block of lead, inserted between the sample and the cyclotron, served to reduce as much as possible the amount of γ-radiation reaching the emulsion. The sample was surrounded by paraffin wax in order to obtain a favourable proportion of thermal neutrons. After irradiation, the emulsion was developed and compared with the metal surface in an ordinary microscope. The results are illustrated by the accompanying reproductions. It is evident that the emulsion stripped from the sample reproduces the distribution of boron quite accurately, and that it is possible to work at quite considerable magnification.

I am grateful to the Nobel Institute for Physics in Stockholm, where Mr. S. Thulin kindly carried out the cyclotron irradiation, and to Mr. L. Erwall of the Division of Physical Chemistry at the Royal Institute of Technology, Stockholm, who placed the Kodak Autoradiographic plate material at my disposal; this emulsion undoubtedly played an important part in the success of this experiment.

MATS HILLERT

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April 12.

The Point-Charge in the Non-symmetric Field Theory

GAGANBIHARI BANDYOPADHYAY'S remark[1] about one of the spherically symmetric static solutions, that were given in a paper by one of us[2], is interesting, but it has not the meaning this author attributes to it. This solution cannot possibly refer to an electric charge at the centre, but only—if to anything electromagnetic—to a magnetic charge, that is, to an isolated magnetic pole. Indeed, the one component to which the six-vector is reduced in this solution is radial and is labelled by the indices 1 (referring to the radial direction) and 4 (referring to time). Now, in contrast to the conventional labelling, the present theory has to identify the electric field with the three components of the six-vector that do *not* include the index 4 (*if* the skew part of g_{ik} is to represent electromagnetism). The reason is that the theory definitely yields one and only one set of four Maxwellian vacuum equations. This set has to enunciate the vanishing of the *magnetic* four-current, not of the electric one; and this imperatively demands the association of labels indicated above. We may add that the necessity to reverse the convention is very satisfactory and is, in itself, likely to strengthen our confidence in the new theory. Indeed, very good reasons for reversing the conventional association were pointed out by Einstein[3] long ago and repeated by one of us[4] since.

Thus Bandyopadhyay's remark[1] really means that an isolated magnetic pole, attached to a finite mass, impossible according to the more stringent version, roposed by Einstein lately[5], of the non-symmetric heory. We might strengthen this argument by aying that, to introduce as a singularity what the eld equations definitely disallow where they hold, as a daring enterprise anyhow, justified only by he endeavour to investigate, at the then undeveloped tage of the theory, *all* spherically symmetric solutions.

But what about the electrically charged masspoint ? The same paper[2] (§§ 8 and 9) fully discusses his case as well, though it is analytically far more ntricate and has only recently found its explicit xpression (see Wyman[6]). It is gratifying to find that he only reasonable solution with a radial *electric* ield is not only *compatible* with Einstein's recent more stringent version, but, of necessity, complies ith it (see equations 30*b* and 23, *l.c.*[2]).

To sum up: the new theory exhibits a pleasing ack of symmetry with regard to electric and magnetic quantities. Even in its most stringent form it dmits of electrically charged mass-points, while solated magnetic poles are well-nigh inadmissible in ny form of the theory.

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Nature, 167, 648 (1951).

Papapetrou, A., *Proc. Roy. Irish Acad.*, 51 (A), 163 (1947).

Sitz. Ber. d. Preuss. Akad., 414 (1925).

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Effect of Cross-wind on a Projectile

THE usual formula for drift of a projectile due to ross-wind is:

$$z = w\,(t - x/v)\ \text{(ft.)}, \tag{1}$$

here w is velocity of cross-wind (ft./sec.), t is time f flight (sec.), x is range through air (ft.), v is muzzle elocity relative to the air (ft./sec.). At short times f flight it is not always easy to calculate $(t - x/v)$ ith reasonable speed and accuracy.

By integrating the equation of motion along the rajectory

$$mx = -\rho\,(v^2 + w^2)\,r^2 f_R, \tag{2}$$

here m is mass of projectile (lb.), x is range along he trajectory (ft.), ρ is air density (lb./ft.^{3}), r is adius of projectile (ft.), f_R is drag coefficient, and , w are as in (1), expanding in series and substituting n (1), we obtain

$$z = 0{\cdot}000067\ wvt^3\,d^2 f_R/m\ \text{(ft.)}. \tag{3}$$

Equation (3) is easy to use, but is valid at short times of flight only. The result is better at subsonic velocities than at supersonic velocities.

It is hoped that a full account of this will appear elsewhere.

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Feb. 15.

Negative Point-to-Plane Corona—a New Mode of the Discharge

A NUMBER of investigators[1,2] in the field of negative point-to-plane corona have reported on the unsteady nature of the discharge at high values of gap voltages. Reference has been made to the movement of the active spot about the point, and the formation of 'plural spots'. I have found that, with certain gap geometries, a new mode of discharge can be observed.

As the applied voltage is increased, the point discharge passes through an unstable 'switching phase', sometimes with two or more active spots, but quickly settles down to the new mode. This consists of a ring-shaped discharge fitting neatly and symmetrically about the point, almost like a halo. Its structure is similar in appearance to that of the single spot, namely, a miniature glow discharge, with a negative glow of pronounced luminosity, a Faraday dark space, followed by a diffused and flared positive column. As yet I have been unable to achieve sufficient optical resolution to observe the Crookes's dark space.

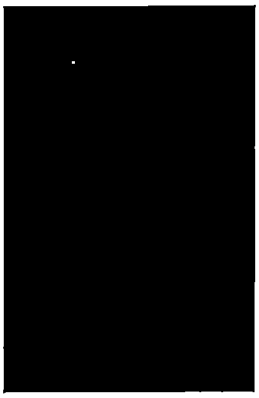

Fig. 1

It is obviously impossible to obtain a direct view on to the tip of the point, the line of vision being obscured by the plane; however, by using a highly polished plane, the image of the point and the discharge, in the plane, may be readily seen with the aid of a suitable optical system. Observations are best carried out in total darkness with a dark-adapted eye.

Fig. 1 shows a photograph of the ring on a 1-mm. diam. steel point, taken in this way; the point-to-plane gap was 10 mm., and the applied voltage and mean current were 10·9 kV., and 65 μamp., respectively. Fig. 2 shows a sketch of the point, drawn to the scale of Fig. 1, for the purpose of comparison.

In its new mode, the pulsating character of the corona persists, but oscillographic measurements

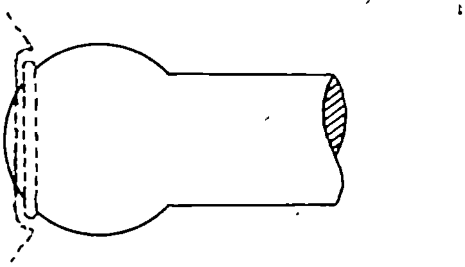

Fig. 2

indicate an apparent discontinuity in the frequency characteristic. A change in the mean current/gap voltage relationship, resulting in an increase in the charge per burst, is also evident.

A likely explanation of the phenomenon, which has so far gained considerable experimental support, is to be found in an extension of Loeb's[3] theory on the mechanism of Trichel pulses; that is to say, the new mode is engendered by space-charge considerations, as distinct from changes in Townsend's second coefficient, γ, for example.

A fuller report and discussion on the subject will be published in the near future.

ALLAN GREENWOOD

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[1] Trichel, G. W., *Phys. Rev.*, **54**, 1078 (1938).

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A Relationship between Heat Conductivity and Viscosity of Liquids

ANDRADE[1] developed a theory of viscosity of liquids based on a model in which the molecules are regarded as executing vibrations essentially similar to those characteristic of the solid state, the chief difference between the solid and the liquid states being that in the latter the amplitudes of the vibrations are so large that molecules make collisions (resulting in 'temporary unions') with neighbours at every extreme displacement. His viscosity equation is

$$\eta = \frac{4}{3} \cdot \frac{m\nu}{\sigma}, \qquad (1)$$

where η is the viscosity of the liquid, m the mass of a molecule in the liquid, ν its vibration frequency, and σ the average distance between the centres of the molecules.

From an essentially similar model, Osida[2] deduced that

$$K = \frac{4k\nu}{\sigma}, \qquad (2)$$

where K is the heat conductivity of the liquid and k the gas constant per molecule.

From (1) and (2),

$$mK/\eta = 3k.$$

Multiplying each side by the Avogadro number N,

$$NmK/\eta = 3Nk,$$

or as the molecular weight $M = Nm$ and the molar gas constant $R = Nk$,

$$MK/\eta = 3R. \qquad (3)$$

Since R in calories is very nearly 2,

$$MK/\eta = 6;$$

K is in calories, and η in poises.

In the accompanying table are shown values for the molecular weight in the vapour state M, the heat conductivity at the boiling point (a 'corresponding' temperature) K_{bp} in calories, the viscosity at the boiling point η_{bp} in poises and MK_{bp}/η_{bp} of some 'normal' liquids, K for which is known fairly accurately from Bridgman's measurements[3]. Values for K_{bp} have been calculated from Bridgman's data at 30° and 75° C., assuming a linear relationship between K and temperature[4]. Values for η_{bp} are after Macleod[5]. It will be seen from the last column of the table that

Liquid	M	K_{bp}	η_{bp}	MK_{bp}/η_{bp}
Acetone	58·1	0 000414	0·00232	10·4
n-Pentane	72·1	320	200	11·5
Ether	74·1	328	205	11·9
Carbon disulphide	76·1	375	308	9·26
Toluene	92·1	319	248	11·9
Ethyl bromide	109	284	329	9·41
Ethyl iodide	156	261	371	11

$$MK_{bp}/\eta_{bp} = \text{constant}. \qquad (4$$

The mean value of the constant is 10·8. It is eviden from this that, to be applicable at the boiling point the numerical coefficient in equation (3) require modification. This can be done, satisfactorily enough only on examination of a number of liquids. Unfortunately, however, data on K are scarce. Further different methods of measurement yield varyin values. Until these difficulties are overcome, th numerical coefficient in equation (3) can be modifie tentatively to 5·4.

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Banaras Hindu University.
Feb. 1.

[1] Andrade, *Phil. Mag.*, **17**, 497 (1934).

[2] Osida, *Proc. Phys. Math. Soc. Japan*, **21**, 353 (1939).

[3] Bridgman, *Proc. Amer. Acad. Sci.*, **59**, 141 (1923–24).

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Elastic Constants of Galena

RECENTLY, Ramachandran and Wooster[1] hav obtained the elastic constants of galena, among other substances, from measurements on diffus reflexion of X-rays, and reported disagreement wit the values given earlier by one of us[2]. Ramachandran has also directed our attention to this in privat communications. This substance, in the light o such values, also figures as an exception in a pape by Lonsdale[3] dealing with the vibration amplitudes of atoms in cubic crystals. Its elastic constant have therefore been re-determined, employing th wedge method and a very much better crystal tha was available at the time of the earlier investigations. Frequencies in the range 2–12 Mc./sec., and (001) and (111) sections of different thicknesses ranging from 1·450 mm. to 1·929 mm., have been used. Constants now obtained along with the bulk modulus K in units of 10^{11} dynes cm.$^{-2}$ are $c_{11} = 12·70$, $c_{12} = 2·98$, $c_{44} = 2·48$ and $K = 6·22$. They show that the Cauchy relation is fairly well satisfied. c_{44} and c_{12} do not differ very much from those o Ramachandran and Wooster, whereas c_{11} is somewhat larger. These values are to be regarded a much more reliable than any published earlier.

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Feb. 26.

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FORTHCOMING EVENTS

Tuesday, July 10—Friday, July 13

MEDICAL RESEARCH COUNCIL OF IRELAND (at University College and Trinity College, Dublin).—Colloquium on "The Chemotherapy of Tuberculosis".

Thursday, July 12

UNIVERSITY OF LONDON (in the Physiology Theatre, St. Mary's Hospital Medical School, Paddington, London, W 2), at 5 p.m.—Prof F. Verzar (Basle): "One or Several Adrenal Cortical Hormones".

Friday, July 13—Sunday, July 15

BRITISH MYCOLOGICAL SOCIETY (at Bristol).—Plant Pathology Field Day, Bristol Meeting, and Cotswold Foray.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMIST for work on the co-ordination of research and development on insecticides and fungicides—The Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1 (July 14).

DAIRY CATTLE HUSBANDRY OFFICER—The Director, Animal Breeding and Genetics Research Organization, Glenbourne, South Oswald Road, Edinburgh 9 (July 14)

LECTURER IN AGRICULTURAL SCIENCES at the Cheshire School of Agriculture, Reaseheath, Nantwich—The Director of Education, County Education Offices, City Road, Chester (July 14).

LECTURER IN MATHEMATICS—The Registrar, Technical College, Sunderland (July 14).

LECTURER IN METALLURGY at the Technical College of Monmouthshire—The Director of Education, County Hall, Newport, Mon. (July 14).

LECTURER IN PHYSICS, to teach Physics to B.Sc. (General) degree standard—The Principal, Enfield Technical College, Queensway, Enfield, Middx. (July 14).

RESEARCH DEMONSTRATOR IN BOTANY—The Secretary and Registrar, University College of North Wales, Bangor (July 14).

SCIENTIFIC OFFICERS (2, with good honours degree in botany or agricultural botany) for vacancies, one in grass breeding and one in grassland agronomy, at the Welsh Plant Breeding Station—The Registrar, University College of Wales, Aberystwyth (July 14)

SENIOR ASSISTANT ENGINEER—The Engineer to the Essex Rivers Catchment Board, Essex Rivers House, Springfield Road, Chelmsford, Essex (July 14).

CURATOR (University degree essential and the Museums Association Diploma desirable) IN ARCHAEOLOGY AND ANTHROPOLOGY—The Director, City Museum, Bristol (July 15)

DEMONSTRATORS IN THE BIOLOGY DEPARTMENT—The Registrar, University College of North Staffordshire, Keele, Staffs, endorsed 'Biology Demonstrator' (July 15).

LECTURER IN MATHEMATICS, and a LECTURER IN ANATOMY, at University College, Dundee—The Secretary, The University, St. Andrews (July 15)

READER or SENIOR LECTURER IN CHEMICAL PATHOLOGY, and a DEMONSTRATOR IN PATHOLOGY—The Registrars, The University, Manchester 13 (July 15).

SENIOR LECTURER, and a LECTURER, IN ENGINEERING—The Registrars, The University, Manchester 13 (July 15).

SENIOR PROFESSIONAL OFFICER (with an honours degree in agriculture, or some equivalent qualification, and specialized in field crops and in soil physics and chemistry), at the Sabi Valley Experimental Station, Division of Agriculture and Lands, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (July 15).

DEPUTY CHIEF ENGINEER—The Chief Engineer, Southend Waterworks Company, 13 Cambridge Road, Southend-on-Sea (July 16).

DIRECTOR OF FISHERIES, East Bengal—The High Commissioner for Pakistan, 35 Lowndes Square, London, S.W.1 (July 16).

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT (industrial or analogous experience desirable, with special interests and experience in radio engineering with particular reference to microwave technique)—The Head of the Electrical Engineering Department, City and Guilds College, Exhibition Road, London, S.W.7 (July 16).

RESEARCH ASSISTANT FOR ELECTRON MICROSCOPY—The Registrar, The University, Leeds 2 (July 16).

VIROLOGIST (male) to undertake research on virus diseases of fruit and hops (with special reference initially to the latter crop)—The Secretary, East Malling Research Station, Maidstone, Kent (July 16).

READERSHIP IN MINING—The Assistant Registrar, King's College, 3 St. Thomas' Street, Newcastle-upon-Tyne (July 17).

ASSISTANT DIRECTOR (Technical Underground) IN THE CENTRAL RESEARCH ESTABLISHMENT, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/349 (July 18).

PRINCIPAL SCIENTIFIC OFFICERS and SENIOR SCIENTIFIC OFFICERS in the Ministry of Food: (a) in London, PRINCIPAL SCIENTIFIC OFFICER (with a degree in biochemistry with biological subsidiary subjects, and experience in quality control and manufacture of foods essential) to take charge of the section dealing with the technological aspects of food hygiene and welfare foods; (b) in Aberdeen, PRINCIPAL SCIENTIFIC OFFICER (with a degree in botany or biochemistry, research experience in plant physiology and plant biochemistry; industrial experience of processing of vegetable products essential) to take charge of the section dealing with vegetable dehydration; (c) in London, PRINCIPAL SCIENTIFIC OFFICER (with a degree in chemistry or biological sciences, and practical experience of research and development in food production) to maintain liaison between the Department's Scientific Adviser, other Government departments and branches of industry concerned with manufacture and use of foods for emergency purposes; (d) in London, SENIOR SCIENTIFIC OFFICER (with a degree or an equivalent qualification, including chemistry and biological sciences) to undertake investigations in quality and reduction of wastage in foods; (e) in London, SENIOR SCIENTIFIC OFFICER (with a degree in biochemistry, physiology or chemistry) for advisory and survey work in nutrition; a knowledge of modern theory and practice of nutrition is essential; (f) in Aberdeen, SENIOR SCIENTIFIC OFFICER (with a degree in biochemistry or botany; research experience in plant biochemistry desirable) to undertake research on biochemical problems—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.4037/51 (July 19).

SENIOR PRINCIPAL PRODUCTION ENGINEER, Admiralty Production Pool—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S 4038/51 (July 19).

PROFESSIONALLY QUALIFIED CHEMIST as Assistant Secretary (Scientific)—The Secretary, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1, marked 'Private' (July 20).

ASSISTANT LECTURER IN BOTANY, for B.Sc. (Agric.) and B.Sc. (Hort.) degree courses—The Registrar, Wye College, Wye, Kent (July 21).

BOTANIST (with a good honours degree, and research or other experience in plant breeding, genetics or horticulture) for fruit-breeding—The Secretary, East Malling Research Station, Maidstone, Kent (July 21).

CHEMISTS (Senior Scientific Officer, Scientific Officer, Senior Experimental Officer, Experimental Officer, and Assistant Experimental Officer grades) at the Ministry of Supply Radiochemical Centre, Amersham, to be concerned with the synthesis of compounds labelled with radioactive isotopes, particularly Carbon-14, and with allied research problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.365/51A (July 21).

EDUCATIONAL PSYCHOLOGIST (woman, with honours or research degree in psychology) in the Somerset Child Guidance Service—The Chief Education Officer, County Education Office, Trull Road, Taunton (July 21).

LECTURER IN PHYSICS, and a LECTURER IN PHARMACOLOGY—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (July 21).

RESEARCH DEMONSTRATOR IN ZOOLOGY—The Registrar, The University, Sheffield (July 21).

RESEARCH OFFICER (Veterinary Physiologist) IN THE DIVISION OF ANIMAL HEALTH AND PRODUCTION, at McMaster Animal Health Laboratory, Sydney, N.S.W., to undertake research on animal physiology, especially on the physiology of the alimentary canal of ruminants—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3445 (July 21).

ASSISTANT LECTURER IN THE HYDRAULICS DIVISION of the Civil Engineering Department—The Head of the Department of Civil Engineering, Imperial College of Science and Technology, South Kensington, London, S W.7 (July 23).

RESEARCH FELLOWSHIP IN THE DEPARTMENT OF MATHEMATICAL PHYSICS—The Deputy Secretary, The University, Birmingham 3 (July 25).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree, preferably in engineering, and some industrial and research experience) in the Mechanical Engineering Research Organization (Department of Scientific and Industrial Research)—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4041/51 (July 26).

LECTURER IN ENGINEERING—The Secretary, The University, Aberdeen (July 27).

ASSISTANT EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER IN THE HYDRAULICS RESEARCH ORGANIZATION (Department of Scientific and Industrial Research), Wallingford, Berks, to assist in hydrographic surveying of beaches and estuaries and also to assist in research into the effect of waves and currents on beaches—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting E.270/51 (July 28).

ASSISTANT LECTURERS IN ELECTRICAL ENGINEERING—The Registrars, The University, Manchester 13 (July 28).

CHEMISTS (with a four-year University degree in science with chemistry as a major subject; experience in analytical work is essential and a specialized knowledge of pedology or soil science desirable) in the Chemistry Branch of the Division of Agriculture and Lands, Southern Rhodesia Government—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (July 28).

RESEARCH OFFICER IN THE ORGANIC CHEMISTRY SECTION, Division of Industrial Chemistry, Fishermen's Bend, Melbourne, to aid with investigations in progress on the chemistry and the refining of cane and other waxes—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3460 (July 28).

ANALYTICAL CHEMIST (with a degree in chemistry, biochemistry, or agricultural chemistry, preferably with honours) to be responsible for analytical work on grass and grass products, and an ASSISTANT ADVISORY OFFICER IN MYCOLOGY (with an honours degree in botany with specialization in either mycology or plant physiology, or a degree in agriculture with postgraduate study in these subjects)—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (July 31).

ASSISTANT CURATOR OF THE PATHOLOGICAL MUSEUM (the Keith Museum) of the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 31).

CHAIR OF AGRICULTURE at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 31).

CHAIR OF PHILOSOPHY in the Faculty of Theology, Royal University of Malta—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

CHIEF AGRICULTURAL ECONOMIST (with a specialized degree in agricultural economics) in the Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (July 31).

DEMONSTRATOR IN GEOGRAPHY—The Secretary, The University, 38 North Bailey, Durham (July 31).

INSTITUTION OF GAS ENGINEERS RESEARCH FELLOWSHIP for post-graduate research in gas chemistry—The Registrar, The University, Leeds 2 (July 31).

LECTURER IN ECONOMICS at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

LECTURERS or **ASSISTANT LECTURERS** (3) **IN GEOGRAPHY**, to carry out research in climatology and oceanography, historical geography, plant and animal geography, social geography, and field work, with special reference to Malaya and South-East Asia, at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 31).

LECTURER IN CIVIL ENGINEERING, and a **LECTURER IN MECHANICAL ENGINEERING**, at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 1).

RITCHIE PROFESSOR OF RESEARCH IN ECONOMICS at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 7).

VETERINARY OFFICERS and **RESEARCH OFFICERS** in the Ministry of Agriculture and Fisheries—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 130–173/51 (August 9).

LECTURER IN MATHEMATICS at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 15).

SENIOR LECTURER IN FLUID MECHANICS AND HYDRAULICS, and a **LECTURER IN CIVIL ENGINEERING**, at Canterbury University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.2 (August 20).

LECTURER IN GEOGRAPHY—The Secretary, The University, 38 North Bailey, Durham (August 31).

ALLEN AND HANBURY'S RESEARCH FELLOWSHIP (applicants must be pharmaceutical chemists or graduates in pharmacy, science or medicine of a university)—The Secretary, School of Pharmacy (University of London), 17 Bloomsbury Square, London, W.C.1 (September 1).

RESEARCH FELLOWSHIP IN THE DEPARTMENT OF ELECTRICAL ENGINEERING, for research in the field of vacuum insulation—The Registrar, Queen Mary College, Mile End Road, London, E.1 (September 1).

LECTURER IN MATHEMATICS at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 15).

ASSISTANT EXPERIMENTAL OFFICERS (including biologists) in various Government departments and divided between the following main groups and subjects: (*a*) mathematical and physical sciences, (*b*) chemistry and metallurgy, (*c*) engineering subjects, and (*d*) miscellaneous (including geology, library and technical information services)—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No 3068 (October 1).

CIVIL ENGINEERS, SANITARY ENGINEERS and **STRUCTURAL ENGINEERS** in a number of Departments in England and Scotland—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3405.LA (December 31)

ASSISTANT ENGINEER in the Public Works Department, North Borneo—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No 27322/48.

ASSISTANT LECTURER IN THE SCHOOL OF PHYSICS AND ALLIED SCIENCES—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

BIOCHEMIST to carry out research and other routine work in the Institute of Medical Research, Federation of Malaya—The Director of Recruitment (Colonial Service), 2 Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27106/49/51.

CIVIL ENGINEER (Ref. No 27322/211), and a **MECHANICAL ENGINEER** (Ref. No. 27333/39), to the Jamaica Government Railway—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting the appropriate Ref. No.

DEMONSTRATOR IN BOTANY at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

DEVELOPMENT GROUP MANAGER (with a good honours degree in chemistry, physical chemistry or physics, associateship of the Royal Institute of Chemistry or the Institute of Physics, or equivalent qualifications) at the Ministry of Supply Factory, Division of Atomic Energy (Production), Capenhurst, Chester, to take charge of an applied research and development laboratory engaged on special development work for a new atomic energy project—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

ELECTRICAL ENGINEERS in the Electrical Engineering Department of the Admiralty—The Admiralty (C.E H., Room 88), Empire Hotel, Bath.

EXECUTIVE ENGINEER in the Department of Works and Hydraulics, Trinidad—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/16.

HORTICULTURAL PRODUCTION AND MARKETING OFFICER—The Controller, Land Settlement Association, 43 Cromwell Road, London, S.W.7, endorsed 'H.O.'.

INSPECTORS OF AGRICULTURE (4) in the Ministry of Agriculture, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Inspector of Agriculture—4/11'.

INSPECTORS OF MINES in Malaya—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27099/5A.

INSTRUMENT ENGINEER (with an honours degree in engineerin corporate membership of one of the Institutions of Mechanical Electrical Engineers, or equivalent qualifications) at Windscale Work Sellafield, Cumberland, to be responsible for the supervision of wor shops engaged in the construction, installation, maintenance, repa and calibration of a wide variety of instruments—The Ministry Supply, Division of Atomic Energy (Production), Risley, Warringto Lancs, quoting WD.2/1.

LECTURER IN MECHANICAL ENGINEERING—The Secretary an Registrar, University College, Southampton.

LECTURER IN METALLURGY—The Registrar, University Colleg Singleton Park, Swansea.

LECTURER IN PHYSICS—The Principal, North Staffordshire Technic College, Stoke-on-Trent.

PROFESSIONAL ENGINEERS, General Service Class (Main and Seni grades), in the Admiralty and other Government departments—T Secretary, Civil Service Commission, Trinidad House, Old Burlingt Street, London, W.1, quoting No 8.86/51.

SENIOR SCIENTIFIC OFFICERS and **SCIENTIFIC OFFICERS** in vario Government Departments and covering a wide range of scienti research and development in most of the major fields of fundament and applied science—The Civil Service Commission, Scientific Bran Trinidad House, Old Burlington Street, London, W.1, quoting No. 39

SONICS SCIENTIST (physicist or biophysicist with Ph.D. degree, goo grounding in acoustics with two or more years experience in soni research, British) to be responsible for a sonics section with a staff several junior scientists—The Director of Research Personnel, Defen Research Board, Department of National Defence, 'A' Buildin Ottawa, Ont., Canada, quoting Competition G-8.

WORKS MANAGER (with either *a*, an honours degree in engineerin or corporate membership of the Institution of Mechanical or Electric Engineers, or *b*, an honours degree in chemistry or physics and ass ciateship of the Royal Institute of Chemistry or the Institute of Physic at the Ministry of Supply Factory, Division of Atomic Energy (Pr duction), Capenhurst, Chester, to be responsible for the operation of large chemical engineering plant engaged in the production of atom energy material—The Ministry of Supply, Division of Atomic Energ (Production), Risley, Warrington, Lancs, quoting 'CB/3'.

REPORTS and other PUBLICATION

(*not included in the Monthly Books Supplement*)

Great Britain and Ireland

British Library of Political and Economic Science Annual Report 1949–50. Pp. 20. (London: British Library of Political an Economic Science, London School of Economics and Political Scienc 1950.) [24

University of London: University College. Annual Report October 1949–September 1950. Pp. 171. (London: Universit College, 1951.) [24

International Council of Scientific Unions. Report of the Executiv Committee, 1950. Edited by F. J. M. Stratton. Pp. viii+78. (Cam bridge: At the University Press, 1951.) 5*s*. [24

Department of Scientific and Industrial Research: Road Researc Laboratory Road Research Technical Paper No 20: Pavemen Design for Roads and Airfields. By H. H. Davis. Pp. vi+50. (London H.M. Stationery Office, 1951.) 1*s*. 9*d*. net. [24

Library Association (London and Home Counties Branch). Repo on the Municipal Library System of London and the Home Countie 1949. General Editor: James D Stewart. Pp. 32. (London: Librar Association (London and Home Counties Branch), Central Publ Library, Hampstead, 1950.) [25

Other Countries

International Union for the Protection of Nature. Proceedings an Reports of the Second Session of the General Assembly, held Brussels, 18–23 October 1950. Pp. 82. (Brussels: International Unio for the Protection of Nature, 1951.) [24

Koninklijk Nederlands Meteorologisch Instituut, De Bilt. No. 108 Seismic Records at De Bilt, 34, 1946. Pp. vii+38 1 *f*. No. 12 (Mededelingen en Verhandelingen, Series B, Deel 11, No. 13): A Investigation on some Aspects of the Effect of Land and Sea Breeze By Dr. F. Balkema Pp. 50. 1.50 f ('s-Gravenhage: Staatsdrukkerij en Uitgeverijbedrijf, 1950.) [24

Scientific Institutions and Scientists in Latin America. Venezuel Vol. 1. Pp. iii+131. (Montevideo: Unesco Centro de Cooperació Cientifica para América Latina, 1951.) [24

Fieldiana. Zoology, Vol. 31, No. 41: A Review of the Woodpecker *Chrysoptilus melanochloros* and *C. melanolaimus*. By Melvin A. Traylo Jr. Pp. 421–438. 20 cents. Zoology, Vol. 31, No. 42: Amphibian and Reptiles of the Hopkins–Branner Expedition to Brazil. By Ka P Schmidt and Robert F. Inger Pp. 439–466. 40 cents. Zoolog Vol. 31, No. 43: A New Lizard of the Genus Varanus from Ne Guinea. By Robert Mertens. Pp. 467–472. 10 cents. Zoology, Vol 31, No. 44: Two New Mammals from Southern Peru. By Colu Campbell Sanborn. Pp 473–478. 10 cents. (Chicago: Chicag Natural History Museum, 1951.) [24

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Gallenkamp Universal Water-Baths. (Publication 531.) Pp. (London: A. Gallenkamp and Co., Ltd, 1951.)

Murex Review. Vol. 1, No. 8. Pp. 165–198. (Rainham: Mure Ltd., 1951.)

BTL Bulletin and Laboratory Notes. Series 2, No. 17, April. P 32. (Chadwell Heath: Baird and Tatlock (London), Ltd., 1951.)

The Nivoc Supplement. Spring 1951. Pp. 20. (London and Birming ham: W. and J. George and Becker, Ltd., 1951.)

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PLANNING AND LAND UTILIZATION

THE progress report by the Ministry of Local Government and Planning* on the work of the Ministry of Town and Country Planning from its establishment in February 1943 until it was merged in the Ministry of Local Government and Planning in January 1951 touches on numerous matters of direct interest to the scientific worker. There is a most readable account of the way in which the establishment of the Ministry arose out of the unsuccessful attempts in the previous twenty years to deal with planning problems permissively and piecemeal, and out of the consistent recommendations of the Barlow, the Uthwatt and the Scott Reports in favour of a central planning authority. The legislation of these eight years, during which five major Acts were passed, is then reviewed, and, in particular, the difficulties of the Town and Country Planning Act, 1947, are explained, and the present organization for planning is outlined; the second part of the report deals broadly with local and regional planning and is at pains to show how development control operates, the position in regard to compensation and the reasons why progress in some respects has been so slight.

This lucid exposition of the work and policy of the Ministry explains many of its actions if it does not always justify them; but the major effect of such a stock-taking is to raise more fundamental issues, and on the chief of these the report is silent. It refers, for example, to difficulties which the local authorities encountered and stresses their new powers and responsibilities; but it ignores the important factors which are eroding the whole structure and spirit of local government and which were emphasized in a recent debate in the House of Lords on April 25. Although the report admits that town planning has few positive achievements to its credit as yet, the Ministry still appears to be confident that such achievements will be possible in the future. But the question whether the capacities of the Ministry really match its powers is never faced. Indeed, this survey leaves the answer to that question in some doubt. Many of the factors that have held up progress have been due to causes outside the control of the Ministry; but on the evidence of this report, the Ministry has sometimes failed to appreciate the meaning of effective priority. Moreover, when achievement is small, the question is inevitably asked whether the large machinery set up and engaged in the routine administration of planning controls is yielding a social dividend. If it is not doing so, and is not seen to be doing so, a clear answer must be forthcoming to the question what the public is getting in exchange for its money and for the disturbance which the planning authorities, and with them the Central Land Board, are causing.

Further, the really fundamental issues raised in the third part of the report, which deals with planning problems of national importance, are not adequately discussed. Technical problems intrude to a limited extent into the discussion of local and regional problems in the second part of the report; but in the main it is with this third part that scientific workers will be most closely concerned.

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* Town and Country Planning 1943–1951. Progress Report by the Minister of Local Government and Planning on the Work of the Ministry of Town and Country Planning. (Cmd. 8204.) Pp. vii+215. (London: H.M. Stationery Office, 1951.) 5s. net.

First among these problems is that of the conflicting claims on land. Here again the report gives a reasonable account of the way in which the attempt is made to discharge the most important and difficult responsibility of the planner: that of balancing, and, where possible, reconciling, the rival demands between agriculture and other forms of development so as to secure that land is used in the best interests of the community at large. There is, it is emphasized, little more than half an acre of food-producing land in Great Britain for each member of the population, and the amount of improved farm-land also represents roughly the amount of land which, being well-drained and fairly level, is most suitable for development.

The report points out that it is a healthy sign of a more realistic attitude to agriculture that inroads upon agricultural land to-day provoke outspoken criticism; and on the showing of this report the Ministry has been more successful than is frequently supposed in resisting claims that conflict with the wider national interest. Particularly in dealing with the demands of the Services, the Ministry has been able to secure the withdrawal of a large number of important proposals. The record of its activities given in this chapter of the report deserves to be widely known; for it presents the broadest picture of the whole situation that is conveniently available. The question of mineral extraction and the restoration of land is dealt with in a subsequent chapter; but otherwise the picture is fairly complete. Industrial development, agriculture, transport, the hydro-electric schemes, water supply, housing, schools and playing fields—the demands which all these make for land are passed in review, and generally speaking it would appear that the situation is much more satisfactory than might have been expected in view of the failure to implement certain of the recommendations of the planning reports mentioned earlier.

Certain main features in the present situation are well indicated; but not all of them receive full attention. Stress is rightly laid on the importance of new proposals, such as hydro-electric schemes, being discussed with the local planning authorities while it is still possible to modify them. Nothing, however, is said as to the importance of such projects being considered—and at an early stage—in relation not merely to conflicting claims on the land but also to other schemes in the same field. Particularly in regard to the Services claims for land, some of the hydro-electric schemes and the projects for water-supply, there is reason for doubting whether the possibilities in regard to co-operation or alternatives have been properly explored or even considered before advancing some of the proposals. Few if any of the water undertakings have faced the plain fact that unless steps are taken to deal with the waste of water, all the possible gathering grounds of Britain will be insufficient to meet the demand within a few decades, even if agriculture and every other interest are entirely disregarded.

Nor is there anything in this report which brings out adequately the Ministry's anomalous position. Where the demands for land come from other government departments, it is one among others in attempting to adjudicate, and may even be placed in the invidious position of attempting to judge its own case. The predilection of the Service departments and other departments to do this is one cause of the bitterness with which their claims for land are received and discussed, and the Ministry should not be placed in such a position. It might, indeed, reasonably be reponsible for attempting to secure agreement between departments in the light of government policy for the particular region concerned or the country as a whole, and it might even be responsible for seeing that the national point of view is adequately presented to the interdepartmental committee which is called upon to resolve any continuing clash of opinion. It cannot fairly be responsible for decision.

Although the existing arrangement has worked somewhat better than might have been expected, there have been some unwelcome reminders of late that the situation is not without its dangers. One case, not mentioned in this report, is the new afforestation plan of the Forestry Commission for the Quantocks, reasoned objections to which, on scientific grounds as well as on those of amenity, have been advanced by a local society, the Friends of Quantock. The area is also one which was expected soon to become a detached part of the Exmoor National Park. A War Office scheme for a training area for Territorials at Upper Hulme, between Leek and Buxton, also conflicts with the purpose of the Peak District National Park, and threatens a breeding ground of rare birds; while at the other side of the same National Park a tentative proposal for a reservoir threatens the whole Edale valley.

A fresh threat to Braunton Burrows has also been raised by the War Office application to use this area for training in combined operations (see *Nature*, June 2, p. 869). The scientific importance of this area was indicated in a note in *Nature* so long ago as November 30, 1946; that the area should again be in dispute testifies to the unsatisfactory character of the present arrangements for dealing with such claims, and to that weakness in the Ministry of Local Government and Planning which the present survey tends to ignore. The Ministry's main function in interdepartmental discussions is to see that due weight is given to all conflicting factors, and, until the Nature Conservancy was established, the Ministry was spokesman for the interests over which the Conservancy now watches. It remains to be seen whether such scientific interests will be more effectively pressed by the Conservancy.

When all credit is given to the Ministry for its success in the field generally, on the evidence of this report alone some much more effective means is required for dealing with the claims of government departments, notably where the Services or mineral workings are concerned, and for ensuring that there is proper consideration within departments before the discussion reaches interdepartmental level at all. There is no evidence that the Minister of Defence has attempted to secure co-ordination of the demands of the three Services for land for training purposes or proper co-operation in the use of the land allocated to them; a similar situation appears to exist in regard to mineral working. This question is discussed in some detail in the next chapter of the report. Here again little objection is possible to what is postulated as the main objectives in any policy which is to reconcile industry's need for raw materials with other claims on land, or even to the steps which are regarded as necessary to implement that policy. It is essential to see that mineral working, while meeting industrial needs adequately, does not waste land, interfere with agriculture or damage amenity, and that it is properly integrated with building and other necessary surface uses. That involves, in turn, keeping important mineral deposits available for extraction by preventing surface development that might unnecessarily sterilize them, and also ensuring that suitable deposits are available to mineral undertakers in accordance with the national need.

The doubts that arise in this matter are rather as to whether the steps already taken are sufficient to achieve the desired results, particularly since the provisions of the Mineral Workings Bill for the restoration of land devastated by mineral workings apply only to specified counties and to opencast workings. This exclusion of other mining appears to be unsound; and although according to this survey the Ministry of Fuel and Power consults the Ministry of Local Government and Planning before sites are requisitioned, there is no assurance that this practice will continue or that there is any effective means at present of restraining the Ministry of Fuel and Power from judging its own cause.

Despite, therefore, the examples of successful representations quoted in this report, we cannot rest content with the steps already taken. It is not sufficient for all mineral workings to be brought completely under planning control, and for the Government to take its appropriate place in the planning of mineral workings. It will be little better placed than local authorities to relate particular questions to long-term needs unless it possesses far wider knowledge of both the geological and the industrial aspects of mineral production. Basic information on the economics of production and distribution and of the detailed requirements were lacking, as well as facts about the distribution within known deposits of economically valuable material and its physical and chemical qualities, when mineral extraction first came under effective planning control.

Research into these problems is the first essential, and should be undertaken as a matter of urgency. The absence of the basic information makes nonsense of the suggestion in this report that the responsibility of deciding that certain areas shall not be worked for minerals must carry with it the obligation to ensure that suitable areas are selected for working, and that industry can secure the necessary ownership or working rights. Had the essential information on the economics of working, including restoration, and on alternative sources been available, some of the worst devastation due to opencast coal mining might have been avoided. No lesson of this survey is indeed more emphatic than that of the futility of attempting planning in any positive sense except on the basis of factual knowledge.

Something more is said on this point in the final chapter of the report. Although the research staff of the Ministry of Local Government and Planning includes geologists who are responsible for preparing reports on the minerals essential to industry and on the incidence of the more common minerals won by surface working, it does not appear that expansion of this staff is either contemplated or desirable. The task of the Ministry should be rather to stimulate the necessary investigations by the bodies best equipped for the purpose, such as the Geological Survey, the Department of Scientific and Industrial Research, the universities and so on. The field is one in which an Economic Research Council might have been of invaluable assistance, particularly when co-operating with other bodies such as the Agricultural Research Council.

The activities of the Ministry in regard to the protection of amenity have already been mentioned incidentally; but a separate chapter of the report discusses such problems in general, and in particular relation to the preservation of trees and woodlands, as well as the preservation of buildings and the design and appearance of new buildings. Its responsibilities in regard to national parks are summarized in a chapter which adds little to what was contained in the first report of the National Parks Commission. The account, however, is even more persuasive as to the ability of the Ministry to restrain the departments and other interests from causing irreparable damage to our scenic heritage. Moreover, in confirming, substantially as it was made by the National Parks Commission, the designation order for the Peak District National Park, the Minister for Local Government and Planning not only strongly endorsed the views of the Commission, but also stressed the importance of mutual accommodation between those who live and work in the parks and those who visit them.

The importance of that factor is somewhat obscured in this report and indeed by the very vigour with which Mr. Dalton is implementing the provisions of the National Parks Act. It is all to the good that the establishment of national parks should proceed apace, and that a national park safeguarding the Pembrokeshire coast and the Prescelly Hills should be proposed for this year and one for Brecon Beacons and the Black Mountains next. But there is at least a danger that too much may depend on the interest and personality of the Minister himself, and under Mr. Dalton's successors the Ministry may prove unable to sustain the battle on the same equal terms. It is plain from this report that there is no one man or body equipped with all the factual knowledge on which to base sound decisions as to the right use of land, nor is it easy to visualize such a body when all the necessary fact-finding and research have been completed. The most that can be expected is some means of preventing snap and *ex parte* decisions, in which conflicting claims and long-term interests are ignored. Adjustment of such claims and of short- and long-term interests must of necessity take place at a high level, but this does not imply of necessity a super-planning authority. The Ministry of Local Government and Planning is clearly capable of bringing into the discussions the reasonableness which makes co-operation and adjustment possible, and to that extent has justified its establishment though not necessarily the full extent of its organization. On that side there is room for much clearer thinking; but on the record here presented, the Ministry is entitled to claim the support of all who are concerned to see that the use of the land of Britain shall be determined on the basis of the fullest possible factual knowledge and on the due consideration of all the conflicting interests involved from a national and not from a purely sectional point of view.

TIME AND CLIMATE

Dating the Past

An Introduction to Geochronology. By Prof. Frederick E. Zeuner. Second edition, revised and enlarged. Pp. xviii+474+24 plates. (London: Methuen and Co., Ltd., 1950.) 30*s*. net.

THIS work is a second edition of a book first published in 1945. It opens with a discussion of the methods of dating by tree rings and varves, and their use in establishing a chronology of Neolithic and post-Glacial times. This is followed by a discussion of the correlation and climatic changes of the Old Stone Age. The last eighty pages describe the time-scale for the whole geological column before the Pleistocene, as derived from radioactive considerations, and discuss the rate of evolution. The subject therefore includes diverse fields of the greatest difficulty and complexity. Its proper discussion demands a critical consideration of the whole of archæology and prehistory, a balanced judgment on the most delicate points of statistical theory and some knowledge of astronomy, meteorology and nuclear physics. To say that the author does not possess the necessary knowledge is not a criticism: no one does, least of all the present writer. To pick holes is easy; there are statements that "make one gasp and stretch one's eyes", as, for example, where it is said on page 16, "of 96 sun spots no fewer than 63 have periods between 9·9 and 11·9 years". Such absurdities are probably inevitable in so long and diverse an argument and do not touch the real purpose of the book.

The main theme is that the Croll–Ball–Milankovitch theory of the astronomical cause of ice ages gives an alternation of cool and warm periods that conforms to the facts of archæology. I must confess that I remain unconvinced. An enormous and intricate structure of fact and surmise is presented that at many points fits well with the calculated curves giving the variation of the heat arriving from the sun at the surface of the earth. It is rash for an amateur in these matters to question such a performance; but awkward doubts occur. Why is America dismissed in one page although, "In North America, Pleistocene chronology is, of course, highly developed"? Can it be because it gives little evidence in support of Milankovitch? Is the evidence for three phases of the last glaciation derived from the three buried channels near the mouth of the Thames convincing? There is a channel for each phase, and in a table it looks admirable until one remembers that there are dozens of other buried channels in southern England that are not mentioned.

It may with some justice be argued that a dubious or incorrect principle is better than none, and that, right or wrong, Prof. F. E. Zeuner does provide a framework on which to hang the facts, and does introduce some order into the chaos of prehistory. If the framework is, in fact, wrong, the quickest way to demonstrate it is to hang facts on it until they patently will not fit. In the meantime, it would be difficult to suggest an alternative as detailed that would fit at all.

I think it is impossible for anyone used to the firm ground of physical science, or even to the penumbra of doubt that usually accompanies a geological fact, to read any discussion of prehistoric chronology without a profound feeling of distrust. The mind revolts at such fare. Why should one believe Prof. A. rather than Prof. B. or Prof. Z.? What are the criteria? What is fact and what is wishful thinking? If one is told bluntly that Korn has observed a "sunspot cycle" of 11·5 years in the thickness of the varves in the pre-Cambrian Nama beds in South-West Africa, does it mean that the matter is beyond reasonable doubt? After looking at Korn's paper, I am very doubtful of the existence of any real periodicity, and certain that the point has not been established. The correlation of varve and tree-ring sections and the extraction of periodicities from them are statistical questions involving series the terms of which are not independent. It is remarkable that the great developments in the theory of such series in the last ten years have not been applied in this field. Arguments based on the assumption that the terms must either be independent or be governed by 'periods' can never be convincing. There seems to be a firmly planted instinct in the human mind that wishes to find periods in autocorrelated series, and there is no subject in which there is a greater danger of error. The weakness of Prof. Zeuner's argument in this respect is not to be laid at his door; the subject has just not been developed in a satisfactory manner. In some matters he shows more caution than his predecessors; in particular, he expresses a well-founded disbelief in the teleconnexion of varve series.

In spite of all these doubts and uncertainties, Prof. Zeuner's book does serve a most valuable purpose. It brings together in a coherent way a great body of knowledge and sets it out in such a manner that everyone can see how defective our understanding of it is. The next step in the solution of the difficulties probably lies with the physicist, the chemist and the oceanographer, and for them an easily digested summary such as this is invaluable. It is likely that in the next ten years work on radioactive carbon, on the distribution of isotopes and on ionium in ocean cores will enable us to obtain a knowledge of the changes of temperature in the past and of their dates. It may well be that in his next edition Prof. Zeuner will be able to give some of his dates and correlations as facts. He could then with confidence reverse many of his arguments and use the dates to support his interpretation of the facts. E. C. BULLARD

MATHEMATICS OF NON-LINEAR VIBRATIONS

Nonlinear Vibrations in Mechanical and Electrical Systems

By J. J. Stoker. (Pure and Applied Mathematics, Vol. 2.) Pp. xix+273. (New York and London: Interscience Publishers, Inc., 1950.) 40s.

Contributions to the Theory of Nonlinear Oscillations

By S. P. Diliberto, L. L. Rauch, F. H. Brownell, M. L. Cartwright, J. G. Wendel, C. E. Langenhop, A. B. Farnell, W. Wasow. Edited by S. Lefschetz. (Annals of Mathematics Studies, No. 20.) Pp. ix+350. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1950.) 14s. 6d. net.

FOR more than two hundred years mathematicians have studied the properties of linear differential equations. In many problems, such as that of pendulum motion, where the equations are really non-linear, the linear approximations give a sufficiently good idea of what actually happens. However, engineers knew that many oscillatory mechanical devices had properties not explicable by the linear approximations; but until comparatively recently, these devices were small and inexpensive, and the easiest way to investigate them was by constructing and operating them. But now, in these days of aircraft, guided missiles and automatic chemical-process plants, it is an economic necessity to calculate in advance the possibly troublesome phenomena which may arise from the vibrations being non-linear. This work was at first undertaken chiefly by engineers and physicists. Now the pure mathematicians, especially in the United States and the U.S.S.R., have realized their opportunities in this field. They are pleasantly surprised to find how important the classical work of Poincaré, Hill and Mathieu turns out to be as a starting-point in attacking the new problems.

An excellent introduction to the subject is given by the first book, that by Prof. J. J. Stoker, whose lucid exposition gives continual references to particular mechanical or electrical systems from which arise the differential equations considered. The first chapter recalls the properties of linear vibrations. The second and third deal with free vibrations when the restoring force is non-linear, using a graphical discussion of the energy curve in the displacement–velocity plane, in which the time is taken as a parameter, and Poincaré's discussion of singular points is of fundamental importance. These methods, however, cannot be used when the time occurs explicitly in the differential equations, as for forced motion. The fourth chapter gives Duffing's apparently unnatural method for dealing with these problems, a method which succeeded when all straightforward approaches, even that of Rayleigh, had failed. This chapter includes also a number of useful analytical methods, in particular those of iteration and perturbation, and ends with a table showing some contrasts between linear and non-linear vibrations. The fifth chapter deals with non-linearity in the damping, which is responsible for 'self-sustained' oscillations, such as occur in radio valves, and in the 'flutter' of aircraft wings. The collapse of the Tacoma bridge is generally ascribed to these oscillations. A special analytical method for such problems was devised by Van der Pol, and this has been used extensively in the U.S.S.R. Other methods are due to Andronow and Witt, and to Miss Cartwright and Littlewood. It is rather surprising that the sixth chapter should deal with *linear* differential equations with periodic coefficients, but these are necessary for discussing the stability of non-linear oscillations. The classical results of Hill, Floquet and Mathieu thus gain a new importance. The appendixes give a rigorous mathematical justification of methods used in the main part of the book, which can be warmly recommended to engineers, physicists and mathematicians.

The second work under review is a collection of monographs edited by Prof. S. Lefschetz and will appeal chiefly to mathematicians engaged in research on the theoretical aspects of the subject, though many of the problems have a physical origin. S. P. Diliberto discusses some general questions connected with Poincaré's results; L. L. Rauch deals with a differential equation of the third order arising from a problem concerning radio valves; and F. H. Brownell investigates the oscillatory solutions of a difference-differential equation, such as arise in control problems. The longest paper is by Miss M. L. Cartwright, and deals with forced oscillations. Similar problems are treated in a different way in papers by J. G. Wendel, by C. E. Langenhop and A. B. Farnell, and by W. Wasow. This volume, like other Princeton University publications, deserves careful study by research workers.

H. T. H. PIAGGIO

MECHANICAL PROPERTIES OF METALS AT HIGH AND LOW TEMPERATURES

The Properties of Metallic Materials at Low Temperatures

By P. Litherland Teed. (Monographs on Metallic Materials, published under the authority of the Royal Aeronautical Society, Vol. 1.) Pp. viii+222. (London: Chapman and Hall, Ltd., 1950.) 21s. net.

Properties of Metals at Elevated Temperatures

By George V. Smith. (Metallurgy and Metallurgical Engineering Series.) Pp. x+401. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 59s. 6d.

THE wide temperature range, some 1,100 deg. C., over which the engineer is concerned with the mechanical properties of metals and alloys is covered by these two volumes.

"The Properties of Metallic Materials at Low Temperatures" is the first of a series of monographs to be published under the authority of the Royal Aeronautical Society, and contains a survey of existing knowledge regarding the non-ferrous metals and their alloys, and the steels. The bringing together of this information is justified not only in connexion with the construction of planes for high-altitude flight, but also by the increasing use of low temperatures by the chemical engineer. Chapters are devoted to a consideration of the major mechanical properties of aluminium, iron, magnesium, copper, nickel, zinc, tin and lead and their alloys, about one-half being devoted to the plain carbon and alloy steels. The author points out that the variations of properties at very low temperatures are as yet unpredictable, and makes the further most pertinent point that the fruits of long and careful work are too often wasted as a result of inadequate description of the composition, and the mechanical- and heat-treatment of the samples investigated.

The treatment in the second work, "Properties of Metals at Elevated Temperatures", differs considerably, in that almost half of the book is devoted to a more-or-less fundamental discussion of plastic deformation in general, both in single and polycrystalline material. A not inconsiderable proportion of this is concerned with room-temperature properties and behaviour, although the effects of higher temperatures do come in for consideration. This section provides an admirable introduction to the mechanical properties of metals, but appears, in places at any rate, to have no very direct connexion with the real subject of the book. Following this introduction is a chapter on high-temperature tests and the equipment employed, after which are discussed the effects of chemical composition on creep behaviour, of manufacturing variables, varying temperature and load, scaling and microstructural changes at high temperatures—the latter particularly dealing with the stainless steels—and a final chapter on design for service at elevated temperatures. A most useful series of nearly five hundred references to original work is given, and an appendix deals with "super-alloys", that is, materials with the highest (as yet) available strength at elevated temperatures. A very great deal of work has gone into the preparation of this most useful account, which has the added advantage that it provides a satisfactory summary of work done throughout the world, and not only in the United States.

Both these volumes can be recommended to the attention of all metallurgists and engineers who are concerned with the mechanical behaviour of materials at temperatures either below or above the normal.

F. C. Thompson

ELECTRONIC DEVICES

Voltage Stabilizers

By F. A. Benson. Pp. 125. (London: Electronic Engineering, 1950.) 12*s.* 6*d.*

The Industrial Applications of Gasfilled Triodes (Thyratrons)

By R. C. Walker. Pp. xi+325. (London: Chapman and Hall, Ltd., 1950.) 40*s.* net.

THE use of electronic devices in instruments and machinery of all kinds is becoming ever more widespread, both in industry and in the laboratory. Such apparatus is often designed by those who have only a very general training in electronics, and there is thus a great need for monographs on specialized applications to which one can turn for a more detailed description than can be found in general text-books, all the more so since the published literature covers a wide range of scientific and technical journals. Such monographs fall naturally into two classes: those which describe the different types of circuits devised to perform similar functions, and those which describe the different applications of a given circuit element.

"Voltage Stabilizers", which is based on the author's recent series of articles in *Electronic Engineering*, falls into the first of these two classes. In addition to dealing with the conventional types of A.C. and D.C. stabilizing circuits embodying saturated-core transformers, glow tubes and hard-valve circuits, some of the newer and less orthodox non-linear circuit-elements are briefly treated. I found the chapter on glow-discharge tubes particularly valuable, since a large amount of data on the stability of different British and American tube-types is collected here.

"The Industrial Applications of Gasfilled Triodes" is the latest of Walker's monographs and deals with the many different applications, not only of thyratrons but also of other grid-controlled gas-filled tubes. Like the author's two previous volumes, it should prove useful in suggesting ways in which problems of automatic control and measurements can be solved. It is a pity that the relatively high price may keep this book away from many laboratory bookshelves.

An important feature of monographs is necessarily an extensive bibliography, and both books are well served in this respect, although in "Voltage Stabilizers" one would have appreciated a classification of the references given at the end of the book.

U. W. Arndt

PASTEUR

Louis Pasteur, Free Lance of Science

By René J. Dubos. Pp. vii+418. (London: Victor Gollancz, Ltd., 1951.) 18*s.* net.

DR. RENÉ DUBOS is already well known to scientific men as the author of two valuable books, namely, "The Bacterial Cell" and "Bacterial and Mycotic Infections in Man". He has now written a book which has a much wider appeal and will be enjoyed by all who are interested in biological science and its development. No new information about Pasteur or his work has recently come to light; but it is interesting to have a book about a great man of science written after a considerable period of time has elapsed since his death, so that his influence upon progress can be critically examined.

Dr. Dubos is a Frenchman who is engaged in bacteriological research, and is especially well fitted to write about Pasteur's life and work. There is a vitality and enthusiasm in the presentation which suggests that as he studied the information existing about Pasteur, he was caught by the brilliance and importance of Pasteur's achievements, and could not rest until he had set down the whole story as he saw it and as he thought it should be told. It is not a simple biography, for it deals with the historical background which made Pasteur's discoveries possible, and with the philosophical implications of Pasteur's pronouncements. It is the work of a critical man of science who wishes to appraise correctly the scientific value of a man's work, and to try to discover whether his successes were due to the times as much as to the man, and if more to the man, to what especial characteristics.

This approach has resulted in a very interesting book which will not only be appreciated by scientific men, but also by the growing number of individuals who are to-day interested in scientific discovery, in how it comes about, and how it affects the life of the community.

The broad outlines of Pasteur's life and work are probably known to many, and the use of words such as 'vaccines' and 'pasteurization' keeps him always in mind. The historical background of the times in which he worked, and the intensity of purpose, hard work and self-denial which he had to exercise in order to overcome the many difficulties and to achieve success, may well be forgotten. All is clearly set down, and the greatness of Pasteur is vividly brought home to the reader.

It is a book which can be read and re-read with enjoyment and profit.

Cytology and Cell Physiology

Edited by Geoffrey H. Bourne. Second edition. Pp. xvi+524. (Oxford: Clarendon Press; London: Oxford University Press, 1951.) 50*s*. net.

THE second edition of this important book is to be welcomed, even though nothing like a coherent view of protoplasmic activity can yet be obtained from it. It is also perhaps to be kept in mind that its effective date is not 1951 but more nearly July 1948, as indicated by the preface. Even so, a great deal has happened since before the Second World War (the effective date of the first edition was 1941). Somewhat ironically perhaps, the most buoyant expressions of optimism regarding imminent progress to be expected in the next decade have been reprinted without change in the least emended chapters. On the other hand, where opportunity has been found for incorporating a large body of new matter, the usefulness to the reader of the subjects discussed has been very greatly enhanced. This concerns especially Schulman's chapter on monolayers, White's on cytogenetics, Bourne's on mitochondria and Golgi bodies, Ludford's on pathology, and Blaschko and Sanders's revision of the chapter on intracellular enzymes.

Two new chapters on histogenesis in tissue culture and in evolution respectively, by Fell and by Willmer, introduce aspects of normal (as opposed to pathological) histology in animals. At the other end, two additional introductory sections by Sanders and Barer, respectively, deal with some of the very powerful new technical developments such as phase-contrast microscopy, electron microscopy and the reflecting microscope. A certain amount of repetition has resulted from such a considerable insertion of new matter, and there are also a few distressing misprints, such as the quotation of 1300 A. as a wave-length of the infra-red (p. 71). Some of the new references mentioned in the text are omitted from the bibliographies.

These are, however, minor defects. On balance, the changes have been very beneficial, and though no single reader is likely to be equally concerned with the whole contents of the book, the great variety of recent bibliographies collected together under one cover is probably one of its most valuable features.

The Littoral Fauna of Great Britain

A Handbook for Collectors. By Dr. N. B. Eales. Second edition. Pp. xvii+305+26 plates. (Cambridge: At the University Press, 1950.) 20*s*. net.

THE second edition of Dr. N. B. Eales's well-known student's book of sea-shore animals has four additional pages devoted to examples of practical exercises in quantitative distribution on sandy and on rocky beaches. These pages are inserted in the appendix, leaving the main pagination unchanged. Some useful descriptions of eggs and egg capsules have been added here and there, and there are other small additions. Thus, *Elminius modestus* appears in the section on cirripedes, and the magnesium chloride method of narcotization has been added to that on preservation. The price of the book has been substantially increased.

In compiling this book the author was faced with a task from which most would have shrunk. One cannot but admire the way in which she has collected and set out an immense amount of most useful information on the classification, external anatomy—and, to a small extent, ecology—of most common and many uncommon shore animals and provided keys to help with their identification. There is no doubt, too, that this unique compilation is well liked—and justly so—by students attending courses in marine biology, although it probably covers more adequately the fauna at Port Erin than elsewhere, in spite of the inclusion of many species not recorded for that locality. The problem of selection must have been one of great difficulty, and it is only to be expected that it is not as successful for some localities as for others. Some groups receive relatively full treatment (for example, decapods, molluscs, echinoderms and fishes), mention being made of almost all species likely to be found on British shores, and quite a few from the region immediately beyond. Other groups, however, are not so completely covered. The treatment of the polychætes, for example, is inadequate for the south-west of England and, at Plymouth, often leads astray students who ignore the author's own instruction to consult the appropriate monograph for final identification. The inclusion in a future edition of another twelve or eighteen common Plymouth shore polychætes would do much to put this right. The section on amphipods could also be enlarged with advantage.

D. P. WILSON

Flora of the Land of Israel

Iconography. By Naomi Feinbrun and Michael Zohary. Pp. 12+50 plates. (Jerusalem: *Palestine Journal of Botany*, Hebrew University, 1949.) n.p.

THIS is a series of line drawings from living specimens portraying quite effectively a selection of Palestinean plants, mostly on a life-size scale. In addition to the habit, botanical details for some of the species are also illustrated. The collection is a miscellaneous one, and indeed no less than twenty-seven families are represented on these fifty plates. There is no obvious basis of selection; but, since the authors refer to this as a first step towards an iconography of the local flora, one may anticipate that it is but an instalment of what is intended ultimately to be a complete series.

Several of the figures represent endemics of Palestine, including three species of *Iris*, namely, *I. atropurpurea*, *I. mariae* and *I. nazarena*, the liliaceous *Bellevalia desertorum*, and *Orchis galilæus*. The brief accompanying notes furnish some morphological and other data, as well as indications of the distribution; but diagnostic botanical characters would have been a welcome addition, and the value of such would have been enhanced as the work proceeds and more species are added in the different groups.

The drawings mostly convey an excellent idea of the character of the species, and some, as, for example, those of the wild *Cyclamen persicum* and *Bellevalia flexuosa*, are exceptionally lifelike; only a few, such as those of *Ceterach officinarum* and *Oxalis cernua*, conspicuously fail to do justice to their subjects,

E. J. S.

Colours

And How we See Them. By Dr. H. Hartridge. Pp. xi+158+12 plates. (London: G. Bell and Sons, Ltd., 1949.) 15*s*. net.

THE six chapters of this book are mainly the content of the six Christmas lectures for children given by Prof. H. Hartridge at the Royal Institution in 1946. The treatment is therefore necessarily popular and approximate, designed to keep within the comprehension of a juvenile audience. It cannot, therefore, be subject to the same criteria of criticism as a book professing to be an authoritative guide to serious students. Nevertheless, Prof. Hartridge has accomplished the task he set himself extremely well, and the lectures have been turned into a very readable account of an interesting and fascinating subject. Anyone desiring an introduction to the problems and phenomena of colour and colour-vision could not do better than read this book, which can scarcely fail to afford pleasure in the reading or to leave an abiding interest which will induce him to extend his study to the less elementary and more rigorous literature in which the subject abounds.

Although, as already indicated, the advanced worker on colour will not look here for guidance on theory, science teachers and lecturers will find the book a mine of useful information on effective and fascinating lecture demonstrations, especially demonstrations by projection. Many teachers, even in universities and technical colleges, fail lamentably in giving life and interest to the study of light by adequate demonstrations of an arresting character. Prof. Hartridge has included in the book descriptions of many of the excellent demonstrations which illustrated his lectures. These cover many branches of the subject, and most of them require only simple apparatus which should not be difficult to improvise, even from the resources of a school physics laboratory.

The book is well printed in easily legible type. The illustrations include portraits of Sir Isaac Newton (frontispiece) and Thomas Young. There are many line diagrams and twelve coloured plates. The diagrams, on the whole, are good, except in a few cases where simplification has been carried beyond tolerable limits. The colouring of the plates is rather crude; but this is not likely to mislead the reader.

J. GUILD

A Camera in Antarctica

By Alfred Saunders. Pp. 160 (72 plates). (London: Winchester Publications, Ltd., 1950.) 21*s*. net.

THIS book, a record of fifteen years of photographing in the Antarctic, is noteworthy for its really magnificent collection of illustrations. Whether he is showing his reader 'close-ups' of bird or animal, or of scenery, Mr. Alfred Saunders contrives to excel, not only as a photographer but also as an artist. The general standard is so high that it is not easy to single out illustrations, but there is on p. 70 a remarkable photograph of the wanderer albatross. This great sea-bird has a wing span of twelve feet, which, incredible as it may seem, is almost double the wing span of the male golden eagle. The eggs of the wanderer albatross, we are told, weigh 1 lb. and are good eating; only one egg is laid. The Antarctic summer is too short for the growth of the young albatross, which remains in the nest unfledged throughout the winter with its blizzards and severe frosts. It is supposed that during the winter the parent albatrosses do not visit their young, which subsist on their accumulated fat; but Mr. Saunders believes that they do occasionally return and feed the young.

There is a truly remarkable series of photographs of the various Antarctic penguins, and we are shown one of an Adelie penguin being pushed by its large chick during feeding operations to the very edge of a 600-ft. precipice. The author mentions that one day he saw two penguins which had evidently fallen over this cliff. They appeared almost lifeless, and, a few feet away, Skua gulls were waiting for them to die. Yet when he visited the place the following day he found the penguins had almost recovered, and were actually walking about. That a flightless bird should survive after a fall of 600 ft. is almost incredible, especially when the descent ended not on the water but on rocks.

SETON GORDON

The Biochemistry of the Nucleic Acids

By Prof. J. N. Davidson. (Methuen's Monographs on Biochemical Subjects.) Pp. ix+164+4 plates. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1950.) 7*s*. 6*d*. net.

PROF. J. N. DAVIDSON's little book, the first of a new series of 'Methuen Monographs', was published last autumn and has already proved its value to both research workers and students. It gives, in a short space, a very fair account of the chemistry and properties of the nucleic acids, leading to a fuller account of what is known of their function and metabolism. It is remarkable how much recent research he has managed to include in a small book. Although, as he points out in the preface, significant advances have been made since the book went to print and will no doubt continue, yet, broadly speaking, the emphasis is on recent work, and the serious student will find it an excellent introduction to the many researches which are going on.

It is a very remarkable fact that, although a close connexion with the processes of reproduction is suggested by the presence of nucleic acids in the chromosomes and in various particles which are known or suspected to be self-reproducing, and also by the close correlation between the onset of nucleic acid synthesis and the start of the mitotic cycle, no real clue has come to light as to their real function. Many workers have studied these compounds in the belief that they may perhaps discover in them the molecular nature of the gene, yet so far no one has been able to suggest a plausible method by which they could act in this way. All those biologists as well as chemists who want to know the real facts of the case could not do better than study this account.

The Complete Garden Handbook

By Maron J. Simon, John Elliott, Dickson W. Pierce and Beatrice P. Hendrix. Pp. xii+451+32 plates. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1950.) 37*s*. 6*d*. net.

THE aim of the authors of this comprehensive volume is to give "information on every topic of interest to the gardener, including planning the garden, choosing flowering plants, shrubs and trees, and every step in practical gardening". It is designed for American readers and will no doubt be welcomed by them for its completeness and handy size. It is inevitable that many of the terms used sound strange to British ears, and it is to be hoped that the American habit of telescoping plant names wherever possible (for example, "Morningglory") will not spread across the Atlantic. The volume is lavishly illustrated in colour; but, it must be said, the standard of the plates, both in design and execution, is very low. It is difficult to imagine what value there could be in a picture, however good, of a single, unnamed, daffodil flower; but when this appears (Plate 11*B*) as an unrecognizable yellow 'star-fish' against a bright blue sky, the result is deplorable, and the majority of the plates are of much the same standard.

J. S. L. GILMOUR

HYPOTHESES RELATING TO THE BRAIN–MIND PROBLEM*

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FOR the purpose of this article the use of the term 'mind' will be restricted to 'conscious mind' in all its general operational field of perceiving, thinking, willing. As such, mind is a fact of experience, though for each of us only our own mind is an observable. It has been argued that the private and restricted nature of the observation eliminates mind from that class of observable phenomena which are publicly observable and hence by general agreement regarded as facts of experience. But all observation is, of course, just as private and restricted, the public character being given by symbolic communication between observers, in particular through the medium of language. The private observation of conscious mind in this manner achieves public status, and may therefore be ranked as a fact of experience. As such, observations relating to mind become a part of the raw material upon which scientific investigation may properly operate.

The Cartesian dualism of mind and matter necessarily involved the problem of how mind and brain could interact in perception and in willed acts. Most philosophers[1-3] now argue that the hopeless difficulties of this problem have rendered untenable both dualism and the interactionist view of brain–mind liaison. On the other hand, many men of science[4-6] find in dualism and interaction the most acceptable initial postulates in a scientific approach to the problem of mind and brain. In such an approach the question arises: What scientific hypotheses may be formulated that bear in any way on the hitherto refractory problem of brain–mind liaison ? It should be noted that such hypotheses would represent an extension of natural science to a field of non-sensual concepts, and even to a field outside the matter–energy system of the natural world, as has been convincingly argued by Sherrington[5]. But also it should be noted that Adrian[6,7] has recently directed attention to the necessity for such an extension.

There are first various subsidiary hypotheses that have already been formulated, most notably by Sherrington[5] and Adrian[7] and which relate merely to the events in the brain when it is in liaison with mind.

(1) Mind liaison with brain occurs primarily in the cerebral cortex, though diencephalic centres may be also concerned, particularly as continued bombardment by impulses therefrom is necessary for sustaining activity in the cerebral cortex[8-10].

(2) Only when there is a high level of activity in the cortex (as revealed by the electroencephalogram) is liaison with mind possible. Unconsciousness supervenes instantly the activity is lowered (as, for example, in anoxia, anæsthesia, concussion, sleep[11-13]). Dreams are associated with bursts of electrical activity in the electroencephalogram[11].

(3) The uniqueness of each percept is attributable to a specific spatio-temporal pattern of neuronal activity in the cortex[8]. In general, any thought pattern in the mind has a counterpart in a specific spatio-temporal pattern of neuronal activity, which we may call the evocative neuronal pattern.

(4) Memory of all events is dependent on the development and persistence of increased excitatory efficacy across certain synaptic junctions. Lashley[14] has convincingly argued that "the activity of literally millions of neurons" is involved in the recall of any memory. There is a tendency for some particular spatio-temporal pattern of neuronal activity to be evoked by a particular predisposing or triggering neuronal activity and/or excitatory afferent input[8]. The remembered thought appears in the mind as the spatio-temporal pattern is being replayed in the cortex. This hypothesis has been recently supported by the finding that activation of monosynaptic paths in the spinal cord led to prolonged (measured in hours and possibly days) increase in the excitatory efficacy of synaptic knobs rendered specially sensitive by disuse[15]. It may therefore be postulated that the initial development of effectiveness in certain synaptic junctions is a sequel to the primal event that is remembered, and this effectiveness is sustained and even enhanced by each subsequent replaying in the brain (and remembering in the mind).

These four hypotheses relate to one and the other side of the apparently unbridgeable gulf between the matter–energy system of the brain and the 'non-sensual concept' of the mind which has remained unassimilable into the matter–energy system[5]. They describe the specific events in the brain which are linked with specific states in the mind, but say nothing concerning the 'how' of that linkage.

However, there is one partial approach to this key problem that hitherto has not been essayed. We can ask the question: How does it come about that liaison with mind occurs only in special states of the matter–energy system of the human* cerebral cortex ? Is there any special property of this system that places it in a separate category from all the remainder of the matter–energy or natural world and even from its own matter–energy system when it is not in this special state of activity ? It is here contended that such a special property in outstanding measure is exhibited by the cerebral cortex during consciousness, and the hypothesis is developed that the brain by this means enters into liaison with mind, having the property of a 'detector' that has a sensitivity of a different kind from that of any physical instrument. An introductory paragraph giving an outline of the essential structural and functional features of the neurones (nerve cells) of the cerebral cortex provides the necessary basis for an account of this special detector property, but for a full account various reviews may be consulted[8,16-21]. It is assumed that the functional properties of neurones in the cortex are similar to the motoneurones which have been extensively investigated in mammals. This assumption is justified by the essential similarity of structure and function that is revealed by investigations on cortical neurones[8-10,22,23].

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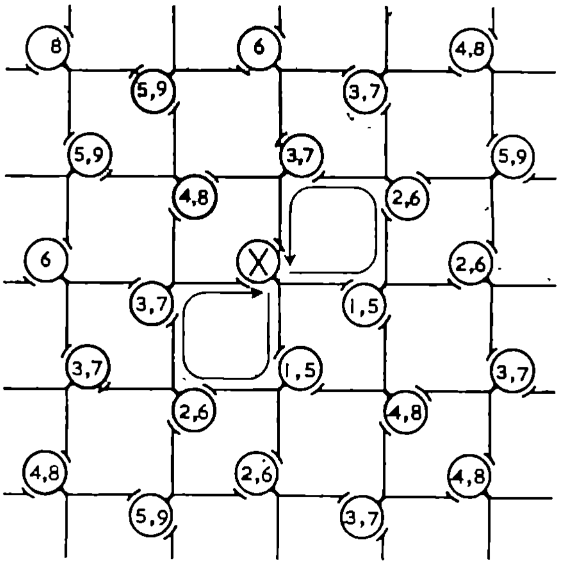
* Substance of a lecture given to the Australasian Association of Psychology and Philosophy (Dunedin Branch) on April 12.

* In respect of the existence of rudimentary conscious minds of animals we must remain agnostic, for the essential information is necessarily derived by private observation and cannot be communicated to us by any animal, lacking as it does the means of adequate symbolic communication in language or otherwise.

The human cerebral cortex is essentially an extensive sheet of neurones about three millimetres thick, and with an average population of 40,000 neurones per sq. mm., there being in all about 10^{10} neurones[14]. Each neurone is *functionally* linked to many others by means of minute specialized areas of *contact* (synapses), there being formed in this way a complex functional network of neurones. Scattered over the surface of a neurone that forms a link in this network there are about a hundred synaptic contacts from other neurones, by any one of which it is a recipient of an excitatory influence when that neurone discharges an impulse thereto. When so activated adequately (a sufficient number of impinging impulses in a sufficiently short interval), the recipient neurone in turn generates an impulse which is discharged down its axon and thence exerts a brief excitatory action on the many other neurones (again perhaps about a hundred) by means of the synaptic knobs on its branching axon. After the generation of such an impulse a neurone passes through a depressed phase from which recovery gradually occurs in rather more than 0·1 sec.[11]. During this recovery phase it becomes progressively more susceptible to the excitatory effects of impinging impulses and again generates an impulse at the instant that the summed synaptic excitatory action reaches an intensity matching its excitability. If immediately preceding synaptic excitations have lifted a neurone to a sufficient degree of excitation, an impulse impinging at a synapse on its surface will initiate the discharge of an impulse after a delay of about 0·5 msec. However, if the excitation is at a lower level, then an impinging impulse causes merely a sudden raising of the excitation which, decaying with a half-time of two to three milliseconds, has virtually disappeared in 10 msec. The added complication produced by inhibitory synaptic action will be neglected for the present.

Lorente de Nó[16-18] has shown in diagrammatic form how the contacts obtaining between neurones in the cortex provide a system that could function as a complex net, the various neurones being at the nodes while the strands are woven from their numerous processes (dendrites and axons) that provide the multiple synaptic contacts. But before considering a net of such complexity, where each node is the convergent point of scores of paths and each in turn projects to scores of other nodes, it is useful to consider the properties of the simplest possible net of the type exhibited in the cerebral cortex (see accompanying illustration). Burns[19] has recently shown that the effects produced by electrical excitation of the cortex are explicable in terms of a similar type of net. Each neurone is assumed to have only two excitatory synaptic knobs on its surface and in turn to have an axon which has only two knobs on two other neurones. Further, it is assumed that the synaptic connexions so formed are of a pattern that allow the neurones to be schematically arranged in the rectangular net-like form of the illustration, where it will be noticed that there is virtually radial symmetry from any point, and the possibility of indefinite extension in every direction. If the allowance is three synapses per neurone, a similar construction with radial symmetry (based likewise on alternating direction of transmission, cf. successive rows of the illustration) would be possible in a three-dimensional network—and in general for n synapses per neurone in an n-dimensional network.



It will be seen that even the formalized and simplified neural network of the illustration potentially contains an enormous variety of neural circuits. For example, if neurone X discharges an impulse, the simplest circuits back to X are shown by the arrows, that is, there are two 4-neurone arcs, and next simplest are six 8-neurone arcs. In addition, it is potentially possible for a progressive invasion to spread over the net. The numerals on each neurone give the number of synapses traversed in leading to its first (and second) activation, there being with each a continued arithmetical progression of four due to the return circuits. In the operation of such a network it may be provisionally assumed that a single impulse impinging at a synapse on a neurone is adequate to generate the discharge of an impulse, and the probable value of 1·0 msec. may be assumed for synaptic delay plus conduction time to its own axonal terminals (the axonal length in the human cerebral cortex is very short for the majority of neurones[16-18]). Thus, there are chains with possible circuit times of 4 msec., 8 msec., 12 msec., etc., the so-called closed self-re-exciting chains[17]. Actually, such short circuits would be most improbable on account of the prolonged (at least 0·1 sec.) and deep (for 20 msec. or so) depression that a neurone suffers after discharge of an impulse.

During inattentive, but awake, states the predominating electroencephalogram rhythmic wave (the α-wave) at about ten a second indicates that the most probable circuit time of all those available approximates to 0·1 sec., that is, to the period needed for almost complete recovery of each neuronal element, and, allowing 1 msec. for each link, it would be expected that roughly there would be about a hundred neurones in one such circuit. But to conceive of such an isolated circuit is an abstraction, for, as here illustrated schematically, each link of any one circuit is held in common with a great variety of other circuits. At each neuronal node in the network impulses either may be ineffective excitors and hence be extinguished, or may fuse in their influence (synaptic summation), so generating a new impulse that in turn disperses to other nodes, there likewise to be extinguished or fused. During inattention much of this patterned activity appears to be virtually random, adopting on the whole the dominant α-rhythm[8].

When the brain is active, for example, during perception, mathematical calculation or skilled action, this randomized activity with its approximate synchronization of large groups of neurones is broken up[8]. We may interpret this as due to the formation of specific spatio-temporal patterns of activity in the neural net. Sherrington[5] vividly and aptly pictures this net as an "enchanted loom where millions of flashing shuttles [the nerve impulses] weave a dissolving pattern, always a meaningful pattern, though never an abiding one; a shifting harmony of sub-patterns".

We have in imagination to develop the two-dimensional formalized net of the accompanying illustration to one of many dimensions, each node or neurone being at the confluence of many paths and itself projecting to many other nodes; and at each node the time of discharge is determined by the microscopic spatio-temporal pattern of the synaptic bombardments on its surface from millisecond to millisecond. The excitatory efficacy of the synaptic knobs of any one neurone will be related to its past usage. Hence, in response to certain spatio-temporal patterns of afferent input into the cortex, the developing cortical patterns will to some extent be determined by this developed structural specificity, as has already been discussed in relation to memory. That is, we are envisaging the pattern of activity in the cortex at any instant as being determined by two factors, the immediate (and very recent) input and the developed structural specificity (inherited and acquired). It is to be noted that unconsciousness is an invariable accompaniment of a net that, as shown by the electroencephalogram, is at rest or only active in low degree or active in a driven stereotyped way as in a convulsion of epilepsy or shock therapy, that is, the net as such is not in liaison with mind. Adrian[8] even brings forward evidence that the part of the net giving the α-rhythm is not in liaison with mind. It is important, therefore, to fix attention on the special properties of the neural net during the specific patterned activity (as indicated by a rapid and irregular electroencephalogram) that occurs when there is liaison to mind.

Suppose some small 'influence' were exerted at a node that would make a neurone discharge an impulse at a level of synaptic excitation which would otherwise have been just ineffective, that is, in general to raise the probability of its discharge. Such a discharged impulse would in turn have an excitatory effect on all the other nodes on which it impinges, raising the probability of their discharge, and so on. If we assume, as above, that the spread from node to node occupies 1 msec., then even on the two-dimensional net of the illustration a spread to a large number of neurones is possible in, say, 20 msec., a time that is chosen because it is at the lower limit of duration of discrete mental events. It is to be remembered that the neurones of the network are at a high level of excitation, as there is initially a large amount of circulating activity (impulses) in the network. Potentially the number of neurones that could be involved would be given by the formula: $2m^2 - 2m + 2$, where m is the number of nodes traversed, that is, twenty in the 20 msec., so the potential number of neurones is 762. With a multi-dimensional network the number of neurones, N, is given, when m is large relative to n, by the general formula, $N \sim \frac{2^n}{n!}\, m^n$, which for $m = 20$ (that is, 20 msec.) and for $n = 4$ (that is, each neurone the receiver and giver of four effective synaptic contacts) gives a total of the order 10^5 neurones involved in 20 msec., and for $n = 5$ the total is of the order 8×10^5. These calculations are intended merely to give some indication of the large number of cortical neurones that could be affected by a discharge originating in any one. When a high level of activity prevails in the cerebral cortex, it may be conservatively estimated that, out of the hundred or more synaptic contacts made by any one neurone, at least four or five are effective in evoking the discharge of neurones next in series. The remainder would be ineffective because the respective neurones would not be poised at this critical level of excitability. So long as the assumed number of effective connexions for each neurone is kept at such values, it is probable that the conventions of the network structure give an approximate method of allowing for all the mass of feed-back connexions that occur in the closed chain linkages of the cerebral cortex[16,17]. Since the cortex is approximately 3 mm. thick and the mean density of neurones 40,000 per sq. mm. of surface[24], the spread to some hundreds of thousands of neurones can be treated as spreading indefinitely in all directions without restriction by the sheet-like structure of the cortex.

An alternative method of calculation may be based on the experimentally observed rate at which a wave of excitation spreads radially through the cortical network from an artificially stimulated focus[9,10,22]. The all-or-nothing character of the spread indicates that during the invasion almost all the neurones are being excited to discharge impulses. Basing the calculation on the value of 50,000 neurones per sq. mm. (the average for gyri[24]), an initially excited focus of 1 mm. radius would include about 150,000 neurones, and at the observed radial rate of spread of 20 cm. per sec. there would be a total invasion of about 4×10^6 neurones in 20 msec. The invasion of each neurone is attributable to the converging excitatory impulses that impinge on it and cause it to discharge. By means of the many synaptic terminals of its axon each of the initially excited neurones thus contributes to the invasion of many neurones and each of these in turn to many more, and so on for the twenty or so successive neurone discharges that occur along an outward spreading chain in 20 msec. Again we have the indication that an impulse discharged by any one neurone has in 20 msec. contributed directly and indirectly to the excitation of hundreds of thousands of neurones.

Thus, within 20 msec. the pattern of discharge of even hundreds of thousands of neurones would be modified as a result of an 'influence' that initially caused the discharge of merely one neurone. But further, if we assume that this 'influence' is exerted not only at one node of the active network, but also over the whole field of nodes in some sort of spatio-temporal patterning, then it will be evident that potentially the network is capable of integrating the whole aggregate of 'influences' to cause modification of its patterned activity that otherwise would be determined by the pattern of afferent input and its own inherent structural and functional properties. Such integration would occur over hundreds of thousands of nodes in a few milliseconds, the effects exerted on any and every node being correlated in the resultant patterned activity of the surrounding hundreds of thousands of neurones. Thus, in general the spatio-temporal pattern of activity would be determined by three factors: (1) the micro-structure of the neural net and its functional properties; (2) the afferent input; (3) the postulated 'field of extraneous influence'. It can be claimed that no physical instrument would bear comparison with the postulated performance of the active cerebral cortex as a detector of minute 'fields of influence' spread over a microscopic pattern and with temporal sequences of milliseconds. The integration, within a few milliseconds, of 'influences' picked up at hundreds of thousands of nodes would be unique, particularly when it is remembered that the integration is no mere addition, but is exerted to modify in some specific way "a shifting harmony of sub-patterns" of neuronal activity, achieving expression through the modifications so produced.

Thus, the hypothesis is that mind achieves liaison with the brain by exerting spatio-temporal 'fields of influence' that become effective through this unique detector function of the active cerebral cortex.

When the cortex is at a low level of activity, it would function inefficiently as a detector on account of the small proportion of neurones poised at the critical level of excitation and the consequent improbability of an effectively spreading influence; hence an explanation is provided for the invariably observed failure of mind–brain liaison when the electroencephalogram reveals depressed cortical activity. An explanation is also provided for the loss of consciousness in the stereotyped and driven cortical rhythms that occur in convulsions, for the nodes of the cortical network would also then lack the critical poise as well as the specific patterning. It is further to be noted that according to the hypothesis only a part of the cortex is needed for liaison with mind. It may be that any area that is in the critically excited state will do. This corresponds to the clinical evidence that mind–brain liaison is not interrupted by excision of a large part of the cerebral cortex, or when a large part is occupied by activity that excludes liaison, for example, by a convulsion or even by alpha wave activity[4]. Maybe less than a tenth of the neurones in the right state of activity is enough to give an effective mind–brain liaison.

When considering the manner in which mind could operate on matter, Eddington[4] discussed two hypotheses. In the first, it was postulated that mind could control the behaviour of matter within the limits imposed by Heisenberg's Principle of Uncertainty. Eddington rejected this partly because the permitted range would be exceedingly small. Presumably he was thinking of an object as large as a neurone. However, a neurophysiologist would consider the much smaller synaptic knob as the key structure on which a 'mind influence' might work. The synaptic knob is approximately a sphere 1·3 μ in diameter[12] and so would have a mass of 10^{-12} gm. If, as Eddington implies, the uncertainty principle is applicable to an object of this size, then it may be calculated that there is an uncertainty in the position of such an object of about 1·5 mμ in 1 sec. and 0·2 mμ in 20 msec. Such distances are very small; but it is conceivable that the excitatory efficacy of a synaptic knob would be appreciably affected by an uncertainty of this order, for the distance between the knob and the subjacent membrane is probably less than 100 mμ, and the excitatory efficacy would be expected to be very sensitive to changes in this value, at any rate on the electrical hypothesis of synaptic transmission[13]. Furthermore, as shown above, minute 'influences' thus exerted on a large population of neurones would be rapidly integrated in the form of a changed spatio-temporal pattern of activity in the neural net. There is thus in the active cortex a mechanism that could effectively amplify by thousands of times minute effects exerted on the individual synaptic knobs. It is therefore possible that the permitted range of behaviour of a synaptic knob may be adequate to allow for the effective operation of the postulated 'mind influences' on the active cerebral cortex. However, Eddington rejected this hypothesis for the further reason that it involved a fundamental inconsistency. First, behaviour according to chance was postulated in making a calculation of the permitted limits according to the uncertainty principle, then it was restricted by a non-chance or volitional action (the mind influence), which necessarily must be introduced if mind is to be able to take advantage of the latitude allowed by the uncertainty. Hence, Eddington was led to an alternative hypothesis of a correlated behaviour of the individual particles of matter, which he assumed to occur for matter in liaison with mind. The behaviour of such matter would stand in sharp contrast to the uncorrelated or random behaviour of particles that is postulated in physics, and may be "regarded by us as something 'outside physics' "[4]. Either of Eddington's hypotheses could form the physical basis of the neurophysiological hypothesis that has here been developed for mind–brain liaison. This latter hypothesis has the merits of relating the occasions when the mind can operate on the brain to the observed cortical events during consciousness, and of showing how an effective action could be secured by a spatio-temporal pattern of minute 'influences'.

In brain–mind liaison the traffic is both ways, from brain to mind no less than from mind to brain. Existing knowledge of the brain provided the basis for the above hypothesis relating to the operation of the mind on the brain. The reverse traffic—brain action to mind—is still more perplexing; but, presumably, if the mind can operate on dynamic spatio-temporal patterns of activity in the cortex, it would be expected to be susceptible to operation in the reverse sense. That would be the operational path in all perception and in the memory of events.

It will be sufficiently evident that the hypothesis here developed is of a fragmentary and tentative character, but it is hoped that it may be of value in further theoretical developments on mind–brain liaison. An outstanding problem for consideration would concern the postulated action of the mind in a spatio-temporal pattern, for presumably it must so act if it is to cause significant modification in patterned activity of the cortex. However, that problem would appear less formidable if there were a sufficiently rapid and detailed feed-back from brain action to mind, which in any case must be assumed for perception.

It will be objected that the essence of the hypothesis is that mind produces changes in the matter-energy system of the brain and hence must be itself in that system. But such a deduction is merely based on the present hypotheses of physics. If these 'mind influences' were of a nature that precluded their detection by any existing physical instrument, then physicists would be ignorant of them, and the hypotheses of physics would necessarily neglect them. It is at least claimed that the active cerebral cortex could be a detector of such 'influences' if they existed. But there are also now extensive reports of well-controlled experiments that give evidence of a quite different kind that there is a two-way traffic between mind and the matter–energy system. Of particular significance for the above hypothesis of mind influence on brain are the psycho-kinetic experiments[25]. These experiments as described leave little room for doubt that very slight changes can be produced by some minds on moving physical objects such as dice, effects which are revealed only when statistical analysis is applied to relatively long series of trials. In particular, the striking decline in effectiveness with time would seem to exclude all physical factors. There are, too, the even better authenticated experiments of the complementary process called extra-sensory perception[26,27]. If these experiments are revealing facts, there is an interaction of physical events with mind, as indeed is also indicated above by Eddington's second hypothesis. If as men of science we reject these experiments, it should be done on the basis of established errors in their execution or interpretation. Such errors have evaded years of careful scrutiny by unsympathetic critics. It will be agreed with Rhine[26] that, if the so-called psi-capacities (psycho-kinesis and extra-sensory perception) exist, they provide evidence of slight and irregular effects which are precisely of the nature that must be postulated for brain–mind liaison, but which occur there in highly developed form. The present hypothesis would offer an explanation for this high development of matter–mind traffic in the active human cerebral cortex, the development including not only continuous operation but also exquisite subtlety in transmission. Both these features would receive explanation on the basis of the interlocking, integrating and ever-changing pattern of activity formed by the multiple (ten thousand million-fold) detectors that exist in the cortex during consciousness.

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THE WEST AUSTRALIAN FLORA*

By Sir EDWARD SALISBURY, C.B.E., F.R.S.

IN order to appreciate the character of the Australian flora it is necessary to realize first of all the influence of the extent of this vast continent isolated by large stretches of ocean from the nearest land mass. The localized distribution in Australia of large centres of population is a sufficient indication of the markedly peripheral distribution of situations favourable to human activity. Indeed, it is true that only about 15 per cent of the total of nearly three million square miles, which is approximately the area of Australia, has a rainfall of more than thirty inches, and this has to be considered in relation to the high and sometimes very excessive summer temperature. Furthermore, the average rainfall data in Australia are perhaps even more misleading than most averages, for nearly half Australia has a rainfall variability of 40–50 per cent, and even in the more habitable parts a variability of 20 per cent is by no means infrequent. In other words, the greater part of Australia is arid for a shorter or lengthier period, and the more arid region, abutting as it does upon the north of the Great Bight which reaches to the Nullabor Plain, means that Western Australia is isolated on the east by thousands of miles of desert as effectively as it is on the west by thousands of miles of ocean. Thus Western Australia is only capable of supporting in its central region specialized vegetation of an extreme xerophyllous type. Western Australia is, in fact, almost isolated from all the most favourable areas for vegetable growth except for its own south-west corner, where temperate rain-forest occurs.

A further point of some importance is that many of the soils in the southern and central parts are comparatively recent. In common with the most favourable areas for vegetation, the geologically ancient areas are likewise marginal. It is therefore scarcely surprising, when we consider all these facts together, that we find the flora of Western Australia is as a whole, like other isolated areas of far smaller extent, characterized by the high proportion of endemics which it comprises, amounting to about 85 per cent of the total.

Nevertheless, despite the isolation of Australia as a whole and of Western Australia in particular, the flora shows affinities with those of South America and South Africa. The facile explanation that some authorities have favoured that the former Antarctic Continent provided land connexions for the migration of a common flora between Australia, South America and South Africa would appear to be an anachronism of wishful thinking, since there is no evidence that the flowering plants, as we understand that group to-day, were differentiated until long after such land connexions had ceased to exist, and indeed the extensive Cretaceous transgression of the ocean that rendered the separation of these areas probably much greater than to-day occurred about the time that the Angiosperms perhaps evolved.

One family, rich in endemics, that is especially a feature of Western Australia, is the Myrtaceae. Members of this family have a wide distribution in warm regions, but the genus *Eucalyptus* with some three hundred species is almost confined to Australia with many species only found in the west, and one of the most beautiful of these endemics is *Eucalyptus macrocarpa*, with large red flowers. Other striking members endemic to Western Australia are the Geraldtown wax flower (*Chamælaucium*), and above all the beautiful fringe flowers (*Verticordia*) which adorn with their dainty blossoms the arid sandy heaths of the West where more than three-quarters of the forty known species are alone to be found. They owe their name to the fringe-like sepals, and in some species the petals are dissected also. The genus *Calothamnus* comprising twenty-five species is entirely Western Australian, and all these exhibit leaves highly resistant to desiccation.

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* Substance of a Friday evening discourse delivered at the Royal Institution on May 18.

The Proteaceæ is one of the most characteristic families of the Australian flora, and this group would appear to have had a wide distribution in Tertiary times. Although many of the so-called proteaceous fossil leaves are of dubious attribution, there seems little doubt that the family was formerly represented in the northern hemisphere, as the late Sir Albert Seward, after a critical assessment of the evidence, concluded. Moreover, recent studies in Australia have shown that the family even there had a more extensive distribution than to-day. The present geographical range is wide over the southern hemisphere but discontinuous, with concentrations in South Africa and Australia; but by far the largest number of endemic species are located in Western Australia. It is therefore difficult to escape the conclusion that this is an ancient family that has experienced a diminishing range and increasing differentiation through the past thirty million years of its history. It is a specialist family peculiarly fitted for growth in conditions of great seasonal aridity and correspondingly unfitted for competition with the more vigorous and faster growing types in conditions more favourable to plant growth. Thus the increasing restriction of this family is probably to be attributed to ecological causes: the climatic differentiation of recent epochs which, combined with soil development, have produced localized areas that constitute the sanctuaries for its survival.

Of the total of fifty genera in this family it is true that only five are confined to Western Australia, the most important being the genus *Dryandra*, with some fifty members, but altogether more than 370 species of Proteaceæ, or almost two-fifths of the entire family, are restricted to this area.

The foliage of the Western Australian proteaceous trees and shrubs is uniformly leathery in texture, but may be needle-like and unbranched as in some species of *Hakea*, or broad and flat as the leaves of *Banksia menziesii*; but, in all, the foliage shows but little change when dried. This is due to the rigid interior skeleton and robust epidermis, which offer a great mechanical resistance to desiccation. The surface is covered with a thick cuticle almost impervious to water vapour, and the stomata are usually sunk in pits and often protected by perforated domes of cuticle which diminish the effect of hot, dry winds. It is noteworthy that a branch of *Dryandra* that has been detached from the plant for more than a year retains the form of its leaves almost unaltered, thus bearing witness to the mechanical resistance to shrinkage and so to loss of water vapour.

It is this same adaptation to drought conditions that is doubtless responsible for the striking similarity of growth habit which is often exhibited by species of different genera and families. I was much impressed by this feature in a heath-like area of scrub towards the edge of the Nullabor Plain, where the average rainfall was between 10 and 15 in. per annum. Here members of a number of families showed a marked similarity of vegetative structure sometimes so close as to render them almost indistinguishable, except by the expert, when not in flower. Such epharmony is particularly well exemplified by the ericoid habit, not only shown as we should expect by the Epacridaceæ but also by *Hibbertia hypericoides* (Dilleniaceæ), *Leschenaultia formosa* (Goodeniaceæ), *Boronia megastigma* and *Thryptomene* sp. (Myrtaceæ), *Acacia rossii* (Leguminosæ), *Eremophila* (Myoporaceæ), *Petrophila ericifolia* (Proteaceæ), and even by the Liliaceæ in that remarkable shrub *Calectasia cyanea*, to mention but one representative from seven different families; but this list could be extended almost *ad nauseam*.

Again, the switch-like habit in which the leaves have undergone extreme reduction is paralleled in a number of quite unrelated species. Examples are furnished by the phyllodic species of *Acacia*, where the function of the leaves is assumed by green modified leaf stalks or flattened stems; and by the she oaks (*Casuarina*), looking like woody horsetails with minute leaves on green longitudinally grooved stems, these grooves providing shelter for the stomata, which are further protected by the presence of hairs. The Restionaceæ is a particularly characteristic Australian family, where the stems also perform the function of leaves.

Alike in these plants the assumption of the leaf function by stem or leaf-stalk has resulted in an increase of mechanical resistance to water-loss and thus in a prolongation of photosynthetic activity.

The shelter afforded by a felt-like covering of woolly hairs which protects the surface of the plant from direct wind action is well exemplified in the Verbenaceous genus *Lachnostachys*, aptly known by the popular name of lamb's tails. Here the white appearance, which the air-filled hairs confer, bears witness to the large amount of the incident light which is reflected and thus enhances the protection that the hairs afford. As a second example mention may be made of the flannel flowers (*Actinotus* sp.), which belong to the Umbelliferæ and recall the edelweiss of the European flora.

The succulent habit is not commonly represented except in the saline areas, where perennial members of the Chenopodiaceæ such as *Salicornia australis* are frequent and exhibit this feature, as also annual species of *Zygophyllum*.

The extreme habitat conditions call forth a similar adaptation for resistance to water loss in such an unlikely group as the Liliaceæ. The Western Australian representatives of this family includes two arboreal genera, namely, the blackboys, *Xanthorrhœa*, and the grass tree, *Kingia australis*. These both have long grass-like leaves internally supported by sclerotic tissue. In the triangular or quadrangular leaves of the blackboys there is a thick investment of woody tissue just beneath the surface that resists shrinkage. In *Kingia* there are in addition internal woody bands that augment the resistance to shrinkage and thus to the escape of water vapour. It should perhaps be emphasized, what is too often overlooked, that the so-called transpiration checks are mainly of importance as prolonging the period of photosynthetic activity and thus fulfil their purpose, even if the leaf eventually wilts or even dies. In order to emphasize that death may not result from extreme desiccation my own experience with *Kochia tomentosa*, one of the Western Australian salt-bushes, is worth recording. I gathered a piece of this plant and, being uncertain of its identity, retained a small sprig and placed this in my pocket-book, where it remained in a very dry and brittle condition for three weeks while I was travelling by a roundabout route to Adelaide via Melbourne and the Murray Valley. It was then packed up with some papers and dispatched to England, where it remained in a centrally heated room for some months. Then taken out, it was inadvertently placed on the top of a cupboard in an unheated room during a spell of foggy weather. When found a week later it had put out some small shoots of diminutive new leaves. What osmotic suction it had attained I hesitate to guess.

The so called protocorm of that unique Australian lycopod, *Phylloglossum drummondii*, to which such importance was attached during the phylogeny hunting of the early years of this century is probably only biologically significant as presenting another adaptation to an intermittently arid environment that we see so strikingly developed in the tuberous sundews. British sundews, which grow in permanently damp places, have a meagre root system, but these Australian sundews, which grow in areas that are under water in winter but become dry and arid sandy wastes in summer, seem invariably to possess an underground tuber two to six inches beneath the surface according to the species. From such a hard round tuber arise the long stems of the climbing species that deck the branches with their glistening leaves and bear at the summit large white, pink or even yellow flowers. The sundews are particularly well represented and very diverse in character. *Drosera macrophylla* has a rosette of large leaves which together with the white flowers arise from a black tuber about half an inch in diameter and four or five inches deep. Some are like our own species, while *Drosera gigantea* suggests a sea lavender with numerous small white flowers on a richly branched inflorescence that arises from a deeply seated black tuber of elongated form. This tuberous habit can be regarded as a means of evasion of the climatic extremes, and can hence be compared with the annual habit so well exemplified by the ephemeral Compositae of the desert areas that compass their whole life-history in a few weeks after the infrequent rains. These composites paint the desert like a Joseph's coat of many colours, and not the least interesting feature is the marked dominance of one species over a considerable area, so that you may get square miles looking white with the presence of *Helipterum niveum*, while farther on are acres which are yellow or red through the dominance of other species. What the factors are which determine this dominance is uncertain. Very often there is no obvious soil difference to account for this. Like most desert annuals, the Australian species are short-lived plants which germinate during appreciable rain and pass their whole life-history within a few weeks. If, as may well happen, no appreciable rain falls, the seeds remain dormant until conditions become more suitable; but the abundance of these annuals bears witness to the relative fertility of the soil and to the limiting conditions upon vegetation which are imposed by the vagaries of the climate.

The sandy coastal plains are chiefly characterized by their poor soils, consisting of alluvial deposits so notoriously deficient in nutrient salts as to produce herbage inadequate for the support of healthy sheep and stock and responsible for the coastal diseases. We now know that these are the outcome of deficiencies, especially in the trace elements copper, zinc and cobalt. The last, though only requisite in amounts measured in parts per ten million of the food eaten, is now known to be essential to the well-being of ruminants, while zinc and copper are, in amounts of similar diminitude, essential alike to plant growth and animal welfare. The spraying of spruce trees with very dilute solutions of zinc sulphate has a most spectacular effect on the rate of growth of this tree on these soils. This response is indicative of the influence that such deficiencies may exert on competition on one hand between species that are tolerant of meagre rations of these trace elements or particularly efficient in their appropriation from inadequate supplies, and, on the other, those species that make greater demands for such upon the soil or are perhaps less efficient in their exploitation.

Not the least interesting feature of the Australian flora is the way in which species after species introduced from the Mediterranean or South Africa has 'run amok' in those areas where man has disturbed the natural vegetation.

It is possibly true in Australia, as the late Dr. Cockayne said of New Zealand, that the native species are quite capable of holding their own against introductions except where man disturbs the natural conditions. The native species are, in fact, specialists, peculiarly fitted to the natural environment. But certain it is that in the areas occupied by man or materially disturbed by him the introductions have established themselves in Australia in a most spectacular way. Near Humbug Scrub, not far from Adelaide, one can see many acres of pasture almost completely occupied by the globe artichoke, which, beautiful though they are in flower, are apparently of little value. Again, the Mediterranean bugle, *Echium plantagineum*, has been encouraged in some of the arid areas as providing fodder during the dry season, and here it rejoices in the name of "Salvation Jane"; but one sees potentially good pastures ruined by its superabundance in the region of Port Augustus, and here it is called "Patterson's Curse"! The many acres which it there covers with its blue flowers are to the mere visitor a charming sight. Again, the South African *Oxalis cernua* was introduced into Australia as a garden plant and was at one time sold at *4s. 6d.* a root. To-day one can see citrus orchards in which the whole of the ground among the citrus trees is one continual sheet of yellow with its brilliant flowers, and soursop, as it is called, has likewise become a pest in many parts. To-day, too, one can see in southern Western Australia the arum lily (*Richardia*) occupying the ditches, and tall species of *Watsonia*, constituting what might almost be described as thickets, and species of *Homeria* rendering poisonous the pastures they infest. It is no wonder that Australians to-day hesitate to grow even the most beautiful of the South African plants for fear they should get out of hand and become one more pest added to the unwelcome invaders. One has only to see the swamps in Western Australia invaded by arum lilies or the exuberant species of *Watsonia* to realize how easily erstwhile garden plants can become a curse.

If we consider the flora of West Australia in its wider aspects we cannot but be struck by the fact that it is at once highly specialized, but small and restricted in character in relation to the area involved. Despite its million square miles the total vascular flora numbers only about 5,800 species. It is true that much of Western Australia is desert; but a large part of this carries its own specialized flora. To apprehend the relative paucity it is sufficient to state that the whole of France with scarcely one-fifth of the area of Western Australia has a flora containing nearly five thousand species or roughly five-sixths, and comprising a far greater diversity of genera. The flora of France comprises more than 884 genera compared with only about 560 genera in the flora of Western Australia. Still more significant is that South Africa, with a similar area to Western Australia, has more than twice the number of genera. Isolation has thus on one hand permitted a high degree of specialization; but this has progressed in a much less varied biological community than would obtain in an area that had not been isolated and may well account in large measure for the vulnerability of the Western Australian flora to competition from immigrants when conditions of their environment are changed.

NEWS and VIEWS

Physics at Queen's University, Kingston, Ontario: Prof. J. K. Robertson

After forty years of faithful and constructive service, Prof. John Kellock Robertson, head of the Department of Physics at Queen's University, Kingston, Ontario, has resigned. Prof. Robertson was born in Perth, Ontario, in 1885. He attended the local schools and entered the University of Toronto, where he graduated in 1907, and later served as demonstrator in the Department of Physics. He was appointed lecturer in physics at Queen's University in 1909, and except for two years when he was absent at Cambridge during 1912–13 and at the Imperial College of Science and Technology, London, as visiting professor during 1933–34, he has worked there ever since, becoming head of the Department in 1943. He received the degree of doctor of laws at the spring convocation this year at Queen's. For many years he was a member of the Faculties of Arts, Engineering and Medicine—something almost unique in Queen's administration. His lectures on optics were well known, but he achieved the greatest distinction in his courses for medical students. He was elected a Fellow of the Royal Society of Canada in 1926, served as secretary of Section III for several years and was elected president of that Section in 1942–43; finally, in 1944, he was elected president of the Society.

During his long career, Prof. Robertson has found time to write many papers and books. Among the books should be mentioned a volume on physical optics which appeared in 1929 and has gone through three editions. This is an exceptionally readable and comprehensive text and is a very useful introduction to the subject. His book on X-rays and X-ray equipment is designed primarily for medical students and practitioners. Of a less formal character is a charming little book entitled "Atomic Artillery", the title of which tells its scope. His research interest, as shown by numerous papers, has been in the field of discharges in gases and vapours excited by high-frequency and micro-waves. For many years he served on the editorial board of *Queen's Quarterly* and has contributed articles to this and other journals. Prof. Robertson will be remembered by many graduates as an enthusiastic and inspiring teacher. Those who were fortunate enough to work with him in his own laboratory have been profoundly impressed and form a group of progressive and resourceful young physicists. In his retirement he has left Canada to live with his daughter, who has resided in London for a number of years.

Prof. B. W. Sargent, M.B.E.

Dr. B. W. Sargent, who is succeeding Prof. J. K. Robertson, leaves the post of assistant director of the Physics Subdivision, Atomic Energy Project, Chalk River, Ontario. Born at Williamsburg, Ontario, in 1906, Dr. Sargent received his early education in local schools and at Queen's University, where he obtained his B.A. in 1926 and M.A. in 1927. Following graduation, he spent two years at Queen's doing research in radioactivity under the direction of Prof. J. A. Gray, Chown research professor. The award of an 1851 Exhibition Scholarship in 1928 enabled him to spend the next two years at Cambridge, where he continued research in radioactivity at the Cavendish Laboratory under Lord Rutherford. His work there on beta-ray spectra and related problems led to an important relation known as Sargent's Law. In 1930 he returned to Canada as a lecturer in physics at his *alma mater*. For the next thirteen years he combined teaching duties with research so successfully that in 1941 he was elected a Fellow of the Royal Society of Canada. In 1943 he was granted leave of absence to join the Atomic Energy Project, Montreal Laboratory, under the National Research Council of Canada. Resigning from the staff of Queen's University in 1946, he has remained with this group until the present time; during 1945–50 he was head of the Nuclear Physics Branch, first at Montreal, then at Chalk River, and since January 1, 1951, he has been assistant director of the Physics Subdivision there. Dr. Sargent is an authority on problems relating to neutrons and to heavy-water piles, and has published papers on these and other subjects.

U.S. Navy Aviation Medical Acceleration Laboratory: Prof. Robert F. Rushmer

The University of Pennsylvania and the U.S. Naval Air Development Center at Johnsville, Bucks County, Pa., have announced the appointment of Dr. Robert F. Rushmer, of the University of Washington, Seattle, Washington, to be superintendent of the Scientific Department at the new Aviation Medical Acceleration Laboratory of the U.S. Navy. This Laboratory is one of the five laboratories of the Naval Air Development Center, which has made an agreement with the University of Pennsylvania whereby there is to be mutual exchange of personnel and facilities between the two institutions. Dr. Rushmer has also been appointed professor of applied physiology in the Faculty of Medicine, University of Pennsylvania; others appointed to the Aviation Medical Acceleration Laboratory will also receive appropriate faculty appointments in the University. The new Laboratory is at Johnsville, approximately eighteen miles north-east of Philadelphia, and its main functions will be the study by naval and civilian medical authorities of man's reactions to acceleration under conditions closely resembling the stress patterns encountered in actual air combat. The Laboratory has been designed as a complete aero-medical laboratory, well equipped for work in physiology, animal surgery, radioactivity, biophysics, biochemistry, gas analysis, pathology and electronics, a medical library, conference rooms, service and fabrication shops.

Dr. Rushmer is a native of Ogden, Utah, where he was born in 1914. He graduated from the University of Chicago in 1935 with a science degree and from Rush Medical College in 1939 with a medical degree. During 1940–42 he studied at the Mayo Clinic, Rochester, Minnesota, with a fellowship in pediatrics. In 1941 Dr. Rushmer was appointed an assistant in aviation medicine at the Mayo Foundation, and he served as a research projects officer in the Department of Clinical Investigation, AAF School of Aviation at Randolph Field, Texas, during 1942–46 inclusive. After the War, Dr. Rushmer joined the medical faculty of the University of Southern California as an associate professor of aviation medicine, and in 1947 he took up a similar appointment in the University of Washington.

Royal Society of Edinburgh : Honorary Fellows

At a meeting of the Royal Society of Edinburgh held on July 2, the following were elected Honorary Fellows of the Society.

British : Sir Charles Harington, director of the National Institute for Medical Research ; Sir Harold Spencer Jones, Astronomer Royal.

Foreign : Prof. George W. Corner, director of the Department of Embryology, Carnegie Embryological Laboratory, Baltimore ; Prof. H. A. Kramers, director, Institute of Theoretical Physics, Leyden ; Prof. Vincent du Vigneaud, professor of biochemistry, Cornell University Medical School, New York ; Prof. Sewall Wright, professor of zoology, University of Chicago.

Prof. E. L. Hirst delivered the Bruce–Preller Lecture, his subject being "The Synthesis and Functions of Sugars in Plant Life". The Makdougall-Brisbane Prize (1948–50) was presented by the president to Prof. James Small, Queen's University, Belfast, for his papers dealing with quantitative evolution, two of which have been published in the *Proceedings* of the Society during the period of the award.

Development of Atomic Energy in Great Britain

In the House of Lords on July 5, Lord Cherwell put forward a motion regretting "the slow progress made in this country in developing atomic energy for peaceful and for war-like purposes", and asking for the transfer of the work from the Ministry of Supply to a special organization "under the direct control of the head of the Government". He remarked that the matter had become more urgent in view of the impending retirement of Lord Portal, director of atomic energy, whose chief scientific adviser had already left the service. The Civil Service, he said, is unfitted for dealing with this kind of undertaking ; and a more flexible organization is required. Many good engineers and scientific men are reluctant to join the Civil Service because their work would be regulated by the administrative side, which knows little about the subject. Lord Cherwell also referred to security measures, which he believes are inadequate as applied in this field. No other country, he said, has attempted to carry on research and development in atomic energy through a government department, and he asked for a change of organization as a matter of urgency.

The Government reply was by Viscount Alexander, chancellor of the Duchy of Lancaster. He remarked that the Government is quite prepared to change its views on this important matter if it is convinced that progress is being held up in any way. In point of fact, however, the Sellafield development, he said, has been completed well within the time schedule. Any new organization would be faced with the same shortages and frustrations due to post-war difficulties which have hampered not only the Civil Service but also every part of industry in Great Britain. Further, he believed that a change of organization at the present time would cause considerable disturbance and set back the atomic energy project by months. He claimed that under the Ministry of Supply there has been no delay in decisions on policy, no lack of money and, until recently, no difficulty in recruiting a proper share of the country's scientific men. The Prime Minister had given instructions that the project was to have the highest priority, and it has been conducted on the largest scale possible in view of the country's resources. The present arrangements, Lord Alexander said, do not preclude a close degree of personal attention by the Prime Minister. Lord Cherwell's motion was carried by 52 votes to 31.

British Coal Utilization Research Association : Annual General Meeting

The successful fusion in Great Britain of the research interests of the nationalized coal and electricity industries with those of the independent appliance manufacturers and coal consumers in an autonomous co-operative research association was referred to by Sir Charles Ellis during the course of his presidential address at the annual general meeting of the British Coal Utilization Research Association held on June 13 at Leatherhead. Introducing the annual report of the Association for 1950, Sir Charles, after commenting upon the success of the system of committees by which the affairs of the Association are conducted, and upon the satisfactory financial position, reviewed briefly a few of the more outstanding activities and achievements of the Association during the year. The investigation into the effect of coal characteristics upon the performance of shell boilers, for example, had provided quantitative data on the beneficial effect of using coal of the correct moisture content ; studies of the performance of gas producers had revealed a promising new method of automatic control based on an instrumental link between coal feed and off-take gas temperature ; a new study of the gasification of slurries had been commenced ; work was progressing on the design of a cyclone furnace which should provide not only a power source for a gas turbine, but also a method for the economical combustion of coal intermediate in size between normal boiler fuel and pulverized fuel ; and the work on domestic heating was being directed towards the achievement of smokeless combustion in open fires. Finally, Sir Charles Ellis announced the establishment of an annual Coal Science Lecture, believed to be the first ever inaugurated by a research association, and announced that Sir Alfred Egerton had been invited to be the first lecturer.

Regulations concerning Full-time Work in the Colonial Service

One of the constituent institutes of the Joint Council of Professional Scientists recently directed the Council's attention to the varying interpretations, in respect of men of science in the service of Colonial Governments, which are placed on paragraph 52 of Colonial Regulations (Colonial No. 88–1 of 1945), namely: "An officer whose remuneration is fixed on the assumption that his whole time is at the disposal of the Government is prohibited from engaging in trade, or employing himself in any commercial or agricultural undertaking". While agreeing that it is undesirable for servants of Colonial Governments to act as consultants to industrial firms, the Joint Council expressed the view to the Colonial Office that it was not in the best interests of the Service for this rule to be interpreted in such a way that it would prevent a scientific worker acting, for example, as a university examiner or undertaking other academic work or contributing to scientific literature in the ordinary way. The Council's view was that much would be gained if scientific members of the staff of an establishment were free to undertake such extra-mural work as the director of research, or other responsible officer, expressly approved, and if these directors and officers had wide discretion in authorizing such work and in deciding what extra-mural activities they themselves should undertake. These views were submitted to the Colonial Office in a document signed by its chairman and the presidents of its four constituent bodies: the Institute of Biology, the Royal Institute of Chemistry, the Institution of Metallurgists and the Institute of Physics.

The Assistant Under-Secretary of State for the Colonies in charge of research, both in interview and in correspondence, pointed out that it is a matter of common practice for scientific officers in the service of Colonial Governments to contribute to scientific literature, and in the same way other officers frequently publish matters not excluded by the terms of the Colonial Regulation. He also pointed out that it is by no means uncommon for specialist officers employed by a Colonial Government to undertake, for remuneration, lectures at a university or college in the territory and to serve as external examiners. The official view is that in general the regulations are interpreted reasonably from the point of view of both scientific and other officers and of the Colonial Governments; but the Secretary of State has undertaken to inquire into any particular case where it is considered that an unduly strict interpretation of the relevant Colonial regulations has been adopted.

Co-operation between the Cape and Radcliffe Observatories

All interested in astronomical observations will welcome the adoption of a scheme for co-operation between the British observatories in South Africa. By payment of an annual sum to the Radcliffe Trustees, the Cape Observatory will secure the use of the 74-in. reflector at Pretoria for a third of the observing time. As is well known, the funds available for the Radcliffe Observatory suffice for the employment of only three astronomers—not nearly enough to make full use of the telescope, which is the largest in the southern hemisphere. The additional sum made available will enable the Observatory to engage a mechanic-night assistant and a secretary-librarian, and so take a burden off the scientific staff. What money is left over will be used for improving the subsidiary equipment and buildings. At the same time, the Cape Observatory will be enabled to extend its researches; for although it has many instruments, they have only moderate light grasp and most of them are fifty or more years old. The Cape Observatory has no reflecting telescope. For the last few years the Cape astronomers have had occasional use of the 74-in. reflector through the courtesy of the Radcliffe Observer, and they can appreciate the possibilities of the new arrangement. Astronomers are only too well aware of the exasperating delays which almost always take place between the planning of a telescope and bringing it into use, and the fact that the 74-in. reflector is already in operation is a point of no small importance.

The Elliott Journal

In 1800 William Elliott set up in business as a maker of scientific apparatus, and for a hundred and fifty years the firm, now Elliott Brothers (London), Ltd., has been associated with instrument making. It is appropriate that the achievements of this firm, its history and the work it is doing should be made known as widely as possible. We therefore welcome the first number of *The Elliott Journal*, admittedly a house journal but one which will be read with interest by many not immediately associated with the firm. The *Journal* is to be published half-yearly and its aim is to give a periodical review of developments in engineering and physical science with particular reference to the work of Elliott Bros. The first number contains a brief foreword by Sir Ben Lockspeiser; a summary of the history of the firm since its foundation; and eight illustrated articles. These discuss the following topics: magnetic amplifiers and their application to industrial purposes; pulsed circuits for resistance strain-gauges; application of the force-balance principle to pneumatic instruments for process control; a photo-electric curve follower; precision A.C. measurement with a D.C./A.C. comparator; a phase-front plotter for testing micro-wave aerials; a precision sine–cosine potentiometer; and thermal fluctuation of charge in linear circuits.

Mycopathologia et Mycologia Applicata

The appearance of the first fascicule of Vol. 5 of the journal *Mycopathologia* under the enlarged title *Mycopathologia et Mycologia Applicata* indicates the wider range that has now been assumed by the journal with the inclusion of more general papers on applied mycology. As the former title suggests, *Mycopathologia* has for several years been the chief world repository for papers on medical mycology. The development of this subject must, indeed, have owed a good deal to the journal, for medical applications of mycology are now known in areas where human fungus diseases were largely unsuspected. Mycological pathology will, indeed, still be represented strongly. The present issue includes, *inter alia*, studies of antidotal properties of various fungi, against the staphylococcus toxin, by Anna Maria Villa; a detailed paper on vitamin deficiencies of pathogenic fungi, by A. E. de Arêa Leão and Amadeu Cury; a critical survey of mycological literature between 1939 and 1942 (Tibor Benedek); and a description of the fungistatic activities of vitamin K on dermatophytes, by A. E. Arêa Leão and Adolpho da Rocha Furtado. Typical of the wider scope is a paper on the enzymatic grouping of bacteria, by Costantino Gosini. *Mycopathologia et Mycologia Applicata* is published by Dr. W. Junk, of 13 Van Stolkweg, The Hague, Netherlands, and the present number is priced at 40 guilders, or £3 15*s*. 4*d*.

Research in the University of Birmingham

The Joint Standing Committee for Research of the University of Birmingham has issued in its twenty-first annual report a very convenient general survey of research completed and in progress during the academic year 1949–50. The departmental summaries are accompanied, as in the previous report, by particulars of theses approved for higher degrees and by lists of published work for the academic year 1949–50 which can be regarded as contributions to original knowledge. The whole presents a concise but impressive picture of the contribution coming from the University of Birmingham, and its value would be only enhanced if all universities followed this example. The increasing dependence of universities upon the State for financial assistance makes such reports a desirable, as well as a reasonable, complement to the reports coming from the University Grants Committee itself.

Personnel Management

In a recent issue of the *Journal of the Institute of Personnel Management* (33, No. 314; March–April 1951), the personnel officer in a large industrial organization puts forward constructive proposals why the 'closed shop' policy in industry should be accepted. In reply, other personnel officers suggest that to make membership of a trade union a condition of employment in any firm is an unwarrantable interference with the liberty of the individual. Among other articles in the *Journal* is one by Miss Helen Baker, the associate director of the industrial relations section at Princeton University, giving her views on joint consultative practice in British industry, a report on promotion policy in nationalized industries prepared by the Acton Society Trust, and an account of the training of new entrants for the Westminster Bank by L. C. P. Cann.

Penicillin Formation in Pea Juice

Popular interest in penicillin is matched by concentrated research to find more about the mechanism of its production. Dr. R. P. Cook and Dr. Margaret B. Brown have studied the production of penicillin on media containing juice of the pea (*Pisum sativum*) and compared it with that from media of known chemical composition (*Proc. Roy. Soc. Edinburgh*, B, 64, Part 2, No. 6; 1950). High yields of penicillin were obtained with one fraction of the pea juice, obtained by adding ethanol to the extract. The chemical composition of this fraction is complex; but the chief constituents have been determined. Other experiments with chemically defined media suggest that the highest yields of penicillin have been obtained only in the presence of a complex mixture of nitrogen-containing compounds. Excess of carbohydrates such as glucose caused an increase in growth but a rapid decrease in the production of penicillin. The Peoria strain 1249 *B*21 of *Penicillium notatum* was used in these experiments.

Correspondence of Lavoisier

Dr. Douglas McKie, University College, Gower Street, London, W.C.1, writes: "In 1948 the Academy of Sciences of Paris appointed a committee for the editing and publication of the correspondence of Antoine Lavoisier (1743–94), the great French chemist. A preliminary catalogue of all letters and documents so far traced in France was compiled by the secretary of the committee, Prof. René Fric, of the University of Clermont-Ferrand; and copies were distributed in 1949 to many libraries throughout the world with the request for further information, as a result of which many important items were located. As there may be others still untraced in Great Britain, I would be grateful to librarians and private owners for information of any such letters or documents in their care or possession."

Royal Statistical Society: Officers

At the annual general meeting of the Royal Statistical Society the following elections were announced: *President*, Prof. Bradford Hill; *Honorary Secretaries*, Mr. R. F. George, Mr. Richard Stone, Mr. Philip Lyle; *Honorary Treasurer*, Mr. R. F. Fowler. Mr. F. A. A. Menzler, president of the Institute of Actuaries, was awarded the Society's Guy Medal in silver.

Announcements

Prof. E. Guyénot, professor of zoology and comparative anatomy in the University of Geneva, has been elected a non-resident member of the Paris Academy of Sciences in succession to the late Prof. L. Cuénot.

Dr. Lillian M. Gilbreth, president of Gilbreth Incorporated and a member of the board of directors of the American Management Council, has been elected an honorary fellow of the British Institute of Management. This is the first occasion on which the Institute has made such an election.

'Open Days' at the Chemical Research Laboratory, Teddington (Department of Scientific and Industrial Research), have been arranged for September 19 (afternoon), September 20 (morning), September 21 (morning or afternoon). Applications to attend should reach the Director before August 31; firms already on the invitation list need not apply.

The forty-seventh Autumn Foray of the British Mycological Society will be held at Hereford during September 12–19, with headquarters at the Training College, Hereford, at which accommodation will be available. Those wishing to attend should notify the secretary, Dr. C. J. Hickman, Department of Botany, University, Birmingham 15, not later than August 11.

The Faraday Society, on the invitation of the National Research Council of Canada and various Canadian industries, will hold a general discussion meeting at the University of Toronto in September 1952. The subject will be "The Reactivity of Free Radicals". In addition, visits to various universities and industrial concerns are being planned. Those interested should communicate as soon as possible with the Secretary of the Faraday Society, 6 Gray's Inn Square, London, W.C.1.

A "Name Index of Organic Reactions", by Prof. T. S. Wheeler and J. E. Gowan, published by the Society of Chemical Industry (56 Victoria Street, London, S.W.1; pp. 46; 5*s*. net), gives briefly the nature of various reactions named after their discoverers, and should be useful to students of organic chemistry and others who may not recall what a particular reaction denotes. There are references to literature.

Erratum. In the communication "Vitamin B_{12} Content of Soft- and Hard-shell Clams" (*Nature*, July 7, p. 36), the organism mentioned in paragraph 3 is *Lactobacillus leichmannii*; in the last line of the same paragraph, for "0·4 μgm." read "0·5 mμgm.".

HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA AND SOUTH-EAST ASIA

THE history of the sciences, pure and applied, in India and other parts of South Asia, still remains the greatest 'unknown continent' in this world of study, so important for the general cultural history of mankind. It was therefore an excellent idea to gather together in November 1950 a group of Indian and South Asian scholars interested in the history of science, and to publish, even if only in a provisional form[*], the papers which were read to the symposium. The result shows clearly that there is an enormous amount of material already available for the work of synthesis, in which we must attempt to place the development of science and scientific thought in India in its proper framework of parallel developments, some later, some earlier, in Europe and in other parts of Asia. It is also clear, however, from the papers in this symposium, that the task is perhaps the most difficult of all those which face historians of science to-day, owing to the extreme uncertainties in the dating of the most important texts, and even of actual objects which have survived.

Some of the papers, such as the general surveys given by A. S. Altekar and by R. C. Majumdar, are judicious and careful concerning this, and will no doubt be in greatest demand if copies are available separately. Some of the specialized papers (such as that by B. L. Raina) are also reasonably cautious. Unfortunately, this cannot be said of the majority of the papers, which put forward quite unacceptably early datings especially for texts purporting to date from the first two millennia B.C.; particularly bad examples are the two papers on astronomy (by Shukla and Dixit) as well as others on chemistry (by N. R. Dhar), embryology (R. V. Seshaiya) and medicine (G. V. Satyanarayanamurthi). The accompanying table shows the divergence of opinion. It is even maintained that the Babylonians owed the sexagesimal division of the circle and the system of twenty-eight lunar mansions to India. In general, we find throughout the papers too marked a chauvinistic tendency, an effort to minimize foreign influences on Indian science and to emphasize all outward transmissions—this is, of course, all too easy so long as Indian history has not been provided with a strict chronology. Typical of the desire to make a case is the praise bestowed upon the potters of the Mohenjodaro civilization (P. Ray), where no comparison is made with other pottery products studied by the author, nor is any ceramics expert cited whose opinion might carry weight. Along with these tendencies goes the fault of trying to read too much into ancient texts, as when the Pillar Edicts of Asoka or the text of the "Arthashastra" are appealed to as evidence for advanced fishery legislation (S. L. Hora); here the writer is roundly taken to task by a colleague (R. C. Majumdar). But great uncertainty seems to reign, for the sceptic himself seems to be perhaps too sceptical regarding the military use of arsenical smokes—which were certainly developed quite early by the Chinese. So while most of the writers are too rash, others are too modest, notably the writer on Siam (P. Rochanapuranandа), who disclaims any contribution of his own Thai people to science, failing to mention the work of la Loubère[*] in the seventeenth century, which shows that Europeans were at that time much interested in what the Siamese knew. Even if this turned out to be mostly Chinese—as it did—Siam must certainly have had something to show in fields such as textile technology. The same applies to the paper on Indonesian culture (Prijohutomo).

Until the problem of the dating of Indian texts is solved, all those of transmission must remain impossible to deal with. Hence the confidence shown by papers such as that on Indian–Chinese relations (P. C. Bagchi) is entirely misplaced. We cannot admit the derivation of the Chinese lunar mansions from India (probably both systems are ultimately Babylonian). It is absurd to claim Indian influence on a mathematical work such as the "Sun Tzu Suan Ching" (third century A.D.) on the ground that the word 'Ching' was afterwards used for translating the term 'Sutra' in Buddhist texts—all canonical books were known as 'Ching' from the time of the Warring States (fourth century B.C.). Nor is there any mention in this paper of the numerous cases which have been noted of the reappearance of Chinese mathematical problems in subsequent Indian texts.

Nevertheless, the study of the history of science in India remains enthralling. The following words of Filliozat, in the preface to his recent splendid monograph on the theories of classical Indian medicine[†], are well worth pondering:

"Some may doubt the legitimacy of placing Indian and Greek science on the same level, preferring to compare the former rather with that of Islam. The common opinion that Indian science lacked originality presupposes that it was derived from Greek science, and is therefore sister to the science of the Arabs. . . .

"This problem has been far too much prejudged. Indian scholars, moved by national pride, are prone to maintain that their sciences in high antiquity surpassed even those of to-day. In the West, on the other hand, many maintain that the spirit of scientific research could only have been born in Europe, and that what science the Indians had they borrowed. In either case the only proofs presented are a few examples claimed as characteristic and used as the basis for generalizations, hypotheses taking the place of facts which are still undiscovered or which people will not take the trouble to seek. Indeed, opinions rest on racial or national preconceptions rather than on a profound comparative study of the two great scientific traditions the value of which is to be determined. One notes also that those who speak with the greatest certainty in these matters are just those who are familiar with only one of the two traditions, knowing the other only by scattered facts, or studies which they are unable to appreciate. 'To say nothing, of course, of those 'authorities' who know nothing of either of the two traditions about which they speak.

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[*] Proceedings of a Symposium on the History of Science and Technology in South Asia, Delhi, Nov. 1950. Organized by Unesco, and obtainable in mimeographed form from the Unesco Field Science Cooperation Office, c/o University of Delhi. About 150 pp., mostly single-spacing, mimeographed foolscap-size typescript.

[*] "A New Historical Relation of the Kingdom of Siam . . .", tr. A. P. Gent, F.R.S., from the French edition of 1691 (London, 1693).

[†] Filliozat, J., "La Doctrine Classique de la Médecine Indienne", Imp. Nat. (CNRS and Geuthner, Paris, 1949).

DATING OF INDIAN TEXTS

	Dating accepted by critical modern scholarship (and in papers by A. S. Altekar and R. C. Majumdar)	Papers by K. R. Dixit and G. V. Satyanarayanamurthi	Paper by K. S. Shukla	Papers by P. Ray, S. L. Hora and R. V. Seshaiya
Vedic material	c. −14th (−1400/ −1000)	−6000/ −1500	−4000/ −2000	
Upanishads period	−10th to −6th	−17th/ −7th		−2500/ −2000
Calendrical texts:				
"Jyotisha Vedanga",	−600/ −200		−1400	
"Surya Prajnapti"	c. −400		−500	
Astronomical text.				
"Surya Siddhanta"	+4th or +5th		±0	
Economic and technological text:				
"Arthashastra"	−1st			−4th
Medical and biological texts:				
"Susruta Samhita",	−1st (present text +11th)	−7th		−6th
"Charaka Samhita"	+1st (present text +8th)	−7th		−6th

"The greatest historians of science have not always escaped from the inconvenience of knowing only one side of the matter. Paul Tannery, so famous for his studies on ancient mathematics, is an example. We know that the trigonometric sine is not mentioned by Greek mathematicians and astronomers, that it was used in India from the Gupta period onwards (+3rd. century), that the *Surya Siddhanta* (+4th. or +5th. century) gives a table of sines, that the Arab astronomers knew them from their Indian contacts and passed them on to Europe in the +12th. century, when the work of al-Battani was translated into Latin. The only conclusion possible is that the use of sines was an Indian development and not a Greek one. But Tannery, persuaded that the Indians could not have made any mathematical inventions, preferred to assume that the sine was a Greek idea not adopted by Hipparchus, who gave only a table of chords. For Tannery, the fact that the Indians knew of sines was sufficient proof that they must have heard about them from the Greeks.

"If this is the way we are to argue, there was never any science other than Greek science, and the question whether science has any origins other than the Greek 'miracle' is solved in advance. Only a profound study of Indian scientific developments in parallel with those which took place elsewhere about the same times, can reveal the degree of originality of that science, and hence enable us to understand the rôle which India played in the history of the growth of man's knowledge of Nature."

In the present symposium, the writer on Siam ends, somewhat pathetically: "At present we all seem to believe that science is something which originated especially in Europe and the Near East, and that the Far East had no share in the building of this most important branch of human knowledge. Yet Asian countries such as India and China were important centres of culture both materially and spiritually. Their peoples had learned how to control the natural world around them, and to live a life in which there was room for leisure, only it seems that the knowledge gained by them never joined up with what we know today as modern science. However, Asian people now find no difficulty in learning science and do not lack ability in scientific research."

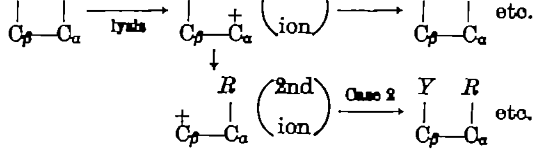
In my opinion, future research on the history of science and technology in Asia will, in fact, reveal that the achievements of these peoples contributed far more, in all pre-Renaissance periods, to the development of world science than has yet been realized. The programme of Filliozat is the answer to the perplexity of Rochanapurananda.

JOSEPH NEEDHAM

WAGNER CHANGES, SYNARTETIC ACCELERATION AND SYNARTETIC IONS

By F. BROWN, PROF. E. D. HUGHES, F.R.S.,
PROF. C. K. INGOLD, F.R.S., and J. F. SMITH
University College, London, W.C.1

IT has been established[1] that the Wagner rearrangement is a form of unimolecular nucleophilic substitution or elimination (S_N1, $E1$); its primary step is that of all such unimolecular reactions, namely, a heterolysis with the production of a carbonium ion. Let us, for present convenience, call the obvious structure for this ion that of the 'first' carbonium ion. This ion might simply take up an anion (S_N1 substitution), or lose a proton ($E1$ elimination). However, the characteristic phenomenon of a Wagner change is that, prior to any such occurrence, a carbon atom with its full octet shifts over from an adjoining position to the charge-centre of the first ion. If nothing else happened, this would produce what we might call the 'second' carbonium ion. It is from this that the rearranged products may be considered as derived, either by uptake of the originally separating anion (Wagner isomerization), or by uptake of a different anion (Wagner substitution), or by loss of a proton (Wagner elimination):



As shown earlier[2], some primary heterolyses are 'accelerated'; that is, they occur much more rapidly than when the bond undergoing fission has the same local surroundings in simpler molecules; some heterolyses are not accelerated. Also, some heterolyses involve Wagner rearrangements, and some do not. The relationship between incidence of acceleration and of the Wagner change requires analysis.

One possible mechanism for the acceleration of a primary heterolysis depends on the release, during the process, of initially stored non-bonding energy: this has been defined[2] as 'steric acceleration'. Obviously it might operate whether a Wagner change is involved or not. Another mechanism of acceleration, which could evidently operate when a Wagner rearrangement is involved, would gain the excess rate from a release of bonding energy during the bond-shift characteristic of the Wagner change: this we shall call 'synartetic acceleration', for a reason that will become clear later. We shall also note later, what is not immediately obvious, namely, that this mode of acceleration may operate even when a Wagner change is not involved. The ranges of incidence of the two accelerative mechanisms require consideration.

We have approached the two problems stated by trying experimentally to answer a number of simple guiding questions by the provision of examples. One might first ask: Can acceleration ever arise without a Wagner change? The following example shows that it can. The rate of hydrolysis of camphene-hydrochloride in aqueous solvents to camphene-hydrate and camphene is too great to be easily measured; it is obviously greater than the corresponding rate for simple tertiary alkyl chlorides. The rate of the analogous unimolecular ethyl-alcoholysis has been measured[3] (for example, $k_1 = 4{\cdot}0 \times 10^{-5}$ sec.$^{-1}$ at 0° in dry ethyl alcohol), and has been found to be about 6,000 times greater than the corresponding rate for *tert.*-butyl chloride.

The next question is complementary: Can a Wagner rearrangement ever occur without acceleration? Again the answer is affirmative. The unimolecular solvolysis of *neo*pentyl bromide[4], to give exclusively Wagner-rearranged *tert.*-amyl alcohol or *tert.*-amyl alkyl ethers and *iso*amylenes, takes place at rates ($k_1 = 1{\cdot}53 \times 10^{-6}$ sec.$^{-1}$, for hydrolysis at 95° in wet formic acid) which are of the same order of magnitude as those of the corresponding solvolytic reactions of ethyl bromide ($k_1 = 2{\cdot}70 \times 10^{-6}$ sec.$^{-1}$ in the same conditions). The unimolecular solvolysis of pinacolyl chloride, again to give exclusively Wagner-rearranged products, takes place at rates ($k_1 = 1{\cdot}94 \times 10^{-7}$ sec.$^{-1}$ in 80 per cent aqueous ethyl alcohol at 80°) which are of the same order as those estimated for the unimolecular solvolysis of *iso*propyl chloride ($k_1 \sim 5 \times 10^{-7}$ sec.$^{-1}$ in the same conditions)[5]. A similar comparison could be given of pinacolyl iodide and *iso*propyl iodide[6].

These two types of examples show that the boundaries of the areas of incidence of acceleration and of Wagner rearrangements intersect.

Next we ask: Can an accelerated Wagner change be shown to derive its rate from 'steric acceleration'? Theoretically, an affirmative answer is expected, because, given a sufficiently ramified structure, steric acceleration is a mechanism generally applicable to the primary heterolysis. However, an unambiguous example is difficult to provide. Probably the best available example is that of the isomerization of camphene-hydrochloride in aprotic solvents to *iso*bornyl chloride. It has been found[7] that chlorine exchange between camphene-hydrochloride and chloride ions takes place more rapidly than the isomerization, which is not catalysed by chloride ions; and the conclusion has been drawn[8] that the heterolysis essentially precedes the Wagner rearrangement, which occurs during one of two competing forms of ionic reassociation. Now the initial heterolysis is identical, apart from the solvent difference, with the initial stage of the solvolysis of camphene-hydrochloride, which, as noted above, is strongly accelerated, but involves no Wagner change. Hence the acceleration could be a 'steric acceleration'. But even here, as we shall see later, 'synartetic acceleration' is not excluded. However, having regard to the structure, and the large magnitude of the observed effect, we incline to the view that both mechanisms make substantial contributions.

The complementary question is: Can an accelerated Wagner change be shown to derive its rate from 'synartetic acceleration'? Here the answer is definitely affirmative. As indicated in an earlier communication[9], tritylmethyl chloride, like *neo*pentyl chloride, is incapable of easy bimolecular reactions; and hence its unimolecular reactions, which give exclusively Wagner-rearranged products, may be studied, not only in formic acid, but also in aqueous alcoholic solvents. Charlton, Dostrovsky and Hughes found[9] that in formic acid it was hydrolysed by water at a rate ($k_1 = 2{\cdot}3 \times 10^{-6}$ sec.$^{-1}$ at 95°) estimated as about 50,000 times that for *neo*pentyl chloride. Comparisons referring to aqueous alcoholic solvents gave similarly large ratios. We assume that steric acceleration could not apply to the ionization of a primary halide, and that therefore synartetic acceleration is here responsible.

The following example[3] is especially instructive. First, the unimolecular solvolysis of bornyl chloride, to yield Wagner-rearranged products of the camphene series, takes place at rates ($k_1 \sim 1{\cdot}5 \times 10^{-7}$ sec.$^{-1}$ extrapolated for 80°, in 80 per cent aqueous ethyl alcohol) which are of the same order as those of the solvolysis of pinacolyl chloride ($k_1 = 1{\cdot}94 \times 10^{-7}$ sec.$^{-1}$ in the same conditions). Secondly, the solvolysis of *iso*bornyl chloride, also to give rearranged products, has rates ($k_1 \sim 1{\cdot}4 \times 10^{-2}$ sec.$^{-1}$ as above) which are about 70,000 times those of pinacolyl chloride. Steric acceleration seems here to be excluded, because *iso*bornyl chloride, the *exo*-isomeride, can scarcely be supposed to have *more* non-bonding energy than bornyl chloride, the *endo*-compound: again we conclude that synartetic acceleration is responsible. Moreover, it neatly interprets the stereo-kinetic distinction. For in the *exo*-structure, a Wagner-type bond-shift could be initiated before the ionizing chlorine atom has attained the separation of the transition state of ionization (that is, before the chlorine atom has moved by more than about 0·4 A.); and therefore the initiation of the bond-shift could kinetically influence the heterolysis. But in the *endo*-structure, no such bond-shift could commence until the chlorine atom has passed out of the

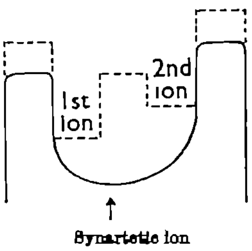


Fig. 1

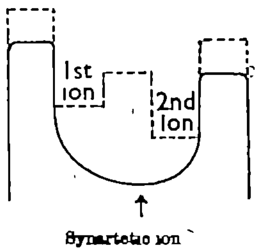


Fig. 2

(The reaction path enters from the left and leaves over whichever transition state lies lower, that is, by the left in Fig. 1 and by the right in Fig. 2)

Case 1, *sN* (broken line). Non-rearranging $S_N1/E1$ without synartetic acceleration (for example, solvolysis of *tert.*-amyl bromide).

Case 3, *sN* (full line). Synartetically accelerated non-rearranging $S_N1/E1$ (for example, solvolysis of camphene-hydrochloride).

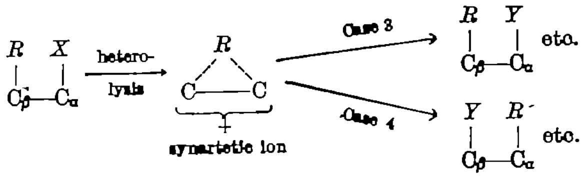
Case 2, *sW* (broken line). Wagner rearrangement, without synartetic acceleration (for example, solvolysis of *neo*pentyl bromide).

Case 4, *sW* (full line). Synartetically accelerated Wagner rearrangement (for example, solvolysis of *iso*bornyl chloride).

way (that is, to well beyond the transition-state distance); and thus the shift could here have no kinetic influence.

While recognizing that marginal situations arise, we can divide the reactions discussed into four main classes, as illustrated by the schematic energy-reaction curves of Figs. 1 and 2. In unaccelerated unimolecular reactions, whether or not they involve a Wagner rearrangement, the 'first ion', and the transition state of its formation, are unaffected by the existence, or possibility of existence, of the 'second ion'. We assume that in unaccelerated Wagner changes there must be two ions; but that when, in unaccelerated reactions, there are two, they are separated by an energy barrier substantial enough to preclude their energetically significant interaction. So we have either (case 1, *nN*) (the letters mean 'normal rate, normal structure') non-rearranging unimolecular reactions without synartetic acceleration (Fig. 1, broken line), or (case 2, *nW*) ('normal rate, Wagner change') Wagner rearrangements without such acceleration (Fig. 2, broken line), according as the transition state of the heterolysis which forms the 'first ion' lies energetically lower or higher than that of the co-ordination which destroys or would destroy the 'second ion'.

The other two classes can be most simply described by assuming that there is no resonance-stopping barrier between the first and second ionic structures, which interact according to a suggestion[10] made earlier, to produce a normal ion more stable than either—a *synartetic ion*, as we may call it, with a split single bond *fastening together* the locations of a split ionic charge. We then have not only a stabilized ion, but also stabilized transition states of ionization, and therefore either (case 3, *aN*) ('accelerated, normal structure') non-rearranging unimolecular reactions with synartetic acceleration (Fig. 1, full line), or (case 4, *aW*) ('accelerated, Wagner change') Wagner rearrangements with such acceleration (Fig. 2, full line), according, as before, to which of the two transition states lies lower. For these cases, we should modify our previous formulation:



Marginal cases (between 1 and 3, and between 2 and 4) should arise when a tunnel effect permits weak resonance between the first and second ions; but we shall not now discuss this phenomenon. Marginal cases of another sort (between 1 and 2, and between 3 and 4) arise when the two transition states lie on a common energy-level, so that the diagrams of Figs. 1 and 2 become symmetrical, as in Fig. 3. This happens when the unrearranged and Wagner-rearranged products are identical, but for some non-energetic distinction, as when they are enantiomeric, or are labelled isotopically. We then have either (border-case 12, *nNW*) reactions without synartetic accelerations (Fig. 3, broken line), or (border case 34, *aNW*) reactions with synartetic acceleration, leading, in either case, to 50 per cent of Wagner-rearranged product (for example, to racemization when the optical distinction is employed). A normal-rate reaction having the described symmetry (border case 12) has been found by Cram[11] in the solvolysis with racemization (at both asymmetric centres) of that form of 2-phenyl-3-*n*-butyl *p*-toluenesulphonate for which the normal and rearranged substitution products would be enantiomers.

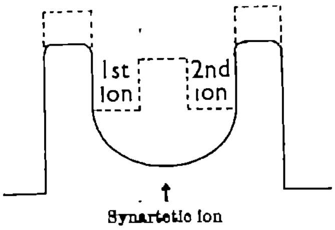


Fig. 3

(The reaction path enters from the left, then divides, and leaves equally by the left and by the right)
Border cases 1, 2 (broken line) and 3, 4 (full line)

One usually thinks of CC-bond σ-electrons as having a much smaller tendency to enter into other orbitals than have CH-bond σ-electrons, or of course π-bond-electrons or unshared *p*-electrons. Yet it appears that CC-bond σ-electrons can interact strongly with a carbonium ionic centre to form what we have called a synartetic ion, at least when the stereoelectronic situation is favourable, and when the normal types of conjugation and hyperconjugation are more or less restricted. This seems somewhat less strange when we recall that the carbonium ion has the same electron configuration as the tercovalent boron atom, and that it is one of the lessons of boron chemistry that all low-lying orbitals will somehow achieve partial occupation, even when there are too few electrons to occupy them fully (this was recently pointed out to us by Dr. S. H. Bauer): the same principle may apply in carbonium ion chemistry.

[Feb. 2.

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[1] Dostrovsky, Hughes and Ingold, *J. Chem. Soc.*, 192 (1946).

[2] Brown, Davies, Dostrovsky, Evans and Hughes, *Nature*, [167, 987 (1951)].

[3] Results of present authors.

[4] Dostrovsky and Hughes, *J. Chem. Soc.*, 164, 166, 171 (1946).

[5] Martin, thesis (London, 1949); *Nature*, 166, 679 (1950).

[6] Unpublished experiments by Mrs. M. G. Peeling.

[7] Nevell, de Salas and Wilson, *J. Chem. Soc.*, 1188 (1939).

[8] Bateman, Cooper, Hughes and Ingold, *J. Chem. Soc.*, 930 (1940).

[9] Charlton, Dostrovsky and Hughes, *Nature*, [167, 986 (1951)].

[10] Ingold, cited by Watson, *Ann. Rep. Chem. Soc.*, 36, 197 (1939), and "Modern Theories of Organic Chemistry", Oxford Press, 2nd Ed., p. 208 (1941); also by Simonsen and Owen, "The Terpenes", Cambridge Press, 2nd Ed., p. 161 (1949).

[11] Cram, *J. Amer. Chem. Soc.*, 71, 3836 (1949)

DIFFRACTION GRATINGS

THE Optical Group of the Physical Society held a symposium on diffraction gratings at the Imperial College of Science and Technology, London, on May 10. About seventy-six members and visitors attended and the meeting was generally very successful. A large number of exhibits and demonstrations illustrating the ruling and testing of gratings was shown.

Prof. W. E. Curtis, in introducing the subject, surveyed the present field of application of the grating and indicated the directions in which development is desirable. He mentioned a variety of problems in both atomic and molecular spectroscopy, for which gratings are required, in addition to spectrochemical investigations of a more routine nature, which are steadily increasing in number. He pointed out that for these various purposes a wide range of gratings would be required, particularly in regard to spacing and form of the rulings. He remarked, in passing, that it would be more appropriate to specify the spacing directly in microns, rather than as so many lines per inch, as hitherto. He also urged that the present custom of describing performance in terms of 'resolving power', $\lambda/\delta\lambda$, should be abandoned as neither physically significant nor practically convenient, and replaced by a statement of the limit of resolution (based on the Rayleigh criterion) in cm.$^{-1}$. This has the advantage of depending only on the ruled width of the grating and its setting, and not on the spacing or the spectral region. Its minimum value would be the reciprocal of twice the grating width, as in the reflecting echelon. The optimum spacing in a particular case would be determined by other considerations, such as the overlapping of neighbouring orders and the extent to which groove shape could be controlled.

Prof. Curtis then referred to some special modifications which may prove valuable in the future, notably the Harrison echelle grating. This has yet to prove itself, but certainly appears very promising. The combination of grating and mirror in Littrow fashion, as proposed by Hulthén and Lind, may well prove valuable in certain circumstances. He remarked also that the introduction of the photomultiplier renders a plane-grating – concave-mirror spectrograph an attractive proposition by reason of its simplicity of construction and adjustment.

So far as ordinary gratings are concerned, Prof. Curtis considers that there are four main directions in which improvement should be sought: the elimination of ghosts, either by perfecting the traditional ruling-method or by developing entirely new ones; the concentration of light in a given direction by control of groove form; the provision of larger gratings, although a greater ruled width only would suffice for some purposes; and finally, a substantial reduction in cost, so that a spectroscopist can acquire a number of gratings from which he may select the one best suited to each problem. Having regard to the effort already expended on the ruling of gratings, it might seem that only limited progress along these lines would be possible; but modern advances in technique and materials are such as to give good grounds for optimism.

Speaking of the history of the diffraction grating, J. S. Clark said that it originated in the pioneer work of Joseph Fraunhofer early in the nineteenth century. Reference was made to Nobert, of Barth in Germany (1850), and to Rutherford in the United States (1875), who was the first to rule a reflexion grating on speculum metal. The ruling of gratings at Johns Hopkins University, Baltimore, was initiated by Rowland in 1880 and continued by Anderson (1909), Wood (1923) and Strong. Other grating-ruling engines established in the United States were those of Michelson (1900) and Gale (University of Chicago) and those of Anderson (1916) and Babcock (Mount Wilson Observatory).

The Blythswood ruling engine, which has been in the possession of the National Physical Laboratory, Teddington, since 1908, dates from about 1880, when its construction was undertaken by Lord Blythswood with the assistance of Otto Hilger (one of the founders of the firm of Adam Hilger). Its subsequent history was described by Mr. Clark, and brief mention was also made of the ruling engines constructed by Grayson (1893) at Melbourne and by Siegbahn (1930) at Uppsala and at Stockholm. After pointing out that all existing ruling engines of conventional design have been either of the shaper type (for example, Rowland and Blythswood machines) or of the planer type (such as Strong's new machine at Johns Hopkins University), Mr. Clark went on to discuss the future prospects of ruling large gratings by conventional methods and concluded with a fairly detailed description of the Blythswood machine in its present state.

J. Guild described how interference tests, which have long been familiar in their application to the examination of mirrors, prisms, lenses and even complete optical instruments, can be applied to diffraction gratings, and stressed the fundamental importance of these tests in assessing the optical performance of gratings and indicating the nature, magnitude and location on the grating surface of the defects of figure or errors of ruling responsible for defects of performance.

The tests described were an adaptation of the well-known Fizeau test for plane mirrors to plane reflecting gratings: an adaptation of the differential interference (sheared wave-front) test developed by Ronchi and Bates for concave mirrors to either concave or plane gratings; and a test depending on the interference between the wave-fronts diffracted by a superposed pair of transparent replicas of a plane grating. For the second test Mr. Guild employed a simple beam-dividing device based on the Wollaston or Rochon double-image prism. This is free from some of the defects of Ronchi's apparatus and, while possessing all the flexibility required for the present purpose, is much simpler and less costly than the wave-front shearing interferometer of Bates. Slides were shown of interferograms obtained by each of these methods, those illustrating the first two being of gratings ruled on the Blythswood, Rowland and Siegbahn engines.

It was clear from those examples that, judged by ordinary optical standards, there is plenty of room for improvement in the best gratings produced by ruling engines of the traditional types. It was also apparent that the makers of gratings should be more careful than they seem to have been to rule only on blanks of good optical quality.

Dr. L. A. Sayce began by pointing out that diffraction gratings made by the traditional methods laid down by Rowland have certain defects, some inherent in all reciprocating engines and some attributable to the residual errors of screws, division plates, thrust bearings and the like. There is therefore special interest in a new approach to the problem suggested by Sir Thomas Merton which is being developed in the National Physical Laboratory by the Light and Metrology Divisions. Dr. Sayce explained that the fundamental concept is to rule diffraction gratings upon cylinders. Such helical gratings can be used directly in conjunction with cylindrical lenses or mirrors, but can more conveniently be used as matrices for the preparation of plane replicas of which many identical 'copies' can be made from each original ruling.

Using this principle, therefore, the production of a plane grating now consists of three main stages. In the first, a screw of up to 15,000 threads per inch is cut upon one-half of a metal cylinder using a suitably modified lathe. In the second, this lathe-cut thread is copied upon the other half of the cylinder using a 'Merton nut' to remove its inevitable periodic errors. In the third stage, the corrected helix is covered with a thin layer of plastic which, when hardened and annealed, is removed from the cylinder and opened out upon an optically flat surface of swollen gelatine. When the whole has dried, the plastic 'pellicle' can be removed, and the underlying gelatine is found to be moulded into a flat replica of the corrected helix and can be hardened and aluminized.

It was shown by means of specimens and interferograms that these methods have already produced satisfactory gratings, particularly for work in the infra-red, and there seems every reason to hope that they will in due course yield large ghost-free gratings suitable also for emission spectroscopy. As it has been found impossible to devise a method of producing concave gratings from cylindrical matrices, a machine has been developed at the National Physical Laboratory for applying to a reciprocating concave blank a tool advanced by a 'Merton nut' driven by a screw of the pitch of the required grating.

Dr. A. C. Menzies, after referring to some recent work by Messrs. Hilger-Watts on the construction of fine-mesh metallic grids, went on to describe a modification of Sir Thomas Merton's process with the object of producing long gratings. This employs three successive operations. In the first, a short length of fine-pitch thread is engraved on a metal cylinder *B* by a diamond driven from a 'Merton nut' riding on a similar cylinder *A* on which a coarse thread has been engraved by a lathe. The two cylinders are connected together by a gear of ratio 32 : 1. In the second stage, a 'Merton nut' on *B*, with a diamond just ahead of it, extends the fine pitch thread as far as desired along the cylinder. The passage of the nut over the thread which it has ruled tends to produce irregular burnishing of the rulings. Although this would probably have little effect on the performance of a replica taken from the cylinder, it may be eliminated by ruling a third cylinder *C* by means of a 'Merton nut' riding on *B*, the two cylinders being coupled together by a 1 : 1 gear. This cannot introduce periodic error, although it may give rise to slight non-linearity of the rulings, which, however, is regularly repeated and therefore not objectionable. In all cases, one end-bearing consists of a 'Merton nut' on a 'neutral' thread, and the other of a similar nut on polished bar. A steel bar ruled by this method for a length of about nine inches was exhibited.

Dr. Menzies also directed attention to the probable value of the 'superfinishing' process, as used by Chryslers in the United States, in much reducing the time required to polish the metal cylinders preparatory to ruling by the Merton method.

In the discussion which followed, F. Twyman emphasized the desirability of comparative testing of existing gratings, especially some of the older ones reputed to be of 'good' quality. Prof. Curtis asked whether any correlation has yet been attempted between the results of the tests described by Mr. Guild and the performance of the grating in an actual spectrograph, to which Mr. Guild replied that this has not yet been possible as sufficient gratings of various qualities have not yet been available. Mr. Guild said that it is his object to establish such a correlation, and added that, although the tests might be capable of disclosing defects which are too slight to affect spectroscopic performance, such additional sensitivity is of great advantage in monitoring the development of the ruling process.

G. Sissen asked Mr. Guild whether it is possible by his wave-front shearing method to alter the inclination of the interfering wave-fronts, and consequently the spacing of the fringes. The latter replied that variation of fringe spacing is effected by displacing the double-image prism along the axis of the instrument. The direction of the fringes is, however, fixed relative to the direction of shear, in which respect Mr. Guild's beam divider is less flexible than that of Bates for general optical testing. Mr. Sissen then asked Dr. Sayce whether the thickness of the gelatine layer in the third stage of his process could be sufficiently increased to produce infra-red gratings, and received the reply that, although an increase in the thickness of the layer causes a slight departure from flatness, this is not enough to be detrimental in the infra-red region.

There was some discussion of the possibilities of the step-by-step method of grating ruling, which is attractive by reason of the elimination of the screw and its attendant errors. Various speakers referred to attempts on these lines, made in Germany, Sweden and Great Britain ; but it appears that none has been successful. The fundamental difficulty is thought to be that in any process of this type an accidental error of spacing will necessarily affect the whole of the subsequent rulings.

College of Science
Calcutta

THE 1951 EXHIBITION OF SCIENCE

THE 1951 Exhibition of Science is splendidly housed, to the south of the Imperial College, in an extension of the Science Museum which is to form the nucleus of new permanent additions to the Museum buildings. A wealth of skill and decorative genius has gone to the making of a display which, despite some minor shortcomings, is an outstandingly good presentation of some of the main developments of pure science during recent years, with some appropriate historical background. It is planned as a continuous narrative (one might almost say a short course) and the round trip takes between one and two hours.

One enters by a maze-like tunnel with sound-proofed bays, in each of which a loud-speaker suggests that one is shrinking to atomic dimensions as illuminated models of graphite crystals expand successively ; at the end of the tunnel the visitor is on equal terms with an electron cloud. He is to see modern science from the atomic point of view.

The first stage of the journey around the exhibition itself deals with atomic structure. The diagrams and mural showing the history of the Periodic Table and its modern representation are good. The experiments on the electron are indifferent, chiefly due to lack of explanation as to why electric and magnetic deflexions occur ; and some of those listed are missing. There are some excellent animated diagrams illustrating radioactivity and nuclear physics, and two cloud chambers which work beautifully ; but why the catalogue should include under radioactivity a spectrometer "capable of refractive index measurements of 0·000001", whatever that may mean, is a mystery.

Next come sections on chemical structure, the nature of chemical bonds, and the structure of metals and crystals. These are on the whole magnificent, lending themselves admirably to representation by the modeller. The exhibits on enzymes are introduced curiously—first by a film-strip of a rugby footballer which is quite irrelevant unless it is intended as a miming for the word 'conversion' (though it is a penalty kick), and then by a model of a dancing class which could not be interpreted; but the exhibits themselves are clear enough.

Associated with the chemical section are a number of poorly adjusted ripple-tank experiments, which do not do justice to a well-known make of apparatus, and which are intended to lead up to the idea of X-ray diffraction by crystals. In this section also is shown the *EM3* electron microscope. The catalogue says this uses four magnetic lenses; as exhibited, it uses one electric lamp underneath one lantern slide, but nevertheless admonishes the public not to tamper with the controls. Is not a leading make of British electron microscope something to show proudly, in working order, on such an occasion ?

In the biological exhibits the emphasis is rather on living matter than on the organism as a whole; here again the modeller has had full scope and has done magnificently.

In the "Stop Press" section, pride of place must go to the exhibit on cosmic rays. This is fully documented, and tells the whole story from the first unaccountable electroscope leak to the most recent photographic plate work. It was worth the visit to see this exhibit alone, and to watch a counter-controlled chamber in action. Less impressive, but none the less excellent, is the smaller section on electrons in crystals, which explains the behaviour of luminescent materials clearly and effectively. Nimrod, the Ferranti electronic computer, is a good demonstration; the game it plays is simple, and any opponent who knows the rules has a good chance of success. The operator says it has a temper; but its face lights up after every move, whether advantageous or otherwise.

Nimrod, in fact, sets a standard by which many of the other 'working' exhibits might be judged. It really is in full working order, and it has someone in charge to explain what it is doing. Further, there is an excellent pamphlet published by Messrs. Ferranti, Ltd.*, which describes how it is constructed and how it works, and gives a little of the mathematical theory of digital computers. This pamphlet did not, however, seem to be available within the exhibition itself, which is a pity. There is a bookstall, at which expensive-looking commemorative jig-saw puzzles and scientific books quite unrelated to the exhibition are displayed; how much it could have contributed to the purpose of the whole if an explanatory pamphlet setting out details of some of the more striking individual exhibits (and moderately priced) had been on sale there! For the official guide-catalogue, useful as it is in explaining the exhibition as a whole, does not say very much that is helpful about individual items and is even confusing in places; in view of the fact that many items are neither clearly numbered nor effectively provided with displayed descriptive matter, this is a little disheartening. It says a great deal for the real quality of what there is on show that this criticism, which must be made, does not diminish one's admiration for the whole.

The writer was one of a small company of appreciative visitors who seemed to be pretty well outnumbered by the attendants. By all accounts, the exhibition has not so far touched the popular imagination, and there may be several reasons for this. It is the academic conversazione on the grand scale, with the exhibits clearly linked by one central idea, the structure of matter. Perhaps this is the reason, for people will pay to be entertained or impressed, but not to be instructed. Its very success in achieving its aims may well limit its popular appeal. Or it may be that an enterprise of this kind takes a long time to become widely known and appreciated, or even found. It is quite possible to emerge from the South Kensington subway, and be inside the exhibition on the history of the Science Museum itself, before realizing that it is not what you were seeking; though, of course, there is some discreet short-range guidance for the reasonably observant.

One feels that there is something of permanent educational value here, and a pleasing creation which would be worth a visit if only to see a scientific exhibition dressed in a Festival gaiety.

G. R. Noakes

GERMAN SOCIETY FOR ELECTRON MICROSCOPY

THIRD ANNUAL CONFERENCE

The German Society for Electron Microscopy held its third annual meeting in Hamburg during May 18–20. Although the meeting was convened as a national conference, invitations had been accepted by many foreign men of science, so that the conference took on a certain international flavour. Its success was due not only to the high quality of many of the contributions by German and foreign scientific workers, but just as much to the opportunities it offered to make, or renew, contacts between men and women of many countries.

The work of the conference was opened by H. Ruska with a general lecture on the more recent results of electron microscopy, mainly illustrated by examples taken from the biological and medical field. Stress was laid on combining results obtained by electron microscopy with those obtained by other means.

Only some of the large number of papers read (about seventy) can be mentioned here. Mathematical investigations into the properties of certain magnetic electron lenses were presented by Lenz and by Glaser, and experimental methods for the field determination in magnetic lenses were described by Lenz and by Wolff. A very simple 'electron-optical' bench arrangement, to facilitate experimentation, was shown by Boersch.

Instrument design has been pursued steadily during the last year, and Möllenstedt described a simple way of increasing the specimen penetration in the electrostatic instrument by placing the specimen into a chamber kept at $+50$ kV. with respect to earth, the gun operating at -50 kV.; a direct switch-over from 50 to 100 kV. can be made. The use of the electron microscope in electron diffraction studies has been extended through the development by Heise of an adaptor for glancing incidence work with the AEG–Zeiss instrument. The design of a small magnetic microscope built at the University of Munich was described by Kinder; this instrument is very similar to the RCA desk-model. An instrument of unconventional design was described briefly by von Borries. This instrument uses a single permanent magnet with two gaps in the iron circuit, one exciting the objective lens, the other the projector lens, the final image being free of image rotation; the magnification of the projector lens can be varied continuously by an axial movement of the pole piece insert. Further experiments with Boersch's filter method, in which the majority of the inelastically scattered electrons which reduce the image contrast in electron microscopy and in electron diffraction are eliminated, were described by Rang, who used an electrostatic lens to obtain the required critical deceleration.

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* *Faster than Thought*: the Ferranti Nimrod Digital Computer. Pp. 40. (Hollinwood: Ferranti, Ltd., 1951.) 1s. 6d.

The usefulness of stereoscopy in the interpretation of complicated structures was demonstrated by Helmcke, who also applied the methods of photogrammetry to a quantitative evaluation of stereograms, and by Grasenick.

The problem of the 'tolerance dose' without specimen destruction was discussed from various aspects. Boersch estimated that hydrogen atoms will always remain invisible; but that carbon atoms might possibly be made visible if the resolving power could be increased sufficiently far. Experimental investigations by König gave a much more pessimistic picture; specific loads of 10^4 to 10^5 Wsec./cm.^{2} at the specimen already lead to a partial breakdown of the more complicated materials. Rang showed that by correct choice of the observation screens optimum conditions regarding specimen load during focusing can be maintained.

Interesting details were given by König of the 'carbon skin' method of obtaining three-dimensional 'replicas' of substances which do not stand the high beam intensities often required in their imaging. The specimen to be coated is placed on the aluminium anode of a glow discharge maintained in benzene vapour of about 1 mm. pressure. The carbon coating formed is later 'hardened' either by subjecting the coated specimen in the electron microscope itself to a high beam current, or by keeping it for some time in a vacuum oven at 400° C. The original specimen can then be dissolved, or evaporated out, leaving the carbon skin intact; this gives a faithful representation of the original, as was proved by stereograms of diatom replicas shown by Helmcke.

Surface structure, phase changes and crystal growth phenomena at elevated temperatures in steel and iron–nickel alloys were demonstrated convincingly by Rathenau, using the emission electron microscope; other applications of electron microscopy to metallurgical problems were discussed by several authors. Grasenick has studied crystal growth in magnesium oxide, and Helwig the formation of zinc and cadmium oxides. Several papers described the structures of activated aluminium oxides. Rang and Schluge, as well as Bernard, and Möllenstedt, showed how the Bragg diffraction lines appearing in many electron micrograms of crystalline materials can be co-ordinated with certain lattice positions.

A number of papers dealt with the methods of preparation of biological material; Kellenberger described a critical study of various methods of preparing *B. coli* for the electron microscope, and Winkler an investigation into the method of fixation which gave closest agreement with the light optical picture. The varying success of the 'freeze-drying' method was discussed by Studer and others. Contributions to the study of collagen and reticulin fibrils were presented. Further papers dealt with the reaction of bacteria to certain treatments (for example, of T.B. bacilli to streptomycin) and other cytological questions, and with the first electron microscopical representations of new material.

Progress in the preparation of thin sections of tissues was reported by several workers. Kellenberger described the design of a new microtome (made by Trüb-Täuber, Zurich), cutting reproducibly to 0·05 micron, and illustrated this by slides of thin sections through nerve fibres of frogs and neuro fibrils. Bretschneider uses a modified C.I.C. microtome; he considers that the problem of thin sectioning is no longer one of microtomes but of the technique of fixation; this he described in detail. (Of eighteen mixtures investigated, a composition of paraffin wax, beeswax and carnauba wax was found most successful.) This talk, too, was illustrated by interesting slides. Bernhard discussed investigations on cancer cells using the thin-sectioning technique; the interpretation of earlier American results, showing virus particles in cancer cells, could not be confirmed, as most virulent cancer cells investigated were free of these bodies. Hence, normal cells were studied, in which several new features were discovered, the function of which is still unexplained. Mölbert and Beyersdorfer also described a new microtome (made by Jung, Heidelberg), and discussed the technique of its use. They found that an after-treatment of the thin sections by an electrical discharge in air of 0·05 mm. mercury pressure made them more resistant to the electron beam.

Many other subjects were discussed, for example, polymerizing methyl methacrylate replicas, investigations on textile fibres, rubbers and plant cells, size measurements of sub-microscopical crystals, fine-grain photographic emulsions and studies of surface contamination phenomena with Muller's point projector microscope.

An exhibition of photographs and of new instruments was held in conjunction with the conference. Besides microscopes, microtomes and vacuum accessories, four electron microscopes were on show. All these instruments were distinguished by a high standard of craftsmanship employed in their manufacture, but they were expensive by our standards. The Philips electron microscope has been exhibited in Great Britain on several recent occasions, and does not, therefore, require any further description; but the AEG–Zeiss electrostatic instrument will not be known to many workers here. This machine uses electrostatic lenses throughout. The need for frequent cleaning of the lenses has been greatly reduced through a built-in 'stigmator', which compensates the astigmatism caused by dirt particles getting into the lenses. Three magnifications can be selected by using the two fixed projector lenses singly or in combination; an additional diffraction lens is provided. Siemens demonstrated two instruments, their standard three-lens type for 100 kV., and a new simplified type for 60 kV. Both types are post-war developments of the original Siemens instrument Both new instruments employ a revolving projector lens head, which allows any of four projector lenses to be brought quickly into operation. Many other improvements over the old type are incorporated, for example, grease vacuum joints are replaced by rubber seals. G. LIEBMANN

LETTERS TO THE EDITORS

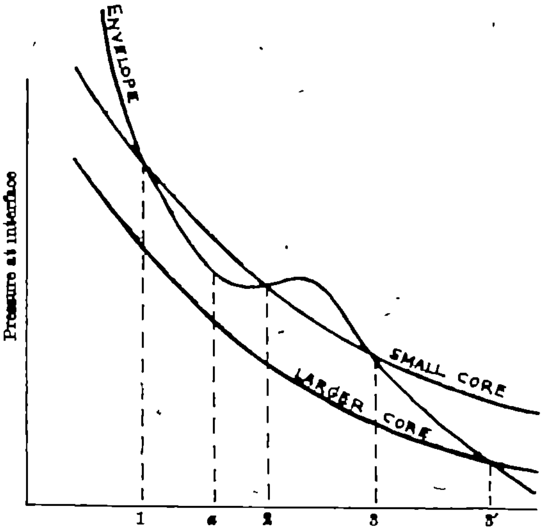
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Hydrogen Exhaustion and Explosions of Stars

It is a well-established fact that energy production in stars is due to the thermonuclear transformation of hydrogen into helium. Since hydrogen forms about one half of normal stellar material, the rate of its consumption, that is, the luminosity of the star, determines the stellar life-span; in the case of our sun it can be calculated to be about fifty thousand million years, which is very long as compared with the estimated age of the stellar universe. Since, however, stellar luminosity (hydrogen consumption) increases very rapidly with stellar mass (hydrogen content), the life-spans of brighter stars are considerably shorter. Thus stars of about zero absolute magnitude would run through their hydrogen evolution in a few thousand million years, that is, in a period of time which is generally accepted as representing the age of our universe. Indeed, we notice that the stars of zero absolute magnitude seem to represent a demarcation line in the stellar population of our galaxy. Thus the main sequence of the Russell–Hertzsprung diagram shows a noticeable discontinuity at that particular point. The brighter stars are very scarce in space and are in a state of rapid axial rotation; the fainter stars are very abundant and scarcely rotate at all. Also, within stellar population II, as defined by Baade (the regions of the galaxy where no interstellar material is present), the upper part of the main sequence is completely absent.

All this suggests that zero absolute magnitude divides the main sequence into the older (lower) part containing the original stock of stars formed almost simultaneously a few thousand million years ago, and the younger (upper) part consisting of stars formed by condensation processes at various more recent epochs. We may also notice that zero absolute magnitude serves as an apex from which the main sequence of stars branches out into 'swollen-up' stellar types such as pulsating variables and red giants in general, and 'shrunken' stellar types which include Wolf–Rayet stars, nuclei of planetary nebula, white dwarfs, and various types of exploding stars (U-Geminorum, recurrent novæ, ordinary novæ and supernovæ). It is difficult to escape the impression that stars deviating from the main sequence are those which have run out of their original hydrogen supply, a situation which forces them to go through 'unusual' final stages of their evolutionary life. One would expect, in fact, that all these stars would have comparable masses (at least at the stage when they leave the main sequence) of the order of magnitude of three sun masses and about the same total life-span of a few thousand million years. This conclusion finds support in the Kukarkin–Parenago relation, according to which the intensity of periodic stellar explosions (U-Geminorum stars, and recurrent novæ) is directly proportional to the period between explosions. This relation, indicating a constant total rate of energy production, would be difficult to understand for stars of different masses and, consequently, different central temperatures.

If we look at this problem from the point of view of possible stellar models, we find that an ageing star would be expected to develop a so-called 'shell-source' of nuclear energy. In fact, when all the material in Cowling's convective zone supplying fresh fuel for nuclear reactions in the centre is completely dehydrogenized, the reaction would transfer itself into a spherical layer between the isothermal helium core, and the radiative hydrogen-rich envelope. The properties of such shell models have been studied by many authors[1], with rather interesting results. It has been found that an attempt to fit a small isothermal core into a radiative envelope (with the temperature and pressure continuous at the interface) results generally in several possible solutions. One of these gives a star of extremely large radius which can be considered as a tentative model of a red giant (A. Reiz). The other two solutions lie rather close to one another, representing stars of more or less normal size (Hayashi). However, when the fraction of the stellar mass in the core increases (due to the progressive nuclear reaction) these two solutions disappear (S. Chandrasekhar), leaving the evolving star in an odd position of 'not knowing what to do'.



Dependence between the pressure at the interface and its radius for the base of the radiative envelope and the surfaces of two isothermal cores. (Schematic drawing)

The situation is represented schematically in the accompanying graph showing three intersections (1, 2, 3) for smaller cores and only one intersection (3′) for larger cores. The disappearance of two intersections for larger cores means physically that it is no longer possible to fulfil the continuity conditions both for temperature and pressure. If we 'force' a solution for some interface-radius a, we find an inversion of pressure and the star will start to collapse. We can, of course, stabilize the model by raising the temperature (and hence the pressure) at all points of the core; but this will produce a non-stationary thermal state, and lead to gradual heating of the inner layers of the hydrogen-containing envelope. The situation is rather analogous to that in an ordinary electric bell, where the clapper can neither stay at the electromagnet nor at the electric contact. It is difficult to predict the behaviour of the model without rather elaborate hydrodynamical calculations (cf. G. Gamow and C. Longmire); but it is apparent that at this point of evolution the static model must go over into some kind of periodic motion. When the stability conditions are just exceeded, we would expect short-period motion with small amplitudes. As the core grows, both period and amplitude would be expected to become larger and larger. Thus, we have here a picture which may be useful for the explanation of the Kukarkin–Parenago relation, provided we consider different *U*-Geminorum stars as successive evolutionary stages of a single stellar mass. It may, indeed, easily happen that the 'oscillations' described above will result in periodic convectional instabilities. In this case a rapid mixing of cool hydrogen from the envelope with hot helium from the core will result in periodic nuclear explosions of the star. There is also the possibility that similar instabilities may develop in 'swollen-up' solutions of the shell-model. If the resulting central explosions are comparatively weak, they will not show through the thick body of the star and may act as a 'buzzer' mechanism for maintaining regular stellar pulsations.

It is too early to say whether or not the above views will lead to a correct explanation of the dynamical states of ageing stars. The study of the hydrodynamical equations involved in the problem is extremely difficult, and can be done only by means of modern electronic computers. Work in this direction is now being done by the author and his colleagues, A. Carson, G. Keller, C. Longmire, N. Metropolis, L. Peck and R. Richtmeyer, with the hope of having solutions run on a new electronic computer ('Maniac') under construction at the Los Alamos Scientific Laboratory.

G. Gamow

George Washington University,
Washington, D.C.
March 15.

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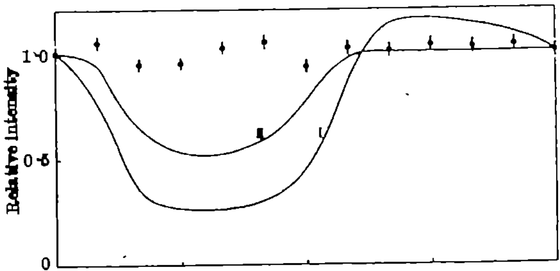
Evidence of Multiple Meson Production

Direct evidence of the production of several mesons by a single primary proton in cosmic rays has been obtained by cloud chambers and photographic plates[1], and indirect evidence by observations of a relatively low average energy of mesons at sea-level[2,3]. Further indirect evidence is furnished by the absence of azimuthal intensity variation obtained as a result of the experiment described here.

Four triple-coincidence counter telescopes, each differing in azimuth by 90°, were used at sea-level, geomagnetic latitude 43·5° S., the middle counter in each telescope having 5 cm. of lead on either side of it. The angle subtended by each telescope was 13° × 3·5°, the larger angle being in the vertical plane, and the zenith angle was 60°. Intensity measurements were made at azimuth intervals of 30°, the average counting-rate being 16·00 per day. From the measured counting-rates, 3·75 counts per day were subtracted, this figure being taken as the shower counting-rate, obtained using a telescope identical with the others except that the middle counter was moved out of line.



Cosmic ray intensity at sea-level

Theoretical curves I (single meson production) and II (including meson decay). ○, observed intensities, showing ± standard error

From the shadow cone theory[4] the primary cut-off momentum interval explored was calculated to be from 3,600 MeV./*c* at azimuth 270° to 16,000 MeV./*c* at 120°.

The measured intensities, after shower correction, are plotted in the accompanying graph, each point being based on approximately 1,700 counts. Curve I is calculated using a primary momentum spectrum $dN = KP^{-3}dP$, the exact form of which is not important, assuming each primary gives rise to a single meson capable of penetrating to sea-level, and is normalized to unit intensity at 0°, corresponding to an observed corrected value of 12·19 ± 0·38 counts per day. Curve II is drawn taking into account the effect of meson decay. It is clear that an asymmetry is to be expected, which is at variance with the observations, for only one point differs from the mean of 12·25 by more than twice the standard error.

The observed uniform intensity at all azimuths may be explained by assuming that several secondaries are produced by each primary, and that the maximum momentum of a secondary produced by a primary with momentum between 3,600 and 16,000 MeV./*c* is less than the momentum loss in traversing the inclined atmospheric path, that is, less than 4,000 MeV./*c*. If the effect of meson decay is considered, this maximum may be increased slightly, as the probability of a meson of initial momentum 5,000 MeV./*c* penetrating to sea-level is less than 0·1. This conclusion appears to be in agreement with previous results[1-3].

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A Convenient Synthesis of Carbon-labelled Benzene

Several syntheses of benzene and its simple derivatives labelled in the nucleus with isotopic carbon have been described[1-5]. The aluminium-halide catalysed rearrangement of alkyl *cyclo*pentanes to *cyclo*hexanes[6,7] affords an attractive route to benzene and its homologues, and we now present a preliminary report of an examination of this method as it applies to benzene itself.

*cyclo*Pentane carboxylic acid, prepared by the carbonation of *cyclo*pentyl magnesium chloride at − 30°, was reduced by lithium aluminium hydride[8] to *cyclo*pentyl carbinol (b.p. 159–161° ; n_D^{21} 1·4567) in an overall yield of 81 per cent from carbon dioxide. Dehydration of the carbinol over activated alumina at 320° gave a mixture of unsaturated hydrocarbons which after hydrogenation over a nickel catalyst gave a 91 per cent yield of a mixture of methyl *cyclo*pentane and *cyclo*hexane (n_D^{20} 1·4149), shown by infra-red and refractive index measurements to contain approximately 30 per cent *cyclo*hexane. This mixture was treated in a sealed tube at 75° during four hours with water-promoted aluminium chloride[6] ; the recovered hydrocarbon (98 per cent ; n_D^{20} 1·4228) contained 81·5 per cent *cyclo*hexane. Selective dehydrogenation of the *cyclo*hexane content of this mixture was carried out over a platinum-charcoal catalyst[9] at 350° ; in this way recoveries of better than 92 per cent of a product containing about 76 per cent benzene, 20 per cent methyl*cyclo*pentane and 4 per cent *cyclo*hexane were obtained. The platinum–porous pot catalyst described by Berl and Koeber[10] gave satisfactory results with pure *cyclo*hexane, but the presence of even a few per cent of methyl*cyclo*pentane markedly inhibited dehydrogenation of the *cyclo*hexane present. Benzene was isolated from the mixture by formation of the clathrate compound with ammoniacal nickel cyanide solution[11,12]. The recovery of benzene from the above, and similar artificial mixtures, was about 89 per cent, the product having n_D^{20} 1·5011 and melting point 5·5°.

In this manner an overall yield of benzene from carbon dioxide of approximately 45 per cent has been obtained, which may be further improved by carrying out the aluminium chloride catalysed isomerization of methyl*cyclo*pentane at a lower temperature[7] for a longer time, and by recovering and recycling the *cyclo*hexane and methyl*cyclo*pentane which do not react with ammoniacal nickel cyanide. A full account will be published elsewhere.

I am indebted to Mr. R. J. Warne for considerable assistance in the concluding stages of this investigation, and to Mr. J. L. Hales for the infra-red measurements. This communication is published by permission of the director of the Chemical Research Laboratory.

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Action of Dilute Sulphuric Acid on Magnetized Iron

FROM some observations on the chemical action of dilute sulphuric acid on magnetized iron, it has been stated[1] that, in addition to hydrogen, oxygen is present in considerable quantities, whereas with unmagnetized iron no such phenomenon occurs. We have investigated this further with an apparatus specially designed to exclude atmospheric oxygen and to prevent its subsequent diffusion into the materials. The results obtained with Swedish commercial iron indicated such an effect of the order of magnitude of only 10^{-3} to 10^{-4} by volume[2].

To narrow the limits still further, specimens of spectroscopically pure iron, first heated in an atmosphere of hydrogen and then degassed *in vacuo*, were allowed to react in a magnetized state. The gas analysis, performed with catechol – ferrous sulphate[3], gave colorimetrically a negative result, that is, an oxygen content certainly less than 10^{-6} by volume, which result was obtainable with unmagnetized specimens as well.

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Solidification Curves and Crystal Spacings of Binary Fatty-acid Mixtures

THE solidification curves of binary systems formed by adjacent even-numbered saturated fatty acids show, besides a minimum at about 73 mol. per cent of the lower-melting acid, an inflexion at the equimolar composition. To explain this departure from the Roozeboom classification of solid solutions[1], various investigators have assumed the formation of a compound by the two components of the system[2], an obvious assumption in view of the tendency of fatty acids towards association established by Robertson's cryoscopic studies[3]. However, compound formation has not been adequately verified by the results of X-ray measurements of fatty-acid mixtures, and Slagle and Ott[4], having found only one long crystal spacing d_1 instead of two d_1 spacings in mixtures other than equimolar, suggested a continuous series of solid solutions. The peculiar shape of the solidification curves of fatty acids was attributed by them to polymorphism.

During the present investigation, d_2 and d_3 short crystal spacings not reported hitherto for fatty-acid mixtures have been determined in addition to d_1 spacings in C_{12}—C_{14}, C_{14}—C_{16} and C_{16}—C_{18} acid-pairs, using a Philips Geiger X-ray spectrometer. Specimens were prepared by melting the samples on glass and rapid cooling. No changes of spacings due to polymorphism were observed. Single sharp values for d_1 spacings computed from third-order diffraction lines were obtained in each case ; but these values were of no particular interest, being reproducible only to ± 0·5 A. On the other hand, values for d_2 and d_3 spacings, which denote lateral distances between the fatty-acid chains, were reproducible to ± 0·01 A.; and while d_2 remained practically the same for all compositions of any given acid-pair, d_3 showed small but distinct changes. As can be seen from the example of C_{12}—C_{14} acids (cf. table), d_3 spacings of the majority of mixtures are uniformly greater than those of either pure component. However, while the mixture containing 5 per cent myristic acid shows a pronounced increase in d_3 as compared with pure acids, mixtures containing up to 25 per cent lauric acid show none. A mixture of 90 per cent lauric and 10 per cent myristic acid has the same d_3 spacing as a mixture of 70 per cent myristic and 30 per cent lauric acid. C_{14}—C_{16} and C_{16}—C_{18} acid-pairs showed similar although less pronounced changes in d_3 spacings for varying compositions.

CRYSTAL SPACINGS OF MIXTURES OF LAURIC AND MYRISTIC ACIDS

Lauric acid (m.p. 44·1° C.) Weight %	Myristic acid (m.p. 54·2° C.) Weight %	Crystal spacings (in A.) d_1	d_2	d_3
100	0	27·0	4·12	3·73
95	5	27·0	4 14	3·80
90	10	27·0	4·13	3·82
80	20	27·8	4·13	3·84
75	25	28·1	4·14	3·84
65	35	28·4	4·13	3 82
55	45	29·4	4·14	3·84
46·8*	53·2*	29·4	4·13	3·82
40	60	30·1	4·14	3·82
35	65	30·4	4·13	3·82
30	70	30·7	4·14	3·82
25	75	31·1	4·13	3·74
20	80	30·8	4·12	3 74
15	85	30 8	4·14	3·74
10	90	31·1	4·14	3 73
5	95	31·5	4·13	3·74
0	100	31·5	4·12	3·73

* Equimolar mixture.

These changes in d_3 spacings acquire significance when compared with the phase diagram for C_{12}—C_{14} acids determined by Jantzen[5], who, on subjecting mixtures of the above acids to very slow cooling (0·2° C. per 24 hr.) to approach equilibrium, obtained the only available solidus–liquidus curve of a binary fatty-acid system. His diagram, as reproduced and interpreted by Bailey[6], indicates maximum inter-solubility in the solid state in mixtures containing up to 20 per cent myristic acid on one side and up to 35 per cent lauric acid on the other, these percentages being, according to Bailey, probably too high. In the remaining range there are partial solid solutions and compound formation. The accompanying table shows that the addition of 10 per cent myristic acid produces the same increase in d_3 spacings as does the addition of 30 per cent lauric acid. It seems justifiable to correlate the above figures with those obtained from Jantzen's diagram, since it can be assumed that maximum intersolubility of two fatty acids coincides with the maximum packing density, which is determined to some extent by d_3 spacings. Both results imply that the longer-chain myristic acid is less soluble in the shorter-chain lauric acid than is lauric in myristic, which is not unexpected.

It appears from Jantzen's diagram that the question of compound formation versus continuous series of solid solutions resolves itself into the problem of determining the areas of various phases existing in the solid state, and we suggest: (*a*) that the boundaries inside which partial solid solutions and compound formation occur are indicated by increased d_3 spacings; (*b*) that an improved technique of measuring short crystal spacings of mixtures of fatty acids may help in defining the above boundaries, not only more conveniently, but perhaps even more accurately than the lengthy procedure of determining solidus–liquidus curves. Solidification curves obtained without achieving equilibrium in the system are of little use in this respect.

We are indebted to Prof. F. J. Llewellyn, of Auckland University College, and to Dr. K. Strzemienski, Soil Bureau, N.Z. Department of Scientific and Industrial Research, for discussion.

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C_{20-22} Unsaturated Acids of Butterfat

APART from the fact that Bosworth and Sisson[1] established the presence of arachidonic acid in butterfat, there is little, if any, precise information (cf. Bosworth and Brown[2]) regarding the nature of other C_{20-22} unsaturated acids. The purpose of this communication is to record the results of work in progress which support Hilditch's opinion[3] in regard to the C_{20-22} unsaturated acids of butterfat that, "while arachidonic acid may be the chief component, there are probably other polyethenoid (tetra- and pentaene) acids present, possibly of the C_{22} as well as of the C_{20} series".

The samples of butterfat used in the present investigations were obtained through the courtesy of the Dairy Research Institute, Massey Agricultural College. Sample *A*, churned in April 1945, was from a mixed herd at the College, while sample *B*, churned in May 1947, was from the Rangitaiki Plains Dairy Co.

The isolation of the C_{20-22} fractions was achieved by high-vacuum distillation of the methyl esters using a Vigreux column (210 cm. × 6 cm.) for the

Table 1. COMPOSITION OF THE C_{22} UNSATURATED ACIDS OF BUTTERFAT
(Results expressed as a percentage of the fraction)

Sample	Conjugated Diene	Conjugated Triene	Conjugated Tetraene	Non-conjugated Monoene	Non-conjugated Diene	Non-conjugated Triene	Non-conjugated Tetraene	Non-conjugated Pentaene
*A*1 (sap. equiv. 338·3, iod. val. 216·5)*	12·3	1 3	0·2	32·3	0·7	18 2	23 9	11·1
*A*2 (sap. equiv. 342·7, iod. val. 178·6)	9 9	1·9	0·2	42·9	—	3 8	18 0	23·3†
*B*1 (sap. equiv. 319·6, iod. val. 157·3)	6·4	2·6	trace	56·4	2·9	7·3	17·5	6 9
*B*2 (sap. equiv. 318·5, iod. val. 228·2)	7·4	3·4	0·1	29·8	4·2	12·5	30 9	11·7

* Constants determined on methyl esters. † Includes also some hexaene acid, $E\ (1\%, 1\ \text{cm})\ 375\ \text{m}\mu = 10{\cdot}5$

preliminary concentration and a smaller (240 cm. × 4·5 cm.) column for the final purification. For sample *A*, the methyl esters from the most soluble acids prepared by crystallization from acetone at − 50° C. were used. In the case of sample *B*, the C_{20} concentrate was prepared from the methyl esters of the total fatty acids. The concentrate thus prepared was first freed from saturated acids by crystallization three times from 15 volumes of acetone at − 30° C. After redistillation of the soluble portion, the corresponding acids (*B*1) were crystallized three times from 10 volumes of acetone at − 78° C. to separate the highly unsaturated acids *B*2.

The results given in Table 1 are based on the alkali isomerization technique as described by Beadle and Kraybill[4]. As, however, no value for *E* (1%, 1 cm.) was available for the pure pentaene acids, it was necessary to prepare a pentaene concentrate by chromatographic adsorption on alumina using as a solvent petroleum ether, b.p. 50–60°, containing 1·5 per cent ether. The concentrate thus prepared, to judge from the iodine value of the methyl esters (366·9), contained 57·8 per cent pentaene acids, assuming that tetraene and pentaene acids only were present. From the absorption characteristics of this concentrate after alkali isomerization by the Beadle and Kraybill[4] technique, the absorption characteristics of the pure pentaene acid were calculated by substituting the known values for the tetraene acid as given by these workers (cf. Table 2).

Table 2. Absorption Characteristics of a C_{20} Pentaene Concentrate of Butterfat

	E (1%, 1 cm.) 234 mμ	268 mμ	316 mμ	348 mμ	375 mμ
Before isomerization	42·0	41·5	trace	trace	trace
After isomerization	551·2	453·1	296·0	145·7	trace
Calculated values for pure pentaene acid	448·8	321·7	347·1	252·1	—

Widmer and Holman[5], using for isomerization 23 per cent potassium hydroxide–glycol for 8 min. at 180° C., found by interpolation of the values for diene, triene, tetraene and hexaene acids, a value of *E* (1%, 1 cm.) 348 mμ for the pentaene acid of 300. We have found, however, for our pentaene preparation isomerized by the Widmer and Holman[5] procedure a value of *E* (1%, 1 cm.) 348 mμ of 471, corresponding to a value of *E* (1%, 1 cm.) 348 mμ of 814 for the pure acid. The difference between our high value and the much lower value of Widmer and Holman[5] may be due to the fact that the hexaene standard which they used for interpolation was impure.

The absence of a pure pentaene standard, together with the difficulty of separating the methyl esters of the higher unsaturated acids into fractions containing the same number of carbon atoms, imposes limitations on the results now presented. Nevertheless, general confirmation of the presence of monoene, diene, triene, tetraene and pentaene acids has been obtained by chromatographic adsorption analysis on an alumina column using petroleum ether and petroleum ether–ether mixtures respectively for development and for elution of the chromatogram. Limitations have also been imposed by the quantities of material available. The whole fraction, *B*1 concentrate, for example, amounted to 0·4 per cent of the original butterfat, while the other fractions used formed considerably smaller proportions. Larger quantities of material are now being examined, and it is hoped that further clarification of the nature of the C_{20-22} acids will result.

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Effect of Altitude on the Estimation of 'Crude Fibre'

In the estimation of 'crude fibre' by the Weende method, no provision has been made for the effects of altitude and consequent lowered boiling points of the acid and alkali. The Kabete Laboratories are situated at an altitude of 6,200 ft. and the solutions boil at 94° C.

In order to find the effect of the reduced boiling temperature on the 'crude fibre' estimation, ten samples of material of varying fibre contents were taken to Dar-es-Salaam and 'crude fibre' estimations carried out. Estimations were also made on the same samples by the same worker at Kabete. The results are summarized in the accompanying table, the error involved being calculated in each case as a percentage of the results obtained at sea level.

Sample	Crude fibre in dry matter (per cent) at sea-level	at 6,200 ft.	Percentage error
Maize meal	2·229 ± 0·066	2·705 ± 0·071	21·35
Oats	10·677 ± 0·267	11·846 ± 0·220	10·95
Bran	14·017 ± 0·232	14·727 ± 0·133	5·07
Clover spp.	19·085 ± 0·201	20·232 ± 0·106	6·01
Lucerne	25·980 ± 0·300	27·497 ± 0·102	5·84
Grass			
sample 1	30·455 ± 0·122	32·040 ± 0·094	5·20
,, 2	31·212 ± 0·432	32·897 ± 0·267	5·40
,, 3	32·610 ± 0·227	34·637 ± 0·174	6·22
,, 4	35·372 ± 0·016	37·537 ± 0·389	6·12
Sawdust	64·345 ± 0·200	68·920 ± 0·246	7·11

The extent of the error varies with the type of material, the cereal grains showing greater percentage errors than the other samples examined. There is quite close agreement between the errors found for the legume and grass samples, the average percentage error for the six samples being 5·80 per cent with a standard error of ± 0·17 per cent.

There are three ways of correcting this error: (*a*) by increasing the duration of the boiling; (*b*) by increasing the concentrations of acid and alkali; (*c*) by carrying out the estimation by the standard procedure and applying a correction factor. (*c*) is the most convenient of the three, as (*a*) and (*b*) would involve trial-and-error technique to find the correct increase in duration of boiling or concentration of acid and alkali. It is, also, most liable to error since, as shown above, the percentage error and therefore the correction factor vary for different materials. From the above figures it would seem, however, that the greatest variation occurs in materials with low-fibre content, so that the absolute error involved would be small.

It is probable that the estimation of lignin at high altitudes would be similarly affected, possibly to a greater extent in view of the longer boiling periods and higher acid concentration involved.

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Positive Bromine Ions ?

IN a recent communication[1,2], we described experiments in which bromine migrated towards the cathode from acid HOBr solution across paper-collodion membranes. We interpreted this migration as evidence of 'positive bromine ions' (Br^+ or H_2BrO^+ ions) that were present in these acid solutions. Further experiments revealed, however, that there was a considerable electro-endosmosis across the membranes in the direction of the cathode, and it became necessary to reconsider our results.

We avoided the use of membranes by placing two inverted U-tubes between the beaker containing the HOBr solution and those containing sulphuric acid and acting as electrode compartments. The U-tubes were filled with organic fluids lighter than water and able to react with active bromine. A solution of fluoresceine or carotine in butanol served for this purpose, and in both cases the anodic U-tube changed colour, whereas the cathodic one did not. Pure butanol also reacted with active bromine, and analysis revealed here, too, that migration was directed towards the anode. In each case the bromine accumulated to a greater extent in the anodic U-tube than in a control tube filled with the same reagent and immersed in the HOBr solution but without current passing through it, while the reaction at the cathodic side was less than that in the control tube, being, in fact, imperceptible.

This shows that we were able to detect the presence of OBr^- anions even in our 25 per cent sulphuric acid solution, where, using the new dissociation constant of HOBr as determined by Silov[3], the OBr^- concentration was only 10^{-18}. As no reaction whatever was observed on the cathode side, we may safely assume that the concentration of positive bromine ions, if such do exist, must be less than 10^{-11} in our $N/10$ HOBr solution. We also tried to use such compounds as indicating reactants which do not react with HOBr unless it is acidified, hoping to exclude the reaction of the OBr^- ion. Refractometric measurements with xylene and with ethylbenzoate showed no significant effect, and a green solution of nitrosobenzene in butanol failed to give any colour reaction either. The voltage was about 300 V. D.C. and the current varied according to the conductivity of the organic fluid from a few microamperes to milliamperes. Thus, there is no direct electrochemical evidence for the existence of positive bromine ions.

We happened to prove, however, that fluoresceine migrates towards the anode in solutions more acid than pH 3·5, and eosine behaves similarly. We suggest that the ring oxygen atom may be responsible for this effect, acting as centre of an oxonium ion.

A detailed account of our results will appear in *Magyar Kémiai Folyóirat*.

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Budapest. Jan. 16.

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Silov, A., *Zurnal Fiziceak. Chimii*, **24**, 702 (1950)

Conservation of Amino-acid Chromatograms

IN filter-paper partition chromatography, the ninhydrin reaction has been used almost exclusively for the identification and quantitative assay of amino-acids. One of the chief disadvantages of the blue pigment formed in this reaction is its rapid fading on filter-paper chromatograms. This makes it difficult to construct permanent or semi-permanent reference maps from which not only the type of amino-acid, but also the approximate quantity of the unknown mixture, can be deduced.

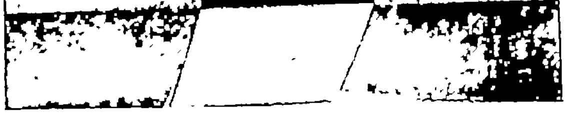
It was found that the blue pigment could be rendered a great deal more stable by coupling it with a metal. This observation was made independently in our two laboratories and has led to a study of the metal derivatives of the blue pigment. All amino-acids form red pigments, except proline and oxyproline which form a yellow metal complex. These findings are summarized in the table. In addition to the metals mentioned in the table, nickel salts also yield red pigments very similar to cadmium.

Amino-acids	Zn''	Cd''	Co''	Cu''
Proline	yellow	yellow	brown	yellow ochre
Oxyproline	grey	yellow	light brown	
Alanine Glycine Serine Threonine	brick red	port wine red	chestnut	salmon
Phenylalanine	red	red ochre	brown	red ochre
Tryptophane	red	orange	brown	red ochre
Other amino-acids	red	port wine red	chestnut	salmon

Apparently the red complex salt is formed from two molecules of diketohydrindylidene-diketohydrindamine (the blue pigment) with one atom of the metal being held between the two nitrogen atoms. Hence it would be correctly described as triketohydrindyliden-2-amino-1-oxy-indenon(3)-metal, for which a structural formula has been suggested elsewhere[1].

In practice, the red complex of the blue pigment is produced by dissolving a salt of one of the metals in methanol or ethanol and spraying each blue spot on the chromatogram with the reagent; on evaporation of the solvent, the corresponding red, reddish-brown or salmon-coloured pigment is formed. The following reagent, which keeps indefinitely, has been found useful: to 1 ml. of a saturated solution of copper nitrate add 0·2 ml. of 10 per cent (v/v) nitric acid and make up to 100 ml. volume with 95 per cent ethanol. This makes approximately a 0·8 per cent solution of copper nitrate at room temperature.

The accompanying photograph illustrates the results which can be obtained. A strip of filter-paper was saturated with a weak solution of alanine, dried, sprayed with 0·1 per cent ninhydrin and heated at 37° C. for 30 min. to develop the blue colour. A centre section of this strip was cut out and put aside, and the remainder was sprayed with the copper reagent. The cut-out section was now replaced and the strip photographed (Fig. 1). The



strip was placed on the work bench in front of the window for one month and then re-photographed on the same film under identical lighting conditions (Fig. 2). The centre section, which had not been treated with copper, had faded completely in this time, whereas the outer portions of the strip show that the red pigment had remained the same.

The red copper pigment, though relatively stable on dry filter-paper where it is out of contact with other ions, is a very unstable salt in aqueous solution. It dissociates into the blue pigment on passing on to the alkaline side of pH 7·0, this change being reversible provided the alkalinity does not exceed pH 9·0. Ions that compete for copper can also dissociate the complex reversibly; for example, the copper pigment does not form in the presence of tartrate or citrate ions, or in the presence of thiourea which forms a non-ionized copper complex. Free hydrogen ions cause rapid bleaching of the red copper complex.

The optimum conditions under which amino-acid chromatograms can be preserved, therefore, are as follows: (1) the paper must be washed; in practice, the method of Novelle[2] has given satisfactory results; (2) the ninhydrin reagent should not contain a citrate buffer like the reagent proposed by Moore and Stein[3]; (3) after spraying with the copper reagent, the red spot must be momentarily exposed to ammonia vapour in order to neutralize traces of free acid; and (4) the chromatogram should be dipped into a saturated solution of methyl methacrylate polymer 'Perspex' in chloroform to prevent moisture and atmospheric contaminants, such as volatile acids, from acting upon the pigment.

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Application of Buffered Solvent Systems to the Detection of Aromatic Acids by Paper Partition Chromatography

The appearance of aromatic acids during the metabolism of phenylalanine in bacterial cultures has been investigated. In view of the fact that these intermediates are most probably formed in very small amounts and afterwards metabolized rapidly, a sensitive qualitative technique is required for their detection; a chromatographic separation of certain aromatic acids was therefore attempted.

The separation of aromatic hydroxy compounds has been effected by Evans, Parr and Evans[1] using butanol – pyridine mixtures in saturated sodium chloride solution, and Kelemen, Tanos and Halmagyi[2] have separated certain *p*-amino aromatic acids with *n*-butanol. Bray, Thorpe and White[3,4] used benzene–acetic acid–water and chloroform–acetic acid–water mixtures for the separation of hydroxybenzoic acids.

Various workers[5-7] have shown that movement of acids on paper can be restricted to more discrete spots if acid or alkali is added to the developing solvent. Although theoretically either should be applicable in the case of aromatic acids, owing to their low volatility, considerable difficulty was, in fact, observed in the subsequent removal of acetic or hydrochloric acid from the paper. The addition of ammonia or organic bases did not in itself produce very good results, presumably due to the loss of buffering action due to their marked volatility. Accordingly, ammonia/ammonium carbonate buffer solutions (1·5 *N* with respect to each) were employed instead of ammonia solution alone to saturate the *n*-butanol in the mobile phase. This resulted in the production of very small spots with little or no tailing.

No. 4 Whatman Paper Used; Chromatograms run at 15° C.

	R_F values		
	n-Butanol ammonium carbonate buffer	*n*-Butanol ethanol ammonium carbonate buffer	*n*-Butanol benzene ammonium carbonate buffer
Anthranilic acid	0·26	0·41	0·20
p-Aminobenzoic acid	0·09	0·15	0·04
p-Hydroxybenzoic acid	0·10	0·23	0·08
Mandelic acid	0·28	0 45	0·22
Hippuric acid	0·31	0·46	0·23
o-Coumaric acid	0·27	0·42	0·20
Sulphanilic acid	0·11	0·19	0·04
Cinnamic acid	0·62	0·62	0·41
Phenylpropionic acid	0·57	0·67	0·44
Phenylacetic acid	0·44	0·58	0·35
Benzoic acid	0·41	0·58	0·34

In the first column of the accompanying table are given R_F values for a number of aromatic acids developed with *n*-butanol saturated with the ammonia buffer. Similar success in limiting the size of spot has been attained in chromatograms of keto-acids run as the corresponding 2,4 dinitrophenylhydrazones, and the homologous series of dibasic acids from oxalic to suberic.

The separation of certain of the acids under these conditions is not great and additions were made to the *n*-butanol–ammonium carbonate buffer in an attempt either to accelerate the rate of the fast-moving acids or to depress the rate of flow of the slower-moving ones. Ethanol was of considerable use in the former respect (cf. column 2 of table), while benzene was effective in the latter (cf. column 3). The constitution of the two mixtures was as follows: *n*-butanol 40, ethanol 11, buffer 19 (v/v); and *n*-butanol 80, benzene 5, buffer 15 (v/v). The response was, however, insufficient to induce the separation of the lowest two members of the homologous series of arylaliphatic acids.

It was found that short runs (20 cm.) by upward irrigation[8] gave the best results, since longer runs suffered from marked diffusion. Occasional fading of the background to assume the acid colour of the indicator on spraying is probably due to the presence of carbon dioxide from the dissociation of the carbonate buffer during the drying process, and a minimum drying period of 4–5 min. at 150° C. is necessary. There was no variation of R_F value with concentration over the range 0·2–1·2 per cent w/v. Concentrations greater than this gave such elongated spots that it was impossible to determine the R_F, an observation which is in agreement with that of Brown for salts of the aliphatic acids.

Selection of a satisfactory indicator was also investigated. The best results were obtained with buffered solutions of methyl red. A mixture of 5 parts of 0·1 per cent alcoholic methyl red solution with 10 parts of $M/15$ phosphate buffer solution pH 7·0 gave pink spots on a yellow background. The latter fades slowly to a very pale pink or disappears completely, leaving the spots still distinct. A mixture of equal portions of methyl red and bromo phenol blue (0·1 per cent alcoholic solutions) with twice the volume of buffer gave bright pink spots on a pale grey background, fading overnight to a pale violet. Benzoic and mandelic acids showed up better with this indicator mixture than with any of the other mixtures tried.

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Ferric-ion Catalysed Decomposition of Hydrogen Peroxide and the Polymerization of Acrylonitrile

THE question of the mechanism of the iron (III) ion catalysed decomposition of hydrogen peroxide has been discussed in two recent communications[1]. The formation of free radicals initiating the polymerization of monomers during reaction between iron (II) ion and hydrogen peroxide has been demonstrated by Baxendale, Evans and Park[2], and the mechanism of the reaction of iron (II) ion and iron (III) ion with hydrogen peroxide has been discussed by Barb, Baxendale, George and Hargrave[3].

To clarify the question of the formation of free radicals in the iron (III) ion catalysed decomposition of hydrogen peroxide, I used water solutions of acrylonitrile (from the American Cyanamid Co., redistilled before use). The amount of hydrogen peroxide decomposed and that of polymer formed were determined during the course of the reaction. All other conditions remaining unchanged, the velocity of the decomposition of hydrogen peroxide in the presence of acrylonitrile is much slower than without it. The velocity of decomposition depends on the concentration of acrylonitrile. As an example, in a reaction mixture at 25·00 ± 0·05° C. which was 8·00 millimolar in iron (III) nitrate, 0·100 molar in hydrogen peroxide, and contained nitric acid so that the pH of the solution was 1·68 and was 0·40 molar in respect of acrylonitrile, the first-order reaction constant of hydrogen peroxide decomposition was $5{\cdot}5 \times 10^{-4}$ min.$^{-1}$, while without acrylonitrile the corresponding constant was $3{\cdot}1 \times 10^{-2}$ min.$^{-1}$. (The reaction constants were calculated analytically using the method of least squares.) The decomposition of the hydrogen peroxide was thus slowed down 56-fold. In the presence of acrylonitrile in the above case, the concentration of hydrogen peroxide was followed for 450 min., at which time about 22 per cent of the original hydrogen peroxide was used up. At the same time, 86 per cent of the monomer originally present was precipitated as an insoluble polymer. The velocity of formation of the polymer, after an initial induction period of about six minutes, during which time the solution remained clear to the eye, goes through a not very pronounced maximum. The maximum occurred between 30 and 40 min., from the appearance of the heterogeneity in the solution; the rate of the disappearance of the monomer was then $3{\cdot}7 \times 10^{-3}$ mol. min.$^{-1}$ lit.$^{-1}$. The ratio of disappearing monomer to that of hydrogen peroxide at the above maximum (expressed as molar ratio) is about 70.

At practically the same pH of the solution, but with the concentration of the monomer increased to 1·06 mol. lit.$^{-1}$ and that of hydrogen peroxide decreased to 0·021 mol. lit.$^{-1}$, the constant for the first-order decomposition of hydrogen peroxide was decreased only 17-fold compared with a monomer-free solution. The maximum velocity of monomer disappearance as measured by polymer formation was $2{\cdot}1 \times 10^{-2}$ mol. min.$^{-1}$ lit.$^{-1}$, and the ratio of disappearing monomer to that of hydrogen peroxide was then about 560. The formation of the polymer proceeds with easily determinable velocity even in the presence of hydrogen peroxide having a concentration of 1·8 millimoles lit.$^{-1}$.

The increasing acidity of the solution decreases the rate of formation of the polymer; it also decreases the rate of decomposition of hydrogen peroxide in the presence of the monomer.

These results extracted from the experimental data can only be interpreted in favour of the chain mechanism of the hydrogen-peroxide decomposition.

Hitherto, the amount of hydrogen peroxide which decomposed in the presence of a monomer with the formation of oxygen has not been determined. The molecular weight of the polyacrylonitrile formed has not been determined. It seems probable that such determination would be possible after polyacrylonitrile is transformed into polyacrylic acid by careful hydrolysis.

A detailed report and analysis of the results will be published in due course.

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Acid Front in Granitization

DURING the course of field mapping a part of the khondalitic region near Salur (lat. 18° 36′ N., long. 83° 11′ E.) in the Vishakapatnam hill tracts, an interesting contact has been observed between a lens-like band of quartz-biotite-granulite (a member of the khondalites) and a porphyritic granite considered as intrusive[1] into the members of the khondalites in this region. The lens measures about 50 ft. in length, and 10 ft. in width, and appears at first sight as a caught-up xenolith amid the porphyritic granites.

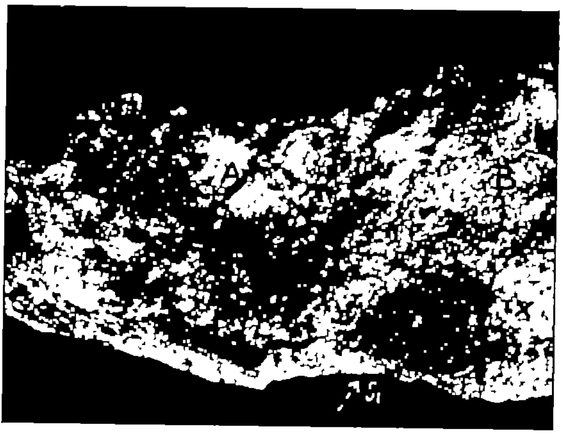

Fig. 1

Careful examination at the contact shows a profound transfusion of quartzo-feldspathic material from the porphyritic granite into the lens along the whole of its length up to a distance of 2 ft. A typical specimen was collected from the contact, and though unfortunately broken into two pieces in the field, it has in no way affected the features exhibited before the mishap.

The whole specimen can be divided into three well-defined zones, *A*, *B* and *C*, as shown in Figs. 1 and 2, which are easily distinguishable from one another to the naked eye by their colour, texture and grain size. Zone *A* belongs to the porphyritic granite, and zones *B* and *C* are those of the lens, adjacent to the granite. Zone *A*, white to greyish-white in colour (sometimes appears black due to streaks of biotite), consists of porphyritic feldspars measuring from two inches to eight inches, embedded in a coarse-grained matrix of quartz, feldspar, garnet and streaks of flaky biotite. Zone *B* is grey in colour, medium- to coarse-grained with quartz, feldspar and relatively tiny flakes of biotite. This zone shows often a tendency to the development of incipient feldspars (marked *X* in Fig. 1). Zone *C* is dark grey to bluish-grey, with fine grains of quartz-feldspar, biotite and grains of garnet.

An interesting feature in the specimen is the recognition of two quartzo-feldspathic screens (S_1 and S_2), consisting entirely of coarse quartz and feldspar grains to the exclusion of biotite and garnet, separating zone *A* from *B* and zone *B* from *C* respectively. The width of the screens varies from 3 mm. at its narrowest to 6 mm. at its widest points. Screen S_1 between zones *A* and *B* sometimes diffuses apparently into a porphyritic feldspar of zone *A*. Moreover, the two screens have slightly diffuse margins towards their preceding zones and clearly defined margins towards their forward zones. Such an occurrence of two distinct quartzo-feldspathic screens approximately parallel to one another precludes the possibility of considering them as chilled margins of the porphyritic granite against the lens, or as reaction rims developed as a consequence of reciprocal reaction between the porphyritic granite and the lens or as segregated veins due to metamorphic differentiation. Transfusion of matter from one solid into another under the influence of heat has been reported from an accidental experiment between two magnesite bricks in a furnace by Adams[2], and hence the development of zones in the lens has to be attributed either to solid diffusion or to transfusion of matter from the porphyritic granite into the lens under the influence of PTX conditions.

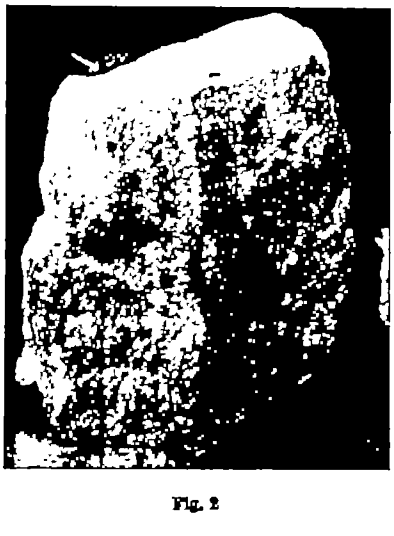

Fig. 2

The existence of "acid and basic fronts in granitization", due to the diffusion of ions of potassium, sodium, aluminium, calcium, magnesium, iron, titanium, phosphorus and silicon through paths of least resistance and obstruction in crystal lattices and along inter-mineral boundaries, has been accepted by the exponents of granitization[3-6]; hence the two quartzo-feldspathic screens may be regarded on the evidence adduced above as 'two acid fronts' advancing as waves either independently or following a basic front in the process of granitization of the lens.

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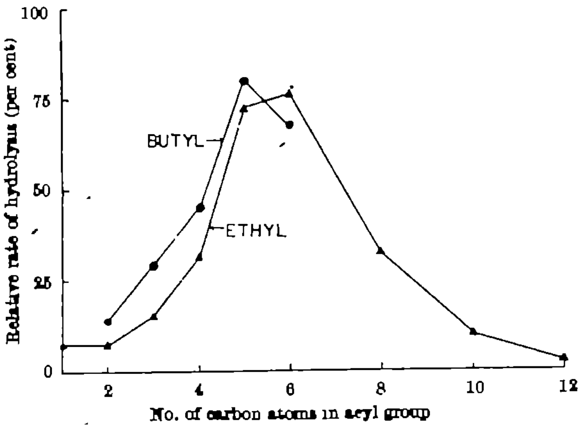
Ali-esterase of Rabbit Polymorphonuclear Leucocytes

Recently, Sturge and Whittaker[1] reported on the relative rates of hydrolysis of a series of straight-chain aliphatic esters by the aliphatic esterase (ali-esterase of Richter and Croft[2]) of horse plasma. With several notable exceptions, acetates were hydrolysed more rapidly than the corresponding propionate or *n*-butyrate (that is, the optimal number of carbon atoms in the *n*-acyl group was usually two) and *n*-butyl esters were hydrolysed more rapidly than the corresponding *n*-propyl or *n*-amyl esters (that is, the optimal number of carbon atoms in the *n*-alkyl group was usually four).

One of the difficulties encountered in studying the substrate specificity of an ali-esterase is that animal tissues contain at least four enzymes, or groups of enzymes, capable of hydrolysing the ester linkage of the simple aliphatic esters, namely, true cholinesterase (specific, *e*-type or aceto-cholinesterase), pseudo-cholinesterase (non-specific, *s*-type or butyro-cholinsterase), ali-esterase (common esterase) and lipase. Most tissue extracts, tissue homogenates or sera contain at least three, and may contain all four, of these nzymes, and there is considerable overlapping in heir substrate specificity.

Using the soluble ali-esterase preparation obtained rom rabbit polymorphonuclear leucocytes (Rossiter and Wong[3]), a study has been made of the relative ates of hydrolysis of a series of straight-chain aliphatic esters similar to that used by Sturge and Whittaker[1]. This enzyme preparation catalyses the hydrolysis of many aliphatic esters; but is inactive owards acetylcholine, acetyl-β-methylcholine, benzoylcholine and triolein. It is thus devoid of true cholinesterase, pseudo-cholinesterase or lipase activity and is a favourable preparation for the study of the substrate specificity of a typical ali-esterase.



Effect of changing the number of carbon atoms in the *n*-acyl group on the relative rate of hydrolysis of a series of ethyl and *n*-butyl esters by the ali-esterase of rabbit polymorphonuclear leucocytes. 100 per cent, rate of hydrolysis of methyl caproate

The accompanying figure shows the effect of increasing the number of carbon atoms in the *n*-acyl group on the relative rates of hydrolysis of a series of ethyl and *n*-butyl esters. Results are expressed as a percentage of the rate of hydrolysis of methyl caproate, which was the most rapidly hydrolysed straight-chain ester. In the two series presented, the most rapidly hydrolysed esters were ethyl *n*-caproate and *n*-butyl *n*-valerate, respectively; that is, the optimal number of carbon atoms in the *n*-acyl group was either five or six. Similar results were obtained with the methyl (peak at caproate), *n*-propyl and *n*-amyl (peak at valerate) esters. Changes in the size of the *n*-alkyl radical had only a slight effect on the rate of hydrolysis, methyl esters usually being the most rapidly hydrolysed. This pattern of specificity obviously differs greatly from that described by Sturge and Whittaker[1] for the horse plasma ali-esterase. The two sets of observations taken together would suggest that there are at least two groups of ali-esterases, each with a characteristic specificity pattern. Sturge and Whittaker[1] mention the possibility that their preparation may contain a second ali-esterase with a different pattern of specificity. The same could well apply to the rabbit polymorphonuclear leucocyte ali-esterase preparation. Limitation of material has precluded any attempts at enzyme purification. No special claims are made for the homogeneity of the preparation other than its freedom from cholinesterase and lipases.

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Renewal of Bone Phosphate in Experimental Hyperparathyroidism

THE mode of action of parathyroid hormone is still obscure. The hormone seems, however, to exert its effect on calcium metabolism partly by a direct action on the bones[1]. Within a few hours profound changes appear in the bones of animals which have been given large doses of parathyroid extract[2]. The bone cells change their appearance and become de-differentiated, that is, they do not reach full maturity functionally[3]. Concurrently there is a rapid resorption of mineral salts, the resorbed bone being replaced by fibrous tissue.

Experiments, involving the use of radioactive phosphate (to be published in full elsewhere), have shown that the inorganic part of bone consists of different fractions with varying solubility in salt solutions, the fractions having different rates of renewal. The portion which is extractable with saturated ammonium sulphate of *p*H 7·5 has the highest exchange velocity with serum phosphate; the rest of the bone phosphate remains weakly labelled for long periods. Neither of these two fractions is homogeneous, however, each consisting of an unknown number of fractions with different rate of renewal. According to radioautographic and microradiographic investigations[4,5], the largest part of the radioactive phosphate taken up by the skeleton is deposited in the Haversian systems (osteons) with relatively low content of mineral salts, that is, young osteons[5], which thus also contain the portion of mineral salts soluble in saturated ammonium sulphate.

The present communication deals with experiments performed in order to obtain information concerning the age and structure of bone resorbed in chronic hyperparathyroidism. For that reason we have determined the ratio between the ammonium sulphate fraction and the remaining fraction, and the renewal in each of them, in rats submitted to prolonged administration of parathyroid hormone

Litter-mate male rats, about three months old, and placed on an optimal diet[6] containing 1 per cent calcium and with a Ca/P ratio of 1·0, have been used. Hyperparathyroidism was produced by giving the animals 'Para-thor-mone' (Lilly Co., Indiana) in increasing doses for twenty days; altogether 800 units were given to each animal. The last dose (100 units) was given two hours before administration of radioactive phosphate; 0·3 mC. radioactive phosphate was injected intraperitoneally. After the lapse of the desired time interval, the animals were sacrificed by decapitation. Blood was collected from the carotid arteries and immediately deproteinized in an equal volume of ice-cold 15 per cent trichloracetic acid. The specific activity (that is, number of impulses/μgm. phosphorus) of orthophosphate was then determined directly[7]. Bone samples (femur and tibia) were removed immediately after death, epiphyseal and diaphyseal bone being separated. The samples were frozen with solid carbon dioxide and pulverized in the frozen state. The powder obtained (about 100 mgm.) was extracted with 2 ml. of saturated ammonium sulphate in the presence of quartz sand for about twenty minutes with the aid of a high-speed rotating glass rod driven by compressed air. After filtering and washings, the residue was extracted with 15 per cent trichloracetic acid.

Table 1. RELATIVE SPECIFIC ACTIVITY OF PHOSPHATE IN TWO DIFFERENT FRACTIONS OF MINERAL SALTS IN EPIPHYSEAL AND DIAPHYSEAL BONE IN NORMAL AND HYPERPARATHYROID RATS

Specific activity of orthophosphate in blood = 100. Phosphate was determined by the method of Fiske and SubbaRow[8]. Radioactivity was measured under a counter after drying an aliquot of the extract on an aluminium dish

Time in hours	1·5		3·0	
Kind of sample	Control animal	Treated animal	Control animal	Treated animal
Epiphyseal bone				
Ammon. sulphate fraction	43	9·9	40	21
Remainder	6·0	1·3	5·4	3·6
Diaphyseal bone				
Ammon. sulphate fraction	15	2·7	22	6·9
Remainder	2·1	0·27	2·1	0·72

Table 1 shows the specific activity of the two fractions of bone salts in relation to that of orthophosphate in the blood. It is clearly demonstrated that, as a consequence of the treatment with high doses of parathyroid hormone, the renewal of phosphate becomes, after the lapse of 1·5 hr., much less both in epiphyseal and diaphyseal bone. The relative lowering of the renewal rate seems to be the same in both fractions. In the experiment of 3-hr. duration, the relative specific activity of the two fractions of bone minerals is in the control animal about the same as after 1·5 hr., which is in agreement with other reports[9,10]. In the treated animals, however, there is a continuous rise in the relative specific activity in the two fractions, both in epiphyseal and diaphyseal bone.

Table 2. RELATIVE AMOUNT OF TWO FRACTIONS OF PHOSPHATE IN EPIPHYSEAL AND DIAPHYSEAL BONE IN NORMAL AND HYPERPARATHYROID RATS*

Fraction	Epiphyseal bone		Diaphyseal bone	
	Control animal	Treated animal	Control animal	Treated animal
	Per cent	Per cent	Per cent	Per cent
Ammon. sulphate	21	19	16	15
Remainder	79	81	84	85

* Each value represents the mean of two determinations.

Table 2 shows that the ratio between the two fractions of bone salts is the same in control animals as in those treated with parathyroid hormone. These results thus indicate that, in hyperparathyroidism, both fractions are resorbed to the same degree, that is, there is the same destruction in young osteons as in old bone.

Because of the variety of mineral salts resorbed, the hypothesis is advanced that the primary action of parathyroid hormone on bone is more intimately associated with the organic constituent of the bone tissue than with the mineral salts. At the same time the difference in the rate of renewal of phosphate in the skeleton between normal animals and thos treated with parathyroid hormone seems to suppor the view that the rate of renewal is not only dependen upon simple physical conditions such as the solubilit of the mineral salts or degree of vascularization calcification as well as rate of renewal must be th result of specific cell activity, which may be regulate by hormonal control.

A more detailed report will be given elsewhere

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Composition of Histone prepared from Rat Liver Deoxypentosenucleoprotein

THE recent report[1] by Hamer on the amino-aci composition of calf thymus histone prompts us to communicate some corresponding observations on histone prepared from rat liver deoxypentosenucleoprotein. Nuclei were isolated from briefly homogenized suspensions of perfused rat liver (Sprague-Dawley–Holtzmann strain) and washed four times A citric acid technique at pH 6·1 was employed i the preparation[2]. The nuclei were subjected t differential extraction with sodium chloride, 1·0 M salt being used for the extraction of the deoxypentosenucleoprotein and dilution to 0·14 M salt fo its precipitation. Unlike the preparations describe in the literature, these are non-fibrous on precipitation, readily soluble in water, non-viscous in eithe water or molar sodium chloride solution, and of lo molecular weight. The deoxypentosenucleoprotei was dialysed against water and the solution s obtained was lyophilized.

Histone was prepared from such stock preparation of deoxypentosenucleoprotein. 300 mgm. was treate with 0·25 N hydrochloric acid at 2°–3° for half a hour. The histone derived from the resultan splitting of the deoxypentosenucleoprotein was salte out by saturation with sodium chloride. The histon was dissolved in water and, after exhaustive dialysi against water, the solution was lyophilized.

When a comparable preparation from calf liver wa examined in the analytical ultracentrifuge (Spinc Model E) at a concentration of 1 per cent and pH 3·8 in water, it showed a single symmetrical boundar throughout the period of sedimentation. Homogeneity was also shown in a similar run (1 per cen solution in 0·2 M sodium chloride) at pH 4·7.

For determination of the amino-acid composition a sample of 38·6 mgm. was hydrolysed with 200 part

Rat Liver Deoxypentosenucleoprotein Histone

N content of dry protein = 17·2 per cent. P content of dry protein = 0·04 per cent.

Amino-acid (with no. of analyses in brackets)		(1) N as % total N	(2) Amino-acid (gm.) per 100 gm. protein	(3) Amino-acid residues (gm.) per 100 gm. protein	(4) Molec. wt. calc. from data in (3)	(5) Assumed number of residues	(6) Molec. wt. calc. from data in (4) and (5)
Alanine	(2)	7·41	8·11	6·47	1100	16	17,600
Ammonia	(3)	5·05	1·05	0·99	1620	11	17,800
Arginine	(2)	29·81	15·98	14·35	1090	16	17,400
Aspartic acid	(3)	4·30	7·02	6·07	1900	9	17,100
Glutamic acid	(2)	5·78	10·44	9·17	1410	12	16,900
Glycine	(3)	6·31	5·61	4·42	1290	14	18,100
Histidine	(3)	4·64	2·94	2·59	5290	3	15,900
*iso*Leucine	(3)	3·54	5·70	4·92	2300	8	18,400
Leucine	(3)	6·24	10·08	8·68	1300	14	18,200
Lysine	(3)	12·20	11·54	10·12	1260	14	17,600
Methionine	(3)	0·88	1·61	1·42	9220	2	18,400
Phenylalanine	(5)	1·39	2·83	2·52	5830	3	17,500
Proline	(3)	1·91	2·70	2·28	4250	4	17,000
Serine	(2)	4·19	5·39	4·47	1970	9	17,700
Threonine	(3)	4·42	6·47	5·48	1860	10	18,600
Tyrosine	(3)	2·41	5·36	4·84	3370	5	16,900
Valine	(3)	4·48	6·43	5·44	1820	10	18,200
Total		104·9		94·3		160	17,600 ± 460

Analytical values on duplicates or triplicates agreed to within 3 per cent of the mean except histidine (± 4), *iso*leucine (± 5), lysine (± 5), methionine (± 21), proline (± 10) and tyrosine (± 8). Cystine and tryptophan were absent.

of 6 *N* hydrochloric acid twice distilled in glass. Starch column chromatography, collection of samples, and analysis of the eluates were carried out as described by Moore and Stein[3–5]. Two of the samples were run in triplicate and one in duplicate by the use of three starch columns on the fraction collector. The results are shown in the accompanying table.

This investigation was carried out as a part of project C-484, supported by the National Cancer Institute, U.S. Public Health Service.

ROBERT BRUNISH*
DELOREZ FAIRLEY
J. MURRAY LUCK

Department of Chemistry,
Stanford University,
California.
March 9.

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* Fellow, U.S. Public Health Service (National Cancer Institute).

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Effect of a Single Injection of Carbon Tetrachloride upon the Activity of the Pseudo-cholinesterase in the Liver and Serum of Male and Female Rats

Brauer and Root[1] and Ellis, Sanders and Bodansky[2] produced liver injury in rats by frequent injections of small doses of carbon tetrachloride over a period of six to twelve days. There was a definite fall in the cholinesterase activity of the liver and a somewhat delayed fall in that of the serum; but the continued administration of the poison renders the findings difficult to interpret. If the enzyme in the serum is derived from the liver[1,2], the regeneration of the liver tissue after injury should be accompanied by restoration of the serum and liver cholinesterase to the normal level. Cameron and Karunaratne[3] found in the rat that a large single injection of carbon tetrachloride caused zonal necrosis, centrilobular in distribution, within twenty-four hours, and that recovery was complete in seven to fourteen days. It was therefore decided to follow the serum and liver cholinesterase activity in male and female rats for eleven days after a single subcutaneous injection of 0·25 ml. carbon tetrachloride (B.D.H. Analar)/100 gm. body-weight.

Forty-two black-and-white hooded rats of each sex were divided into groups of seven, and the experimental procedures for sampling and estimating the pseudo-cholinesterase in the liver and in the serum were the same as in an earlier study of the effect of starvation[4]. The mean weights of the male and female rats were 295 gm. and 200 gm., respectively, and they changed little during the experiments. Histological sections of the liver were kindly prepared for us by Dr. A. M. Barrett (Department of Pathology, Cambridge). Within 24 hr., small areas of necrosis had developed in the centres of the liver lobules of most of the animals of both sexes; but by the eleventh day the livers again appeared almost or quite normal.

Effect of a Single Subcutaneous Injection of 0·25 ml. Carbon Tetrachloride/100 gm. Body-weight on the Pseudo-cholinesterase Activity of the Liver and Serum of Male and Female Rats

Sex	Days after injection	Liver		Serum
		Weight (gm./100 gm. initial body-weight. ± Stand. dev.)	Cholinesterase units/gm. liver	Cholinesterase units/ml. serum
Male	0	3·18 ± 0·22	40	8·3
	1	3·62 ± 0·32	17	6·5
	3	3·42 ± 0·33	20	6·7
	5	3·70 ± 0·32	24	5·9
	7	3·89 ± 0·40	33	7·3
	11	3·43 ± 0·31	35	6·4
Female	0	3·00 ± 0·27	117	32
	1	3·60 ± 0·26	32	29
	3	3·82 ± 0·39	65	22
	5	3·82 ± 0·63	75	21
	7	3·85 ± 0·47	78	18
	11	3·58 ± 0·44	95	36

The unit of cholinesterase is defined as the amount of enzyme which liberated 1 µl. carbon dioxide/min. from acetylcholine under standard conditions.

From the accompanying table it will be seen that the cholinesterase activities of the liver and serum of female rats were initially much greater than those of the males. In the females, within 24 hr. after the injection, the liver cholinesterase had dropped to a quarter of its initial value, but by the eleventh day it had risen again almost to its original level. The activity of the serum fell more slowly, and was still falling some days after the activity of the liver had begun to rise; but by the end of the experiment it also had returned to normal. A similar delay in the fall of the serum cholinesterase was observed during starvation, for whereas the liver cholinesterase dropped rapidly during the first two days, the serum enzyme decreased gradually throughout a six-day fast[4].

In the male rats, carbon tetrachloride caused a much smaller fall in the cholinesterase activity of the liver, followed by recovery almost to the normal level in seven to eleven days, whereas the serum cholinesterase remained within the normal limits. During starvation[4], there was no appreciable change in the cholinesterase activities either of the serum or of the liver.

It appears, therefore, that in the female rat a large fall or rise in the cholinesterase activity of the liver is followed by a corresponding change in that of the serum. The close association between the histological recovery of the liver, and the restoration first of the liver and then of the serum cholinesterase activity to normal values, confirm the hypothesis that the liver is the source of most of, or all, the serum enzyme in the rat. The absence of a definite fall in the serum activity following liver injury in the male rats suggests that either the changes in the activity of the liver after carbon tetrachloride were not sufficiently great to be reflected in the serum, or alternatively that the 'non-labile' liver enzyme[4] is not the source of the small amount of pseudo-cholinesterase in the serum of the male rat.

One of us (M. F. H.) is indebted to the International Federation of University Women for the award of the Alice Hamilton International Fellowship.

Lucy M. Brown
Marion F. Harrison

Medical Research Council
Department of Experimental Medicine,
Cambridge.
March 10.

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Histological Changes in the Epithelium of the Small Intestine during Protein Absorption in the New-born Animal

The absorption, without change, of certain globulins of the colostrum by the new-born animal has been known for many years[1]. Smith[2] has reported that the epithelial cells of the ileum of calves contain feebly staining homogeneous bodies which are present in late intra-uterine life but largely disappear within three days of birth. Other intracellular bodies, apparently protein in nature, have been described in the intestinal epithelium of suckling mice and compared with the meconium corpuscles of the human fœtus[3].

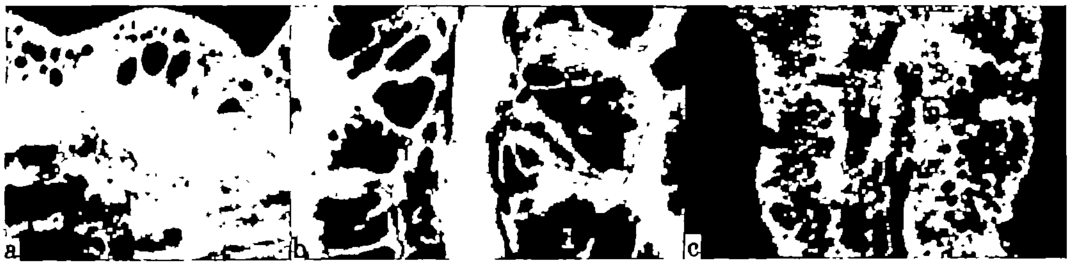
Recent experiments in which the absorption of colostrum globulins was examined in young calves[4] provided material for a study of the changes in the intestinal epithelium under controlled experimental conditions. Colostrum whey, from which the fat had been removed, was introduced through a duodenal cannula. Pieces of the small intestine were removed from the anæsthetized animals and immediately placed in either 10 per cent formol-saline or Susa. Samples were taken from calves 3–24 hr. after birth, which were absorbing the colostrum globulins, and from others of a similar age to which whey had not been administered, and from calves, aged 63–65 hr.

The epithelium of the ileum of calves 9–36 hr. old contained the vesicles described by Smith[2], which stained lightly with toluidine blue.

A striking change was found in the intestinal epithelial cells of calves in which the absorption of protein was taking place. Any whey remaining in the lumen of the gut was coagulated by the fixative and stained as a homogeneous mass with iron hæmatoxylin, azocarmine, eosin or orange *G*. Globules with similar staining properties to the protein of the whey were present in the majority of the intestinal epithelial cells of the jejunum and ileum. In some sections material with the same staining reactions as the whey could be seen in the lacteals. Only a very few droplets of colostrum protein were observed within the cells when the whey was given to calves 63–65 hr. after birth. This is in accordance with the much smaller absorption of globulins found in these older animals.

The size and situation within the cell of the globules of protein varied. In some sections discrete droplets up to 2 μ in diameter were present immediately within the lumen border of the epithelial cells (Fig. *a*). In addition to these, protein material was present in the cytoplasm of the epithelial cells either as one or two large globules, up to 10 μ in diameter, or as a number of smaller drops, 2 μ to about 6 μ in diameter (Figs. *a*, *b* and *c*). These variations resembled in some respects those reported in the distribution and size of intracellular fat droplets during the absorption of fat[5,6].

The observations suggest that, under the conditions of these experiments, the protein which was absorbed without change within the first 24–48 hr. after birth passed through the cells of the epithelium of the small intestine.



Intestinal epithelium of calves 3–24 hr. old, iron hæmatoxylin staining. (*a*) Ileum; (*b*) jejunum; and (*c*) ileum, from animals which received colostrum whey. Magnification 970

We wish to acknowledge the invaluable and skilled assistance of Mr. D. Canwell in the preparation of the histological material.

R. S. Comline*
H. E. Roberts*
D. A. Titchen†

Physiological Laboratory,
Cambridge.
March 8.

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* B.O.C.M., Fellow of the Animal Health Trust.

† With a research training grant from the Animal Health Trust

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Chlorophyll Inhibition and Growth Regulation by Several Tetronic Acid Derivatives

It has been shown that coumarin derivatives are particularly active as inhibitors of germination and root-growth[1-3], and it has been suggested[4] that this action is at least partially due to the unsaturated lactone ring. Since other compounds, hexenolactone[5,6] and protoanemonin[7], containing this unsaturated lactone ring have clearly exhibited some influence on the growth of plants, it seemed interesting to test the simplest compounds having this structure. As an approach to this simple ring, several tetronic acid derivatives were selected which have been synthesized by J. Lecocq[8], to whom we are indebted for the supply of the samples tested.

These compounds were tested on germinating seeds and seedlings of Marketer variety of cucumber (*Cucumis melo*) and White Banner variety of wheat (*Triticum sativum*). The method was to germinate seeds in Petri dishes on filter paper containing the various tetronic acid derivatives at different concentrations. Twenty-five seeds were placed in each dish and 5 ml. of solution was added.

The tetronic acids which were tested included: 3-acetyl-5-methyl-tetronic acid, 3-(α-imino-ethyl)-tetronic acid, 5-5-diphenyl-tetronic acid, 3-(α-methyl-imino-ethyl)-5-phenyl-tetronic acid, 3-diazophenyl-tetronic acid, 3-3′-methylene-5-5-5′-5′-tetra-ethyl-bis-tetronic acid, 3-(α-imino-ethyl)-5-methyl-tetronic acid. A compound of similar configuration, the 2-imino-4-hydroxy-5-5-diphenyl-oxazole was also tested.

The compound producing the most interesting results was 3-(α-imino-ethyl)-5-methyl-tetronic acid. When cucumber seeds were germinated and grown in 100 p.p.m. of this compound, they produced large yellow cotyledons and etiolated hypocotyls. When these seedlings were transplanted into soil and placed on a greenhouse bench, they became white, resembling albino plants, and died after five or six days.

At concentrations greater than 100 p.p.m., not only did cucumber seedlings become chlorotic, but also hypocotyls were markedly inhibited in development. When wheat seeds were allowed to germinate and develop in a solution of 100 p.p.m. or more of 3-(α-imino-ethyl)-5-methyl-tetronic acid, they first germinated and grew normally, but after several days became yellow and then at last partially white. They failed to develop normally and after about two weeks died. When 1 ml. of a solution of 1,000 p.p.m. of 3-(α-imino-ethyl)-5-methyl-tetronic acid was injected into seedlings of red kidney bean stems at a point just below the heart-shaped leaves, the new growth which developed above the primary leaves was in many instances white and stunted. Also, when either of the primary leaves was dipped in a solution containing 1,000 p.p.m. of this compound, the leaf which was dipped became yellow and then gradually white at the margin, and finally about 85 per cent albino with some green colouring still present at the base of the blade.

The action of 2-imino-4-hydroxy-5-5-diphenyl-oxazole was in sharp contrast to that of the preceding compound. When a young primary leaf of red kidney bean was dipped in a solution containing 1,000 p.p.m., the expansion of the leaf was not only almost completely inhibited, but also the leaf became dark green in colour. A solution of 100 p.p.m. also greatly retarded germination of cucumber seeds and completely inhibited seedling development.

The other tetronic acids tested showed less striking effects. For example, responses from 3-(α-imino-ethyl)-tetronic acid were somewhat similar to those from 3-(α-imino-ethyl)-5-methyl-tetronic acid, but to a lesser degree. Preliminary tests with 3-acetyl-5-methyl-tetronic acid suggest that this compound actually stimulates seedling development in wheat.

J. Alamercery
C. L. Hamner
M. Latus

Department of Horticulture,
Michigan State College,
East Lansing,
Michigan.
Dec. 27.

PHYSICS

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New Hosts of *Phytophthora Infestans* in Kenya

The potato has been grown in Kenya for more than half a century, frequently under conditions of temperature and humidity favourable to blight epidemics. It was not, however, until 1941 that blight appeared, and in that year caused widespread destruction of the crop from the eastern escarpment of the Rift Valley, where the first outbreak was observed, to Mt. Kenya[1]. In the following year the disease occurred throughout the Highlands, reaching Tanganyika, Uganda and the Belgian Congo, and is now apparently endemic.

From 1943 blight-immune potatoes from Dr. W. Black have been grown extensively. Those received up to 1948 were immune from blight biotypes *A* and *C* and in the field showed complete immunity. A new biotype *B* which appeared in Tanganyika in 1946 reached Kenya in 1948 and resulted in the breakdown of this resistance, causing much disappointment among farmers. New hybrids immune from biotypes *A*, *B*, *C*, *E* and *F* are now under trial.

During 1950, the foliage of certain woody perennial species of *Solanum* were attacked by blight. In the Highlands of Kenya, these plants abound as weeds of waste places and pastures and as forest under-shrubs. No blight had been observed on them hitherto. The disease was first seen on *S. indicum*, growing in forest shade at 6,000 feet near Nairobi. A few weeks later it was collected on leaves of a *Solanum* species, near to *S. panduraeforme*, in forest clearings at the foot of Mt. Kenya some hundred miles to the north-east. A further search discovered *S. incanum*, one of the commonest species, to be generally attacked in the vicinity of the originally observed outbreak on *S. indicum*. (All plants were determined by P. J. Greenway, East African Herbarium.)

Sporangia from *S. incanum* readily infected an unknown variety of potato, from which plants the fungus was transferred to *S. indicum*. Tests by Dr. Black with cultures from this isolation indicated strain *C* as the biotype.

It would appear that a period of approximately ten years elapsed before the resistance of three of the indigenous *Solanum* species to this exotic fungus was broken down.

The occurrence of *P. infestans* on widely distributed perennial host plants may offer new scope for the evolution of yet more aggressive strains of the fungus.

R. M. Nattrass
Moira Ryan

Department of Agriculture,
Kenya.
Feb. 20.

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Changes in Colour Sensitivity of the Eye with Posture

The colour sensitivity of the human eye appears to be influenced, among other factors, by the physical position of the observer.

Normally, when an observer is making colour comparisons, he is in the erect position and with normal vision both eyes exhibit similar colour sensitivities. I have observed, however, that if the observer is in the prone position lying on one side, a gradual difference between the colour response of the two eyes develops. After a few minutes the lower eye becomes markedly red-sensitive compared with the upper eye. If now the observer lies on his back, the two eyes gradually return to equality of colour response. By turning on to the opposite side, the eye formerly red-sensitive will be uppermost and will then gradually develop blue-sensitivity compared with the lower eye.

It occurred to me that this effect, which I have not seen mentioned elsewhere, may be of interest in connexion with theories of colour vision.

J. N. Aldington

Siemens Electric Lamps and Supplies, Ltd.,
Lamp Research Laboratories,
Preston.
March 14.

The Theory of Magnetic Storms and Auroras

In *Nature* of June 16, in a communication on the theory of magnetic storms and auroras, Prof. H. Alfvén emphasizes the need for the theorist to test his work by experiment. He and his colleagues have striven to follow this laudable maxim, which was also urged in his book[1], for example, on p. 37 regarding cosmic discharges, and on p. 78 regarding magneto-hydrodynamic waves (and a note added in proof records the success of S. Lundquist in experimentally demonstrating them). He gave (pp. 39–41) the scale relations between various physical magnitudes involved in laboratory experiments for illustrating large-scale natural phenomena, and these he discussed also (pp. 201–203) in relation to Malmfors's experiment intended to illustrate magnetic storm and auroral theory.

The difficulty is that it may be beyond present experimental powers to fulfil these scale relations in the laboratory—and Prof. Alfvén remarks (p. 201) that this is so regarding the magnetic field in Malmfors's experiment. I have myself recently proposed[2] another experiment to illustrate magnetic storm theory; the fulfilment of the scale relations involved will certainly be difficult, though apparently not impossible. Not having at my disposal experimental skill or facilities, I should much welcome the execution of the experiment by Prof. Alfvén and his colleagues.

Failing such experiments, a purely theoretical treatment, as Prof. Alfvén remarks (p. 37), though "certainly very precarious", is "still, in many cases, the only way of attack". Prof. Ferraro and I, in our work on magnetic storms[3], have often mentioned our consciousness of the precarious nature of such work, and Prof. Alfvén, in his summary and discussion[1] of his own theory[4], likewise very properly makes many reservations as to the proof of his conclusions and the need for the extension of his analytical treatment.

A theorist in such a field must select what he considers the initial bases for the theory, and then develop it from these premises as accurately as possible; mathematical difficulties may force him to stop his chain of deductions without having taken it as far as he would like, and also to leave some of the links weaker than he would wish. The choice of the initial bases may be partly a matter of dispute, and so may be the accuracy of the chain of reasoning from them.

Prof. Ferraro and I will welcome the publication of the objections to our theory that Prof. Alfvén believes are fatal to it, so that if they are invalid we may rebut them, or if valid, re-direct our efforts.

Prof. Cowling[5] has criticized the accuracy of the deductions made by Prof. Alfvén from his initial premises, and his criticisms have not yet received a satisfactory answer, though they are referred to in "Cosmical Electrodynamics", p. 200.

But the subject is far too intricate to be suitable for its details to be discussed in the correspondence columns of *Nature*.

Sydney Chapman

Queen's College,
Oxford.
June 28.

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FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Monday, July 16

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 4.45 p.m.—Dr. F. Sherwood Taylor: "The History of Science, 1851–1951".*

Monday, July 16—Saturday, July 21

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH (at the College of Aeronautics, Cranfield, Bedford).—Conference on "Automatic Control".

Tuesday, July 17

INSTITUTION OF CHEMICAL ENGINEERS (at the Royal Institution, 1 Albemarle Street, London, W.1), at 10 a.m.—Conference on "Mixing and Agitation in Liquid Media".

FAUNA PRESERVATION SOCIETY (at the Zoological Society of London, Regent's Park, London, N.W.8), at 4.15 p.m.—Mr. F. W. Champion: "Tropical Forests and Wild Life Conservation".

Wednesday, July 18

ROYAL SANITARY INSTITUTE (at 90 Buckingham Palace Road, London, S.W.1), at 11 a.m.—Conference on the Report of the Catering Trade Working Party on "Hygiene in Catering Establishments".

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Sir Harold Scott, K.C.M.G.: "Some British Contributions to Tropical Medicine".

ROYAL METEOROLOGICAL SOCIETY (at East Malling Research Station, East Malling, Maidstone).—Summer Meeting.

Thursday, July 19

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. H. E. Shortt, F.R.S.: "The Life Cycle of the Malaria Parasite".

Friday, July 20

BIOMETRIC SOCIETY, BRITISH REGION (at the National Institute for Research in Dairying, Shinfield, Reading), at 11.30 a.m.—Tenth Meeting.

Saturday, July 21

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, The University, Sheffield), at 10.30 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

JUNIOR ASSISTANT PHYSICIST, mainly in connexion with radiotherapy—The Secretary, University College Hospital, Gower Street, London, W.C.1 (July 20).

ASSISTANT LECTURER (Grade A) IN PHYSICS—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (July 21).

ASSISTANT WORKS CHEMIST (with a sound knowledge of the control of gas manufacture, and experienced in carrying out all the usual gas works tests)—The Divisional Manager, West Midlands Gas Board, Walsall and District Division, Walsall Factory Estate, Tame Bridge, West Bromwich Road, Walsall, quoting Ref. N. (July 21).

ASSISTANTS (Grade B) IN MATHEMATICS (knowledge and interest in statistics would be an asset), BIOLOGY (degree including zoology and botany with honours in one of these subjects), and CHEMISTRY (2 posts, *a*, research or industrial experience and some knowledge of biological subjects would be an advantage, *b*, to teach inorganic chemistry up to B.Sc. Special and A.R.I.C. standard and to assist in general chemistry up to B.Sc. General level)—The Principal, Derby Technical College, Normanton Road, Derby (July 21).

CHEMIST in the Executive's Laboratory Service, to be in immediate day-to-day charge of a power station laboratory in the N.W. or S.W. area of London—The Staff Officer (F/EV.180), London Transport Executive, 55 Broadway, London, S.W.1 (July 21).

GRADUATE with biological training, for work on soil bacteriology—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (July 21).

GRADUATES IN CHEMISTRY or PHYSICS for two Bursaries, to do research on flame propagation in gases—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7 (July 21).

PRINCIPAL OF THE WEDNESBURY COUNTY TECHNICAL COLLEGE—The Director of Education, Department F.E., County Education Offices, Stafford (July 21).

ASSISTANT LECTURER IN AGRICULTURAL ECONOMICS—The Registrar, The University, Leeds 2 (July 24).

LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY, and a LECTURER IN ORGANIC CHEMISTRY—The Secretary and Registrar, University College of North Wales, Bangor (July 24).

PROFESSOR OF NAVAL ARCHITECTURE AND MARINE ENGINEERING, a PROFESSOR OF POWER STATIONS (Mechanical), and a PROFESSOR OF STRENGTH OF MATERIALS AND SANITARY ENGINEERING, at Farouk I University, Alexandria—The Director-General, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (July 25).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree, preferably in engineering, and some industrial and research experience) in the Mechanical Engineering Research Organization of the Department of Scientific and Industrial Research, to develop and initiate research into mechanisms for application to mechanical engineering problems—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.4041/51 (July 26).

LECTURER IN ENGINEERING—The Secretary, The University, Aberdeen (July 27).

COMPUTER (Scientific Technologist III) at headquarters Scientific Department (Scientific Control)—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/351 (July 28).

EXPERT DESIGNING ENGINEER under the Government of India, in India, to be responsible to the Chairman, Central Waterpower, Irrigation and Navigation Commission, for the mechanical and electrical design of such transmission systems as will be required for grid supply connecting super-hydro power stations and long-distance power transmission projects—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London; W.C.2, quoting D.280/51A.O. (July 28).

MECHANICAL ENGINEERS (Scientific Officer grade) at the Ministry of Supply headquarters in London, to originate and supervise research associated with mechanical engineering problems in the aero-engine industry and to represent the Ministry in committee work—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.340/51A (July 28).

MECHANICAL ENGINEERS (Scientific Officer grade) at the Royal Aircraft Establishment, for research into the more fundamental aspects of the development of aircraft hydraulics, pneumatic and oxygen systems, involving problems of gas and liquid flow, control systems and storage—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.354/51A (July 28).

SENIOR LECTURER IN ANTHROPOLOGY at the Australian School of Pacific Administration, Mosman, Sydney, and an ANTHROPOLOGIST (male) in the Public Service of Papua and New Guinea—The Official Secretary, Australian High Commissioner's Office, Strand, London, W.C.2, quoting 'Department of Territories, Canberra' (July 28).

TEMPORARY ASSISTANT TECHNICAL EXAMINING OFFICER (male) in the Victualling Department of the Admiralty—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.60/51A (July 28).

ASSISTANT IN THE DEPARTMENT OF BOTANY, University College, Dundee—The Secretary, The University, St. Andrews (July 31).

CHIEF AGRICULTURAL ECONOMIST (with a specialized degree in agricultural economics, and practical experience in the marketing of agricultural products and in investigations dealing with the costs of production of these products) in the Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (July 31).

DEMONSTRATOR IN GEOGRAPHY—The Secretary, The University, 38 North Bailey, Durham (July 31).

ENGINEERS (Principal Scientific Officer grade) at the London headquarters of the Ministry of Supply. (Ref. C.355/51A) to take charge of a section responsible for initiation and co-ordination of research and development work on aircraft pressure cabins and associated problems and equipments; (Ref. C.356/51A) to control a section responsible for co-ordinating investigations with mechanical engineering problems in connexion with aircraft development—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (July 31).

JUNIOR PROFESSIONAL OFFICERS (2) IN THE ENTOMOLOGICAL BRANCH, Department of Agriculture, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (July 31).

LECTURER IN PURE MATHEMATICS—The Registrar, King's College, Newcastle-upon-Tyne (July 31).

LECTURER or ASSISTANT LECTURER IN AGRICULTURAL ECONOMICS at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 31).

METALLURGIST (Chemist III grade) for the Ministry of Supply in Middlesex, to take charge of metallographic laboratories—work covers metallic materials of all kinds used in aircraft, with joining, corrosion preventive and other processes applied to metals—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.440/51A (July 31)

PHYSICISTS and PHYSICAL CHEMISTS (Experimental Officer grade) at a Ministry of Supply research and development establishment near London, to operate an electron microscope and to assist in X-ray crystallographic work—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.180/51A (July 31).

RESEARCH FELLOW IN ANTHROPOLOGY at the West African Institute of Social and Economic Research, University College, Ibadan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 31).

SCIENTIFIC ASSISTANT (university graduate in science or agriculture, preferably with special training in nutrition and/or knowledge of foreign languages)—The Director, Rowett Research Institute, Bucksburn, Aberdeenshire (July 31).

SENIOR PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in some branch of science or engineering, or an equivalent qualification, and good experience in research is essential) in the Building Operations Research Unit of the Building Research Station (Department of Scientific and Industrial Research)—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4042/51 (August 2).

CHAIR OF PHYSICS in the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth 5 Gordon Square, London, W.C.1 (August 4).

GRADUATE IN PHYSICS (with a bias towards engineering) to undertake research work in the unexplored field of glasshouse heating and ventilation—The Head of the Garden Research Department, John Innes Horticultural Institution, Bayfordbury, Hertford (August 4).

RESEARCH OFFICER (Biologist), DIVISION OF FISHERIES, to take part in the research programme on pearl-shell culture at Thursday Island—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3282 (August 4).

CHEMISTS (Principal Scientific Officer or Senior Scientific Officer grade) at the Atomic Energy Research Establishment, Harwell, for work on the electro-magnetic method of separation of stable isotopes—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.4045/51 (August 8).

MECHANICAL ENGINEER (Principal Scientific Officer grade) with considerable design experience, to study and to solve the special problems connected with the design of modern radar aerials and their associated scanning and rotating mechanics, an ENGINEER (Principal Scientific Officer grade) with wide experience in, and complete responsibility for, the successful engineering of complex projects involving many different specialist component parts both electrical and mechanical, an ELECTRONICS ENGINEER (Principal Scientific Officer grade) with outstanding ability in precision designs associated with complex electronic equipment, an ENGINEER (Principal Scientific Officer grade) with high-grade experience of the theory, design and utilization of servo-mechanisms, at an Admiralty establishment in the south of England; MECHANICAL ENGINEERS (Principal Scientific Officer grade) with considerable experience in the design of intricate mechanisms, at an Admiralty establishment in the Home Counties; PHYSICIST or ELECTRONICS ENGINEER (Senior Scientific Officer or Principal Scientific Officer grade) with an excellent theoretical understanding and practical experience of, and responsibility for, the design and development of electronic circuits, especially in the high and medium frequency bands, at an Admiralty establishment in the Home Counties; STRUCTURAL ENGINEER with a first- or second-class honours degree in Engineering, or a MATHEMATICIAN with an honours degree in Mathematics (Principal Scientific Officer grade) to supervise the work of applied mathematicians and engineers in the Structural Mechanics Division, at an Admiralty establishment at Rosyth—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.4043/51 (August 9).

ASSISTANT IN THE STATISTICS SECTION, for work on problems of tree variation and measurement—The Secretary, East Malling Research Station, Maidstone, Kent (August 11).

LECTURER IN PHYSICS (preferably in Experimental Physics) at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (August 15).

SENIOR SCIENTIFIC OFFICERS (with a first- or second-class honours degree in botany, and well qualified in systematic botany), for research work in the Herbarium or Laboratories, supervision of staff, the identification of plants and plant products and the control of Laboratory equipment, at the Royal Botanic Gardens, Edinburgh—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.4046/51 (August 16).

SENIOR LECTURER IN FLUID MECHANICS AND HYDRAULICS, and a LECTURER IN CIVIL ENGINEERING, at Canterbury University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 20).

LECTURER IN GEOGRAPHY—The Secretary, The University, 36 North Bailey, Durham (August 31).

CHAIR OF ANATOMY in the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 1).

RESEARCH ASSISTANTSHIP IN INDUSTRIAL RELATIONS—The Registrar, University College of South Wales, Cathays Park, Cardiff (September 10).

ASSISTANT CIVIL ENGINEERS in the Department of Drainage and Irrigation, Malaya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27329/24.

ASSISTANT ENGINEER with power plant experience (and experience in the running and maintenance of diesel-driven A.C. generators, the upkeep of A.C. motors, switchgear and cables) to the Sudan Gezira Board—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Sudan Gezira Board, Power Plant 4/292'.

ASSISTANT LECTURER AND DEMONSTRATOR (with a sound scientific knowledge; a knowledge of leather manufacture would be an advantage)—The Principal, Leathersellers' Technical College, 176 Tower Bridge Road, London, S.E.1.

ASSISTANT LECTURER (temporary) IN PHILOSOPHY—The Registrar, University College, Singleton Park, Swansea

CHEMICAL ENGINEER or CHEMIST with production experience, for oil plant at Wick, north Scotland—The Herring Industry Board, 1 Glenfinlas Street, Edinburgh 3.

DEPARTMENTAL ASSISTANT (university graduate, preferably with special qualifications in agricultural chemistry) IN AGRICULTURAL CHEMISTRY, and a DEPARTMENTAL ASSISTANT IN POULTRY HUSBANDRY, at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

DIRECTOR (Senior Principal Scientific Officer grade) OF THE WEST AFRICAN BUILDING RESEARCH ORGANIZATION—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

EXECUTIVE ENGINEER IN THE PUBLIC WORKS DEPARTMENT, British Honduras—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/138.

HONOURS GRADUATE (Scientific Officer grade) for research on methods of microbiological assay of vitamins and amino-acids—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

LECTURER (university graduate with an honours degree in engineering or physics) IN REFRIGERATION, and a LECTURER (with a degree in mechanical engineering and some practical experience of fan applic tion) IN FAN ENGINEERING—The Clerk to the Governors, Nation College for Heating, Ventilating, Refrigeration and Fan Engineeri Borough Polytechnic, Borough Road, London, S.E.1.

LECTURER IN INORGANIC CHEMISTRY (including spectrochemic analysis), a LECTURER IN APPLIED MATHEMATICS, a LECTURER PHYSICS, and a LECTURER IN ZOOLOGY—The Principal, Sir John Ca College, Jewry Street, London, E.C.3.

LECTURER IN POULTRY SCIENCE—The Bursar, Harper Adar Agricultural College, Newport, Shropshire.

LECTURER or Grade B ASSISTANT IN PHYSICS—The Registr Medway Technical College, Gardiner Street, Gillingham, Kent.

MATHEMATICIAN or MATHEMATICAL PHYSICIST (with a good honou degree and, preferably, some knowledge of the theory of elasticit for research in applied mechanics—The Personnel Officer, British Ir and Steel Research Association, 11 Park Lane, London, W.1.

MECHANICAL AND ELECTRICAL ENGINEER by the Directorat General of Municipalities, Iraq—The Crown Agents for the Coloni 4 Millbank, London, S.W.1, quoting M 24694.B.

MECHANICAL ENGINEERS (Tractors) in the Department of Agr culture, Sudan—The Sudan Agent in London, Wellington Hous Buckingham Gate, London, S.W.1, endorsed 'Mechanical Engine (Tractors) 4/4'

PHYSICIST or ENGINEER (university degree in physics or mechanic engineering with mathematics subsidiary essential) to join a researc team investigating deformation of metal, particularly the rollin process—The Personnel Officer, British Iron and Steel Researc Association, 11 Park Lane, London, W.1, endorsed 'Rolling'.

POWER STATION CHEMIST (with a University degree in chemistry or an equivalent qualification) by the Central Electricity Boar Federation of Malaya—The Crown Agents for the Colonies, 4 Mil bank, London, S.W.1, quoting M.28340.B.

RESEARCH FELLOWSHIP established by the Nottinghamshire Counc of the British Empire Cancer Campaign—The Registrar, The Uni versity, Nottingham.

RESEARCH STUDENTSHIP for work on oxides in weld metal—Th Head of the Department of Applied Chemistry, Northampton Poly technic, St. John Street, London, E.C.1.

SENIOR EXPERIMENTAL and ASSISTANT EXPERIMENTAL OFFICER to undertake and assist with experimental work involving a wid range of chemical and physical atomic energy development problems and a SENIOR EXPERIMENTAL OFFICER to design and assemble specia electronic equipment for research groups working on atomic energ development problems, in the Research and Development Branc (Applied Research), of the Division of Atomic Energy (Production) at Windscale Works, Sellafield—The Ministry of Supply, Division o Atomic Energy (Production), Risley, Warrington, Lancs (stating pos applied for).

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(not included in the monthly Books Supplement)

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Philosophical Transactions of the Royal Society of London. Serie A: Mathematical and Physical Sciences. No. 865, Vol. 243: Larg Elastic Deformations of Isotropic Materials, 7, Experiments on th Deformation of Rubber, by R. S. Rivlin and D. W. Saunders; 8, Strain Distribution around a Hole in a Sheet, by R. S. Rivlin and A. G. Thomas. Pp. 251–298. (London: Cambridge University Press, 1951.) 11*s*. [254

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Report of the Rugby School Natural History Society for the Year 1950. (Eighty-fourth issue.) Pp. 55. (Rugby: George Over, Ltd., 1951.) [264

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Companhia de Diamantes de Angola. Publicacoes Culturais No. 10: Museu do Dundo. Subsídios para o estudo da biologia na Lunda. Estudos Diversos, 3: Semiaquatic Heteroptera collected in Lunda, North-East Angola (Portuguese West Africa) by Dr. A. de Barros Machado in 1946–1949, by Ludvik Hoberlandt; Chiroptera from Dundo, Lunda, North-Eastern Angola, by Colin Campbell Sanborn; On Diplopoda of North-East Angola, by Ralph V. Chamberlin; On Chilopoda collected in North-East Angola by Dr. A. de Barros Machado, by Ralph V. Chamberlin. Pp 112. (Lisboa: Companhia de Diamantes de Angola, 1951.) [244

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FUNCTIONS OF THE UNIVERSITIES

In the picture of the development of Owens College into the University of Manchester of to-day which Prof. Charlton has given us under the title "Portrait of a University", stress is laid upon John Owens's insistence that the College should make full provision to meet the particular needs of its surrounding district and the way in which this has influenced developments. Inherent in such thinking is the conception of the university as a regional centre which Prof. B. Dobrée expounded in his Earl Grey Memorial Lecture in 1943; but it is apparent from the discussion on this subject at the Home Universities Conference last December that the universities are not agreed as to the extent or nature of their regional functions or responsibilities. Prof. Charlton's study scarcely helps us either, for although he demonstrates the great value both to the University itself and to the region of that intimate contact between the university and industry, commerce and other activities of the surrounding area which characterized Owens College from the start, he does not deal with important detail and barely mentions the tutorial classes or extra-mural work.

It is appropriate at the present time that the universities of Great Britain generally should consider carefully not merely whether they are fully discharging their regional responsibilities, but even whether in certain directions they may not be doing too much. Like other institutions, they may be called upon to face greater stringencies in the immediate future, in view both of rising costs and the demands of re-armament. The easing of the immediate post-war pressure now that the Further Education and Training Scheme has terminated should provide them with a valuable opportunity for stocktaking and for closer attention to standards. A decline in the student population of the universities is not *a priori* a matter for complaint at the present time. Even an increased expenditure on the universities may well prove to be best distributed over fewer students, and any breathing space which a decreased entry may afford the universities should be utilized in a careful scrutiny of policy and objectives in all branches of expenditure.

In the first place, it is necessary to be clear as to the functions of a university and the broad objectives of its policy. In one particular field a recent broadsheet (No. 328) issued by Political and Economic Planning makes an important contribution. The universities now spend roughly half a million pounds a year on extra-mural work—that is, on the teaching of those who are not full-time students. This is a sum quite considerable enough to justify P E P raising such questions as whether the standard of extra-mural study is sufficiently high to justify acceptance as of university level, and again whether the universities are here undertaking work which could be done as well by others—a question which it is equally pertinent to ask of some of the technical instruction given at the universities, particularly in view of the current debate on higher technological education.

A brief sketch of the growth and extent of the universities' concern in adult education was given by Mr. W. E. Salt, director of the Department of Adult Education in the University of Bristol, in the *Universities Review* last September (see *Nature*, 167, 1; 1951); but the present broadsheet, although entitled "The Universities and Adult Education", examines the work of the extra-mural departments and its place in relation to the rest of the work of the university, particularly in the light of the views expressed in the last report of the University Grants Committee. While recognizing that much of the criticism of the extra-mural work is valid, the University Grants Committee was then prepared to encourage expansion of such work in the belief that "the universities are making, and should continue increasingly to make, a unique and indispensable contribution to adult education". The broadsheet accepts, for the purposes of its discussion, the possibility of achieving work of university standard in university adult classes and that such work is therefore acceptable as a university function. It seeks, however, to define that function more closely and the way this side of the work of the universities is likely to develop in the future in view of the widening purpose and growing importance of adult education in general.

To some extent this survey by P E P duplicates that made by Mr. Salt. It brings out more clearly the point made by Bruce Truscot, both in "Redbrick University" and in "Redbrick and these Vital Days", that under the conditions of to-day the extra-mural work of the universities, and particularly that of Oxford and Cambridge, might be reconsidered in relation to regional responsibilities and the establishment of further universities during the past half-century. When universities are complaining with reason of administrative responsibilities thrust upon them, any opportunity for eliminating unnecessary administrative complications should be seized.

This point could well be examined more carefully, and in this connexion it should be remembered that it is no longer true that adult education can look only to the university for leadership. If, however, the universities wish to lighten their load here, the decision should be taken in the light of some clear and, if possible, agreed ideas as to the principles which should govern their future policy, both in adult education itself and in their regional activities generally. There are directions in which the universities are being urged to extend their activities, and in spite of the value of the bridge between the university and the community which extra-mural activities provide, as the University Grants Committee remarked in its last report, it is important that the universities should not dissipate the resources available by endeavouring to meet all demands made upon them for the provision of adult education.

Such a policy would not only waste university resources but also almost certainly lead to much overlapping with other organizations. Moreover, just as a university cannot consider its regional functions without having regard to the primary, and universal, responsibility implied in its name, so in accepting responsibilities for the cultural life of those without its walls it must be free from sectional inhibitions: it should be prepared to consider requests from any part of the community. Selection and discrimination are essential, but they must not be arbitrary; they must be in accordance with the university's primary purpose.

P E P suggests as the first criterion for discrimination that the main concern of the university should be with studies of a high academic standard or degree of specialization which only the university can effectively supply. This accords with the general opinion at the Home Universities Conference, where, however, Prof. R. D. Waller also pointed out that such specialist and near-vocational work is likely to increase and to involve extra-mural departments in considerable administrative responsibilities which might distract them from other tasks. Like the University Grants Committee, he recognizes the value of the relationship with the local community established in extra-murel work and is prepared to justify such work in general not only by an obligation to meet the utilitarian demands of local interests but also by the university's own sense of social awareness, including the needs of its staff as well as of its community.

In going so far, Prof. Waller makes the university itself, rather than any principle or set of principles, the arbiter; for defining limits for the work of the universities in education, P E P strongly supports the practice of trusting the discretion of extra-mural departments or directors. So far as the length and organization of classes are concerned or the requirement of some minimum educational standards of adult students, it is urged that any other course is undesirable. In practice, however, the scope of extra-mural work has depended largely on the activities of other bodies, and P E P suggests that by laying on the local authorities the new duty of ensuring that "adequate facilities for further education" are available, the Education Act of 1944 may well mean an increase in the demand for those types of instruction which universities are best fitted to provide, as well as a change in relations with local authorities. The work of the universities, together with that of the voluntary associations, will in future be viewed in relation to the whole structure of further education, and university policy should take this into account.

Whatever the scope of the work eventually undertaken by extra-mural departments, the crucial considerations are the preservation of academic standards and the integration of the department with the main body of the university. Both alike turn on the question of university resources, and failure to fulfil either condition has been the prime cause of most of the criticism of extra-mural work and of the waste of resources. In practice, achievement of the first depends mainly on the extra-mural tutor, and the second partly on internal departmental relations and organization.

The difficulty in regard to the maintenance of standards arises chiefly because it is necessary to employ part-time non-university lecturers. On a part-time basis such lecturers cannot have the same opportunities of real contact with the university as those who are full-time members of the university's staff. There is, however, now an established body of full-time extra-mural staff, whose employment raises some of the most difficult problems in university adult education. Even these lecturers do not always possess full staff status, which P E P urges is essential if adult education is accepted as a university function.

By itself it is only a first step, and other measures will often be required to enable such lecturers to make a reality of their university membership and to bring them more into contact with other members of the university staff. Mr. Salt fully recognizes this difficulty in his paper in the *Universities Review*, and to what he said P E P adds little more than the suggestion that it would help in the assimilation of the full-time extra-mural staff with the university, and facilitate the transmission to the outside world of the intellectual attitudes and ideals of a university, if the external staff were enabled to do some internal lecturing also and given the opportunity of joining in the research programmes of internal departments. Such measures would demand considerable organization and adjustment, and for the extra-mural department to become more truly part of the university there must first be readiness to co-operate, a strong interest in its work and a sense of responsibility and unity in the university as a whole. Without them adult education or indeed any aspect of extra-mural work is scarcely worth while undertaking.

Nevertheless, however appropriately and adequately staffed may be the extra-mural department which is the main instrument with which the university fulfils its function in this field, there remains the question of resources. Mr. Salt's suggestion that the extra-mural course itself provides the best test is admirable but scarcely sufficient by itself. The course, he suggests, should make such demands that only the serious student is willing to accept its discipline; but in offering such courses a university cannot fail to take account both of the extent of its other responsibilities and resources and of the general conditions in its immediate region and indeed of the country as a whole.

It has already been indicated that university policy in this field requires to take into account the changes in the structure of further education brought about by the Education Act of 1944. It equally involves consideration of the position and growth of secondary education from this point of view no less than from that of entry to the university. Lord Eustace Percy took up this point in his speech at the Home Universities Conference. What appears to be implied above all in the conception of the university as a regional centre in Prof. Dobrée's lecture or in the views expounded by Bruce Truscot is the interchange of thought between the university and its surrounding region, much as, through working so happily with and through the people of the surrounding community, the University of Manchester has largely been shaped in its development by the needs and outlook of the community and, in turn, in expanding, has served these needs. At the basis of that interchange must lie the production of graduates able to think clearly and precisely and to express themselves lucidly, who possess, as Prof. W. Fisher Cassie remarked, the sound and critical judgment, the personality and the readiness to accept responsibility for which industrial leaders look.

Prof. Cassie suggested that it is in the field of applied science that there has been the most marked failure of the universities to satisfy the requirements of their regions for outstanding men capable of assisting their fellows in the application of scientific truths. It is true that, as he observed, constant contact between the staff of a university and the professional institutions and practitioners of the region is the essential basis of regional co-operation; but there may well be other factors which determine the ability of any one university to provide its region with a sufficient number of outstanding men and women. Entry to a university is not determined primarily by the needs of its region, and there is still a tendency for the most promising students to be attracted to a limited number of universities.

The changes in conception and content of the usual technological curriculum suggested by Prof. Cassie, in spite of their undoubted value, will not necessarily, therefore, suffice; but now that it is desirable to reconsider the ways in which the universities distribute their available resources and indeed the functions the universities should perform, it is more important than ever to insist upon the importance of maintaining, if not of raising, standards. So far as technological or science students are concerned, encouraging them in creative work and the assumption of more responsibility may mean a reduction in numbers and an increase in staff and facilities; nevertheless, the nation's needs, even from the point of view of productivity, will be better served by smaller numbers in whose scientific and technological training critical and expressive faculties have been properly developed. Even when that is conceded, it is still true that the universities should be prepared to co-operate in certain regional activities and developments where these promise to enrich the cultural life of the community, in spite of their cost in resources. The Beveridge Committee on broadcasting, for example, directed attention to the opportunity for experiment in Britain with local stations broadcasting programmes controlled by universities.

Such developments are in line with the sketch of the university of the nineteen sixties with which Prof. Dobrée concluded his lecture, and may indeed afford a new and more effective means by which the universities can participate in adult education. Any such new developments must, however, be considered in relation to the university's first purpose—the pursuit and dissemination of knowledge. Regional developments and adult education are not, and never can be, the universities' first concern, and the extent of the universities' participation in all such extra-mural activities must be determined by the extent to which they are consistent with the maintenance of the highest standards in the universities' primary activities.

THE FIRST AMERICANS

Early Man in the New World
By Kenneth Macgowan. Pp. xviii+260. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1950.) 37*s*. 6*d*. net.

THE evidence for early man in America, before the development of the traits connected with agriculture and a settled life, has hitherto been scattered in a number of technical publications, many of them difficult of access to readers in Great Britain. This book presents the material in a manner both popular and scientific. Mr. Kenneth Macgowan, distinguished in other fields, is an amateur anthropologist; but the book shows that he has read both widely and critically, and the result is clear and generally accurate.

In a book of this length, it is at first surprising to European readers to find forty pages devoted to Old World prehistory; but this is clearly necessary when addressing a public unfamiliar with that field. The author is critical of Mortillet's classification of the Palæolithic, which he regards as a scientific strait-jacket; but it has done good and necessary service even if it has been applied too rigidly, and in the final chapter, which is admittedly speculative, he himself seems to look with too favourable an eye on reports of specifically European types of Palæolithic implement (bearing Mortillet's names) in the New World. He places Harrison, of Eolith fame, in Suffolk instead of Kent, and does not know that Oakley's fluorine analysis work has ruled out an early date for Piltdown man; but these are minor points.

The best source of information on early man in North America is a handbook by H. M. Wormington published by the Denver Museum of Natural History, which appears in the bibliography. This author has, with good reason, abandoned the term Yuma altogether; but it must be noted that Mr. Macgowan has retained it, apparently on purpose. Apart from this, the information given for all parts of America is up to date and, in most cases, as full as the nature of the book demands, though rather more might have been made of Junius Bird's work in south Chile, and his presumed early pressure-flaking sites on the coast of Peru are worth a mention. In connexion with the supposed find of mastodon in association with pottery near Quito in Ecuador, it is certainly a pity that the site did not get more satisfactory investigation (p. 145). Jijon y Caamaño, a distinguished Ecuadorian archæologist, told me that he had the gravest doubts about the association, and dated the pottery as late as the twelfth century. If mastodon had survived until this late date, other evidence of its presence should surely have been found by now either in Ecuador or Peru. The find was described by Uhle, who was concerned in it, and the mention of Maya influence on the pottery is a reminder of the extremely speculative nature of his writings at this time.

Some of the later chapters, containing discussions of diffusion, with special reference to Gladwin's views, and of agriculture, are interesting and stimulating, but relevant rather to a time later than that of the main theme of the book. Chapter 11 contains a statement (p. 208) that no maize had been found with the Coastal Chavin culture, which is not true, since Bird specifically states that it appeared at this very time. Further, we have, since 1949, had more precise information about the date of the appearanc of this culture and of maize than is given here, i the shape of a radiocarbon date of 2665 ± 200 year or about 700 B.C.

The book deserves to be widely read. Not onl does it present a large body of information in readable form, but also it is written in such a way a to encourage its readers to assimilate new facts and t make their theories fit them.

G. H. S. BUSHNELL

ELECTRONIC THEORIES OF ORGANIC CHEMISTRY

Physical Aspects of Organic Chemistry
By Dr. William A. Waters. Fourth edition, completely rewritten. Pp. xii+539. (London: Routledg and Kegan Paul, Ltd., 1950.) 35*s*. net.

WHEN the first edition of this book appeared the application of the wave-mechanical treatment of electron behaviour to organic molecules was in its infancy, the concept of hyperconjugation was unknown, the duality of mechanism of substitution and elimination reactions was generally unsuspected, little was known regarding the kinetics of aromatic substitution, and free-radical chemistry was largely restricted to the reactions of more stable radicals like triphenylmethyl. The very great advances in our knowledge of these topics alone, during the past fifteen years, indicate the magnitude of the task involved in the up-to-date revision of this book which Dr. W. A. Waters has attempted in the fourth edition.

The scope is wider than the title might suggest, since the author attempts the application of "the broad conclusions of the electronic theory of valency" to all the principal reactions of organic compounds. Although the size of the book has been increased by some fifty pages, it is obvious that only the more salient features of such a wide field could be included, and this new edition constitutes a very readable and valuable survey of the present theoretical outlook. The impression is gained, however, that the author has been somewhat hampered and circumscribed by the original framework of earlier editions. There is an unhappy blending of different nomenclatures, and the treatment of some topics is not as up to date as might be expected. The intentional historical development of current ideas from their earlier and cruder precursors is valuable, but curtailment of such treatment would have permitted fuller elucidation and the presentation of a more accurate and complete picture of the conclusions derived from recent extensive kinetic studies.

Thus the whole treatment of ester hydrolysis is based essentially on Lowry's termolecular mechanism which, since it envisages proton-transfer from acidic to basic oxygen as a rate-determining step, would find very limited acceptance to-day. In consequence, Day and Ingold's mechanism of acid-catalysed ester hydrolysis is erroneously described (p. 347) as a bimolecular electrophilic substitution S_E2. Restriction of the account of the effect of substituent groups in 1 : 2-eliminations to those governed by the Hofmann rule (that is, control by the inductive effect) is liable to confuse the reader when he encounters similar eliminations which follow the Sayzeff rule (control by the electromeric effect). A strange and unexpected confusion runs right through the book in the misnaming (p. 436) of the polarizability effect which arises from the reagent-stimulated delocalization of π-electron pairs, as the 'inductomeric' instead of the 'electromeric' effect. Moreover, this nomenclature is erroneously ascribed to Ingold, who, in the reference quoted, clearly assigns the term 'inductomeric effect' to the polarizability effect which corresponds to the *electrostatic* polarization known as the inductive effect. The same erroneous terminology is ascribed (p. 71) to Baker and Nathan's concept of the delocalization of the C—H bond electron-pairs of the methyl group in toluene (now known as hyperconjugation), although these authors, again, recognized its true character and designated it by the same nomenclature—namely, mesomeric and electromeric effects.

In spite of such defects and of a number of misprints, which although not numerous are sometimes rather confusing, the book is a valuable account of the physical background and development of modern electronic theories of organic chemistry and will doubtless be welcomed by all interested in this field.

J. W. Baker

PLANT PATHOLOGY

Plant Pathology

By Prof. John Charles Walker. (McGraw-Hill Publications in the Agricultural Sciences.) Pp. x+699. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 64s.

All students of plant pathology will welcome this work by Prof. J. C. Walker, the distinguished plant pathologist in the University of Wisconsin. It is an introduction to the scientific foundations of the subject, and forms a comprehensive treatment of the better-known plant diseases which may serve as a guide to the general principles of plant pathology.

It is, of course, a matter of personal opinion whether the arrangement of the matter in the book is actually the right one to adopt in such an introductory treatise—whether the sequence should be from the 'particular' to the 'general', or vice versa—but there are obvious drawbacks to the former method, which is the one chosen in this work. Following an introductory chapter on the definition of disease and disease terms and on the classification and economic significance of plant diseases, the reader is taken in the second chapter to a discourse on the history of plant pathology. One doubts, however, whether a student new to the subject can appreciate this information, excellent though it be, at this early stage; and it would perhaps have been more profitable to have extended the number of specific diseases described, especially those of trees, with a few others attributed to the Ascomycetes, which are relatively meagrely treated. At the outset, the young plant pathologist is often far more interested in handling the elements of the subject, the different kinds of fructifications and spores, of sclerotia and rhizomorphs, of morbid anatomy and culture work, than in a contemplation of the historical aspects of the subject. Such a dissertation would perhaps be better reserved for a riper stage of experience.

As a study of this subject must obviously go hand in hand with practical work in the field, greenhouse and laboratory, it is very doubtful whether a start on specific types of disease should have been made with non-parasitic diseases. The multiple symptoms usually presented by these maladies are often very difficult to assign to specific causes, and this section would have been better left until the student had gathered as much information as possible about diseases ascribed to specific organisms capable of being isolated in culture or examined in the plant tissue.

Succeeding chapters are devoted to diseases incited by bacteria (eleven types, with a useful key to the main genera); by Plasmodiophorales (two types); by Phycomycetes (fourteen types, preceded by definitions, but no illustrations, of the diverse kinds of spores and organs in this group); by Fungi Imperfecti (twelve types, prefaced by a scheme of classification in which are included several 'imperfect' forms belonging to the Ascomycetes); by Ascomycetes (thirteen types, with a classificatory outline); and by Basidiomycetes (thirteen types, embracing a number of the smuts, bunts, rusts, *Rhizoctonia*-diseases, and only two diseases of trees). Chapters 10 and 11 deal briefly with phanerogamic parasites (mistletoe and dodder) and nematodes, respectively. These are followed by a comprehensive and excellent account of virus diseases. Other chapters are devoted to the relation of environment to disease development, and host–parasite interactions (this might well have appeared much earlier in the book). Disease control is admirably treated at length in the concluding three chapters under the respective titles, exclusion and eradication, protection, and host resistance.

All the sections and individual types are supplemented by full bibliographies of titles and references. The entire work is beautifully executed (a few typographical errors occur) with 194 figures in line and half-tone, and forms a valuable contribution to the modern aspects of plant pathology.

S. G. Jones

UNCONVENTIONAL HYDRODYNAMICS

Hydrodynamics

A Study in Logic, Fact and Similitude. By Garrett Birkhoff. Pp. xiii+186+3 plates. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1950.) 22s. 6d. net.

This is a book of a very unusual kind, quite unlike any of the standard treatises on hydrodynamics. The author himself says that the material treated "involves a heterogeneous combination of destructive logical criticism, detailed experimental fact, and occasional mathematical sophistication, which may at first seem unpalatable to many readers". The first chapter, entitled "Hydrodynamical Paradoxes", gives many examples of plausible arguments which lead to conclusions opposed to observed facts. It is generally supposed that all these discrepancies between theory and observation are due to a single unjustifiable approximation, namely, the assumption of zero viscosity, but Prof. G. Birkhoff claims that there are others. One of the most disturbing is the possibility that very small causes may sometimes produce large effects. This calls urgently for an investigation into the nature of the corresponding partial differential equations. There are also several cases where apparent symmetry in the causes produces unsymmetrical effects. This chapter is what George Bernard Shaw might have written if he had studied hydrodynamics. After pointing the fallibility of mathematicians, logicians, engineers and physicists, Prof. Birkhoff concludes the chapter with a warning, supported by a photograph forming the frontispiece, against trusting in common sense.

The second chapter, entitled "Recent Progress in Free Boundary Theory", is somewhat similar to the first, but is more constructive and contains some new positive contributions to the subject. It includes an account of two physical parameters which are completely ignored in the classical theory of jets and wakes. The third chapter deals with the use of small models to predict the behaviour of full-scale apparatus, and begins with "a number of simple, yet fundamental mathematical remarks which have hitherto escaped general attention". The author distinguishes between dimensional analysis and inspectional analysis. The former is widely used, but he points out its limitations, which seem to be overcome in the latter. However, for a complete inspectional analysis of hydrodynamical modelling we need fundamentally new theorems about partial differential equations. It is possible that these will be suggested by a study of experimental results. Inspectional analysis is really an application of the mathematical theory of groups, which can also be used to test the validity of hydrodynamical theories even when it is impossible to integrate the corresponding partial differential equations. In the fourth chapter the reader will at last realize that the author's main object is to emphasize the importance of group theory, which is presented as a unifying principle, not only in hydrodynamics but also in other branches of physics and in the theory of differential equations. This is illustrated by a variety of important problems. The fifth and last chapter applies group theory to the concept of 'virtual mass'.

The book will be of great value to those who are able to use it to stimulate their own thoughts.

H. T. H. Piaggio

QUAKERS IN SCIENCE AND INDUSTRY

Quakers In Science and Industry

Being an Account of the Quaker Contributions to Science and Industry during the 17th and 18th Centuries. By Dr. Arthur Raistrick. Pp. 361+17 plates. (London: Bannisdale Press, 1950.) 21s. net.

Much research has gone into the making of this book, and its preparation has evidently been a labour of love for the author. It covers especially the period 1650–1800, during which Great Britain changed over from an economic structure largely agricultural in character to one in which large-scale basic industries, such as coal-mining, iron-founding and engineering, were playing a rapidly expanding part.

About the middle of the seventeenth century, George Fox founded the Society of Friends, soon to be dubbed Quakers. The sect soon attracted unfavourable attention from both the Established Church and the State. Yet, such was the intellectual and spiritual force behind the movement that, in spite of the disabilities imposed on it by law, and the persecution to which members were subjected, its numbers expanded rapidly. Dr. Raistrick points out that before the eighteenth century was well advanced, Quakers occupied influential positions in basic industry, trade, banking and medicine, and appeared on the roll of the Fellows and Council of the Royal Society.

In the first two chapters the author traces in some detail the rise of the Quakers, and the part they played as citizens; and shows by means of statistical evidence that they sprang largely from the class that provided craftsmen, artisans and yeomen. Later, however, they became predominantly middle-class traders.

The next six chapters describe the part played by the Quakers in trade and industry. Among the traders singled out for special mention are the iron masters and the mining companies, including the Quaker Lead Co., which dominated lead mining in Britain during the eighteenth century. The Quakers were prominent in other metal industries, such as brass founding and the smelting of copper and zinc; and reference is also made to the wool staplers and linen drapers. The English porcelain industry, which grew out of the discovery of the china clay deposits in Cornwall, was founded by a Quaker, William Cookworthy.

Dr. Raistrick then discusses the part taken by the Friends in technology, science and medicine. The famous clock- and watch-makers Thomas Tompion and Daniel Quare were Quakers, and so was George Graham, who also constructed a number of astronomical instruments for Greenwich Observatory.

The Friends regarded all natural objects, plant, animal and mineral, as the works of a beneficent creator, to be studied and used for the benefit of mankind, so that it is not surprising to find among their numbers some prominent naturalists and men of science. These included Phillip Miller, superintendent of the Physic Garden in Chelsea, and author of the well-known "Gardener's and Botanist's Directory" published in 1731; William Allen, chemist; William Phillips, mineralogist, and one of the founders of the Geological Society of London, and, most distinguished of all, John Dalton. Among Quaker medical men there occur the names of John Fothergill and John Coakley Lettsom.

During the eighteenth century there was widespread intermarriage among the Quakers, and the family relationships and business ramifications were closely interlocked. The latter pervaded industry throughout England and Wales, and even penetrated into Scotland and Ireland. Many names additional to those quoted here, some important, others less so, receive a mention in this book, and there is a wealth of genealogical and biographical information; but sufficient has been said to indicate its scope.

In the final chapter the underlying causes responsible for the remarkable rise of the Quakers are discussed. Prominent among these were their honesty in business dealings, their lack of avariciousness, and their genuine and practical interest in the welfare of their employees.

Dr. Raistrick's book is fully documented, and is a valuable contribution to the social and industrial history of the years between 1650 and 1800, adding also to our knowledge of the development of technology in that period. It should be read by all to whom such matters are of interest. V. A. Eyles

THE NEW UNIVERSAL DIGITAL COMPUTING MACHINE AT THE UNIVERSITY OF MANCHESTER

University College of Science
PHYSICS Dept.
Upper Circular Rd, Calcutta

By DR. T. KILBURN
Electrical Engineering Laboratories, University of Manchester

IN a previous communication[1], a universal digital computing machine was briefly described. That machine was experimental, and its purpose was mainly to investigate the potentialities of a large-scale machine based on the cathode ray tube[2] and synchronized magnetic drum[3] type of storage. The success of the machine made it possible to begin the design in July 1949 of a new machine, which has just come into service. Whereas this new machine is superficially the same as the experimental machine in that it operates serially, uses the binary system of numbers and has the same digit frequency of 100 kc./s., it has several improved features.

Storage. Experience of the experimental machine showed that the electronic storage capacity of 5,120 digits provided by two cathode ray tubes was rather too small to permit flexibility of programming, and that the subsidiary storage on the magnetic drum of 40,000 digits would be quite inadequate for many problems. In the new machine the electronic storage capacity has been increased to 10,240 digits, and improved operation of the store has been obtained by halving the number of digits stored per tube, and by using the defocus–focus system of storage[2]. The magnetic storage capacity has been increased to 150,000 digits, provision being made for a further increase to a maximum of about 600,000 digits if this is necessary. The magnetic drum is 6 in. in diameter, and along its length of 8 in. there is sufficient space to accommodate 256 separate peripheral tracks. Each track holds 2,560 useful digits; the packing density being 165 digits per inch. The mechanism of reading from and writing on these tracks is described elsewhere[4]. The electronic store can be automatically loaded from, or into, the magnetic store as a result of programmed instructions. These instructions cause a transfer of information in which the contents of any stated track are written on a stated pair of cathode ray tubes or vice versa. Alternatively, if it is more convenient, the transfer of information may be between one half-track and one cathode ray tube. In each case, the correctness of transfer can be checked by a single instruction, and, in the case of an incorrect transfer, the transfer can be repeated, or the machine stopped.

Selection of a particular track for reading is by electronic switching, and for writing, by relay switching.

The time taken for the check, and for any transfer, in which a track is read, is 36 msec. For a transfer in which information is written into a track, this time is increased to 63 msec. to allow time for the relay switching. This discrepancy between the times for reading and writing is not important, because reading is more frequent than writing. This is so because the sub-programmes required during computation are all stored on the magnetic drum.

The accumulator. The facilities for performing addition, subtraction and three logical operations have been retained, together with signed and unsigned multiplication, in which the 80-digit product of two 40-digit numbers is added to the content of the accumulator. Multiplication in which the product is subtracted from the accumulator is a new facility.

The most important engineering change of the accumulator is in the multiplying circuit. In the experimental machine the multiplication time, which depended on the number of 1's in the multiplier, averaged about ten times that for addition. A study of available programmes revealed that if this multiplying circuit was used in the new machine, then about half the computing time of the machine would be spent in multiplication. Consequently, the speed of multiplication has been increased, and, in the new machine, an instruction involving multiplication is selected, interpreted and obeyed in 2·16 msec., as compared with a corresponding time of 1·2 msec. for addition, or any other 40-digit number operation. The increase in speed of multiplication is obtained by using a circuit consisting of a network of adders and delays, arranged in such a way that the sub-products are added together in one operation, instead of sequentially. Although some economy of equipment is achieved by carrying out the multiplication in two parts, controlled respectively by the first and second halves of the multiplier, nevertheless this type of multiplier is expensive and increases the size of the final machine by about 10 per cent (the machine contains 1,600 pentodes and 2,000 diodes). This, however, is judged to be worth while when balanced against the resulting overall increase in speed of operation of the machine.

To simplify the standardization of numbers during the course of computation, an instruction has been provided which produces in the accumulator a statement in binary form of the position of the most significant digit of any selected number in the electronic store.

In the near future, an additional circuit will be installed to generate (in 5·8 msec.) a 20-digit random number as a result of a single instruction. This instruction will be used in calculations concerned with stochastic processes.

The B tube. This facility has been improved to allow still greater flexibility and economy in programming. Eight 20-digit storage locations can now be selected by the three '*b*-digits' of an instruction, and thus any one of eight words may be added to an instruction before it is used.

Further, the *B* tube has been provided with a subtracting circuit, and a sign-testing circuit. Any line of the tube can therefore be used as a 20-digit accumulator for simple arithmetical processes. One important example of this is in counting the number of times that a group of instructions has been obeyed, cycling of control being conditional on the sign of a number in the *B* tube. By this means four instructions are removed from any loop in which counting is required.

The instructions provided enable a number from the electronic store to be written into, or subtracted from, the *B* tube; or a number in the *B* tube to be written into the electronic store. The line of the *B* tube involved in these instructions is stated by the three '*b*-digits'. To avoid the necessity for eight test circuits—one for each line—the instruction 'test the sign of *B*' reads a single circuit, which is recording the sign of the content of that line of the *B* tube which was last used.

The time taken to read, interpret and obey these instructions is 960 microseconds.

Input and output. The input and output is based on teleprinter apparatus using 5-hole paper tape. The input uses a photo-electric tape reader capable of reading 200 five-digit characters per second. The output is by a mechanical tape-punch and/or teleprinter each capable of printing ten characters per second.

The speed of input is approaching the maximum for this machine if an input programme is required to organize the input information. However, the speed of output, which is twenty times as slow, can only be justified if, in general, the time of output is smaller than, or comparable with, the input and computing times together. If this proves to be untrue, an alternative scheme for input and output which has been designed around punched cards may be incorporated at a later date.

Speed of operation. The basic rhythm of the machine is determined by the length of the 20-digit instruction, and not by the length of the 40-digit number. This increases the speed of operation of the machine, as compared with that of the experimental machine, by a factor between 1·8 and 2. If the improvements to the *B* tube, multiplier and other parts of the machine are also included, the overall increase in speed is probably not less than a factor of 3.

It should be noted that this increase has been obtained largely by reorganization, and not by the more difficult and expensive method of increasing the fundamental digit frequency.

Programme of work. It is not proposed to limit the programme of work on the machine to any particular type of problem, but to cover a range of problems chosen for their diversity. Thus, in the immediate future the following items are among those which will be investigated: (1) partial differential equations arising out of biological calculations; (2) simultaneous linear differential equations and matrix algebra, and their application to the cotton and aircraft industries, and electricity distribution; (3) tabulation of Laguerre functions; (4) design of optical systems; (5) Fourier synthesis for X-ray crystallography; (6) design of plate fractionating towers; (7) chess problems.

One aspect of the design of machines is to decrease the number of thermionic valves they contain. Thus, for example, it may be said that in the present machine the multiplication time is too nearly equal to the addition time, and that the size of the machine could be decreased by using a simpler multiplier, say, four times as slow in operation. However, with the present input speed of 1 character every 5 msec., it would then be impracticable to programme the input. One method of overcoming this would be to build circuits to organize the input data; not only would this reduce the flexibility of the programming method of input, but it would also nullify the original intention, which was to reduce the size of the machine. This argument can be extended to include other aspects of design such as the relative merits of serial and parallel machines, various forms of storage and so on. It can be seen that all aspects of machine design are related in a most intricate way, and because of this, the design of present machines has to be based to a great extent on the personal experience and intuitions of the individual designer. Consequently, one further important problem which the machine itself may solve is that when fed with input data describing the reliability of circuits, valves and other components, the speeds of operation of the various possible parts, and all other relative factors, it will give a more correct answer to the problem which still confronts engineers, namely, the design specification of the optimum universal computing machine.

The work described in this article is part of an investigation carried out jointly with Prof. F. C. Williams, in the Electrical Engineering Laboratory of the University of Manchester. I wish to acknowledge the assistance of Mr. G. C. Tootill and the members of the Computing Machine Laboratory and of the members of staff of Messrs. Ferranti, Ltd., who collaborated in the development, and who constructed the machine.

[1] Kilburn, T., *Nature*, 164, 684 (1949).

[2] Williams, F. C., and Kilburn, T., *J. Inst. Elec. Eng.*, 96, Pt. III, No. 80 (1949).

[3] Williams, F. C., and West, J. C., *J. Inst. Elec. Eng.*, 98, Part II, No. 61 (1951).

[4] Williams, F. C., Kilburn, T., and Thomas, G. E., *J. Inst. Elec. Eng.* (in preparation).

NATURE AND INFECTIVITY OF GRANULAR FORMS OF THE BOVINE TUBERCLE BACILLUS

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THE part played by the 'granular' forms of the tubercle bacillus in the infective process and their place in the life-history of the mycobacterium are still matters of controversy. At present there is a tendency to regard them merely as by-products, seen in old cultures, or as atypical forms produced under unfavourable growth conditions. The question whether the granules are a kind of microspore[1,2] liberated from the mature bacillus, or whether they are merely short rudimentary rods[3,4], has yet to be decided.

The granular forms first described by Much[5] and known as 'Much's granules' have a more definite character. In staining characteristics they are non-acid-fast but Gram-positive. They are said to predominate in tuberculous lesions in which acid-fast bacilli are difficult to find. For a long time Much's granules were regarded as an alternative form of the tubercle bacillus. To-day one is more inclined to regard them as some kind of degenerate form.

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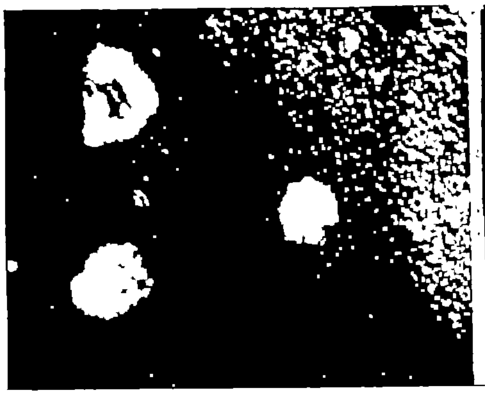

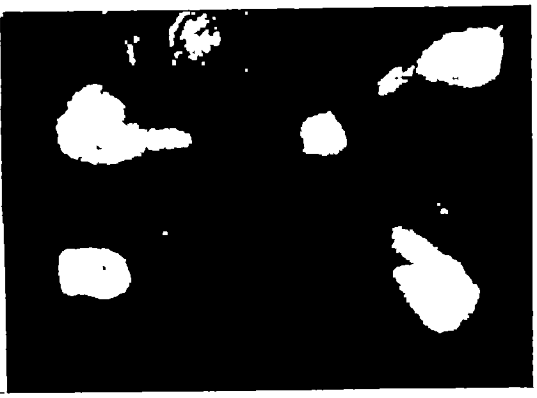

Fig. 1. Granules of 0·5–1·0 μ in size, contained in extracts of high infectivity from rabbits inoculated with *Myc. tub.* (*bovis*). Shadowed with gold-palladium; negative print. Original magnification, 18,000 × ; reproduction, 18,000 ×

Fig. 2. Granules of similar origin and size, but with a projecting rodlet. Preparation and magnification as for Fig. 1

The electron microscope would be expected to reveal the presence and structure of submicroscopic forms, and yet in the few publications on this subject the presence of free extra-cellular granular elements has been seldom mentioned. Intra-cellular granular bodies were described in avian tubercle bacilli by Lembke, Ruska and Christopherson[6], and von Borries[7] interpreted similar structures as Much's granules on rather scant evidence. Brieger and Cosslett[8] found with an avian strain that the dense bodies seen inside the cytoplasm undergo characteristic changes in the first three days of incubation, but there was no definite evidence that free granules occur or that bacilli can develop from free granules. Experiments which are now in progress, employing the technique of differential centrifugation directly on to grids, may throw more light on this intricate problem.

Experiments to demonstrate the presence of granular elements in extracts of infected tissues have been more successful. In recent work by Brieger, Fell and Smith[9], it was shown that tissues removed from rabbits at various intervals after infection with a bovine strain contained only very few acid-fast bacilli, although showing extensive histological changes. If, however, explants of these tissues were cultivated *in vitro* (as tissue cultures), large numbers of bacilli appeared inside healthy-looking macrophages. After about ten days of cultivation *in vitro*, the whole explant became a conglomeration of bacillary colonies. These results showed the need for re-examining the question whether the macrophages, later to become the hosts of large numbers of bacilli, are not, in fact, heavily infected with pre-bacillary elements, which are not demonstrable by present staining techniques.

Fulton and Begg[10] have shown that extracts from tissues infected with rickettsia can be so purified that an opalescent fluid is obtained, after differential centrifugation, which is an almost pure suspension of the organism. Using the same method, Cosslett, Miles and Stoker[11] purified Nigg's virus from infected lungs and spleen of mice. We have now applied the Fulton and Begg technique to the spleens and lungs removed from rabbits seven to twenty-one days after intravenous infection with a virulent bovine strain. Acid-fast bacilli were no longer demonstrable in the fluid obtained after purification and differential centrifugation. In none of the six experiments performed did the electron microscope, phase-contrast microscope or staining methods reveal elements which could be identified as bacillary rods. In itself this would not be sufficient proof that all bacillary elements were eliminated in the process. However, we were also unable to reproduce bacilli by culturing the fluids on a wide variety of media, in spite of long periods of incubation. Microcultures on coverslips did not show any sign of bacillary growth, except in one experiment in which a new and very virulent bovine strain was used. In this case a few acid-fast elements were seen in stained preparations after prolonged incubation.

In spite of the failure to demonstrate acid-fast bacilli, inoculation of a small amount of the fluid (0·2 ml. of a 1 : 5 dilution) into the subcutaneous tissue of the legs of guinea pigs produced a glandular abscess in the draining glands in the course of four to six weeks. Large numbers of acid-fast bacilli were present in the pus, the spleen was heavily infected and a generalized tuberculous infection was present.

The highly infective fluid extracted from the rabbit organs was fixed in osmic acid and samples were placed on metal grids and examined in the electron microscope. Two types of particles were seen: (*a*) particles of about 0·5 μ size or larger; (*b*) small round particles of about 0·2 μ diameter. The larger bodies were obviously related to bacterial elements.

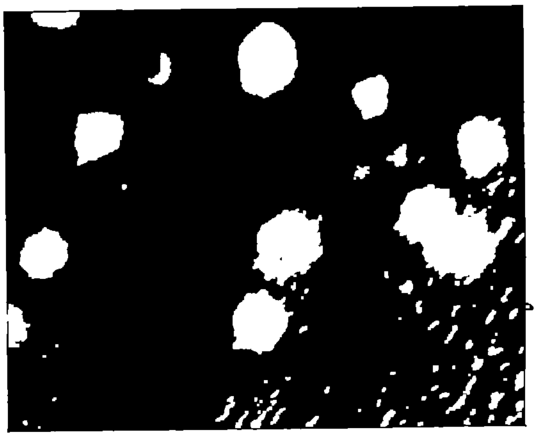

Fig. 3. Granules of 0·1–0·25 μ in size, obtained and prepared as those in Figs. 1 and 2. Original magnification 36,000 × ; reproduction, 41,000 ×

Some had a structure which suggested a set of tightly-packed microrods (Fig. 1). Others had finger-like protrusions and seemed to represent an intermediate stage between granular and bacterial forms (Fig. 2). While the larger particles showed these structures, which distinguished them from contaminants or tissue remnants, the smaller ones (Fig. 3) resembled the smaller animal viruses in size and structure. They were not found in controls prepared from healthy tissues; but it cannot be excluded that they may be normal constituents which are released from cells in pathological conditions.

The fluid was filtered through 0·725 μ A.P.D. 'Gradocol' membranes (which retained *Bac. prodigiosus*) and then did not produce definite tuberculous lesions in guinea pigs. The results of transplanting the glands into normal animals are not yet available[12].

At the present stage, the interpretation of the results must be made with some reserve. Although the presence of normal acid-fast bacilli could only be finally excluded by dilution tests, we may tentatively infer that infection can be caused by particles which are too large to pass the filter but which are not normal rods. These particles may well be identical with Much's granules; our observations show them to have some internal structure. On the other hand, it may be that the smaller particles passed by the filter are essential stages in infection but are unable to produce infection by themselves. In order to build up into the larger, infectious particles, they may require the presence of the living host cell. If this is so, their isolation would break the normal cycle of development in the tissues of the living host.

The fact that the living host cell is necessary for the reproduction and survival of even the larger particles is suggested by the difficulty of culturing them. In one case, when the fluid was injected into a normal rabbit spleen which was afterwards cultured *in vitro*, massive growth occurred, after two weeks incubation, in the juice surrounding the tissue culture. In no case has it been possible so far to grow colonies from the filtrates containing the particles, using the conventional bacteriological media. For this reason, as well as on morphological grounds, the granular particles cannot be regarded as a variant bacterial form, as normally understood. It may well be that they result from the breakdown of the inoculated bacteria in the first stages of infection. They may develop directly into the new generation of bacillary rods which appear at a later stage, or the larger granules may be an intermediate form in such a development, a possibility put forward by Much in his last contribution to the subject[5]. Some of the many problems raised by these observations are now being investigated.

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WILLIAM NICOL AND HENRY CLIFTON SORBY: TWO CENTENARIES

By JOAN M. EYLES

AMONG the various sources of information available to the geologist, rock sections, cut so thinly that they can be examined under the microscope by transmitted light, are particularly valuable. The year 1951 marks two centenaries of especial interest in the early history of this technique.

William Nicol, who died in 1851, was not only the inventor of the well-known Nicol prism, which later became an essential tool in examining rock sections by polarized light, but he was also a pioneer in the making of thin sections. Nicol seems to have confined himself to making sections of fossil wood, and did not make rock sections. H. C. Sorby was the first to do this, and it was in 1851 also that his first paper in which such sections were described was published in the *Journal of the Geological Society*. This paper bore the title "On the Microscopical Structure of the Calcareous Grit of the Yorkshire Coast", and, though epoch-making in retrospect, seems to have attracted very little attention at the time.

William Nicol, who was a teacher of physics in Edinburgh during the early part of the nineteenth century, described the construction of his polarizing prism in 1829[1]. Two years later, in 1831, Henry Witham published his "Observations on Fossil Vegetables", in which are given the earliest illustrations of fossil wood seen in thin section under the microscope. In this work Witham gave credit to Nicol for the method of preparing these sections. While the actual technique of cutting the material was no more than that developed by the lapidaries in cutting precious stones and agates, etc., Nicol seems to deserve the credit for realizing it would be of scientific interest if applied to fossil wood. Further than that Nicol apparently did not go, although it seems only a short step from sections of fossil wood to sections of rocks in general. Nicol left his own collection of sections in his will to his friend Alexander Bryson, of Edinburgh, who was himself skilled in making sections, and added to the collection. Nicol's name does not appear in the "Dictionary of National Biography", but there is a memorial tablet in Warriston Cemetery, Edinburgh, which bears the inscription: "In Memory of William Nicol—1768–1851—Inventor of the Polarizing Prism everywhere known by his name".

Turning now to Sorby, he himself, in a lecture entitled "Fifty Years of Scientific Research"[2], said he learnt the art of making thin sections from W. C. Williamson, then a surgeon in Manchester, but later to become first professor of natural history at Owens College and a well-known palæobotanist. Williamson was the grandson of a lapidiary, and as a youth was familiar with the lapidiary's art; and as he was working on fossil teeth and other siliceous material during the eighteen-forties, there seems no reason to doubt Sorby's statement. Sorby said also that the idea of applying the technique to study the structure of rocks came to him in 1849, and he immediately set about preparing such sections; this led to the paper sent to the Geological Society and published in 1851. In spite of this, it has several times been stated by well-known writers, such as Sir Archibald

Geikie, that Sorby got the idea of making rock sections from examining Nicol's collection in Edinburgh in 1856, when it was in the possession of Bryson. The facts, as stated above, were given by J. W. Judd in various obituary notices, but seem to have been disregarded, or even contradicted. The misconception may have arisen because Sorby, in 1857, presented to the Geological Society an important paper on the microscopic structure of rock-forming minerals, and in it referred to Bryson's collection; but if this is the reason, then it shows how little attention Sorby's earlier paper had attracted.

It is therefore worth recalling that Sorby, in his 1851 paper, had employed methods which are now familiar to every petrographer. His sections, mounted in Canada balsam, were "not much thicker than one-thousandth of an inch". He used polarized light, and rotated his specimens between crossed nicols to distinguish between calcite and quartz. In addition to examining thin sections, Sorby separated the constituents of the calcareous grit by chemical and mechanical means. He did not describe in this paper his manner of preparing the sections, but later gave a very clear account in a lecture to the Geological Society of France, in 1860[3]. This latter account was also published in Germany and Spain. Two years after this lecture had been given, Sorby met Ferdinand Zirkel, and described to him his petrographic methods. This encounter was to have far-reaching consequences, for Zirkel took up this type of work with enthusiasm, and in the following year read to the Vienna Academy a memoir describing the microscopical features of thirty-nine different rocks. Subsequent work by Zirkel, Rosenbusch, Fouqué and Michel-Lévy established microscopic petrography as an important branch of geological science, although in the land of its birth it made slower progress than abroad.

In this centenary year of the first account of rock sections, it would therefore be of especial interest if attention were directed to the anniversary by the exhibition in museums of any suitable material. Sorby was so frequently a contributor to the meetings of the British Association that such an exhibit would be particularly appropriate at this year's Edinburgh meeting, where the names of Nicol and Sorby could be fittingly coupled.

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OBITUARIES

Mr. H. A. Humphrey

MR. HERBERT ALFRED HUMPHREY, who died at the age of eighty-two in South Africa on March 9 of this year, was one of the most versatile British engineers of recent times. He was best known as inventor in 1908 of the Humphrey pump, which is an internal combustion engine in which the piston is replaced by a water surface. It became an effective means of pumping large volumes of water; the Chingford Station of the Metropolitan Water Board has a set of four large and one smaller Humphrey pumps of 180 million gallons a day total capacity. During the course of his consulting work as a civil, mechanical and chemical engineer, Humphrey had opportunity for exercising his inventive talents in many directions, particularly in the field of gas engines and producers; but not only in a professional capacity, for he would also amuse himself at home in his well-equipped workshop with many devices arising from his fertile imagination.

Humphrey was a distinguished Old Centralian, having been trained as an engineer at the Finsbury Technical College and during 1885–87 at the Central Institution, South Kensington (now the City and Guilds College). There he came under the influence of Unwin, Ayrton, Armstrong and Henrici. He entered in 1887 the works of Messrs. Heenan and Froude as assistant to R. H. Heenan, later becoming manager. In 1890 he was appointed engineer and departmental manager in the Winnington works of Messrs. Brunner Mond and Co., where his ability was soon appreciated by Dr. Ludwig Mond. Until 1901 he remained at Winnington, but thereafter acted with Mond's encouragement as an independent consulting engineer. On account of his work on gas engines and the well-known pump, he soon established a reputation extending to many other countries. He was, however, chiefly concerned with the chemical engineering developments in Brunner Mond's and its associated companies, and later in Imperial Chemical Industries, Ltd., into which these companies were merged. Among other developments he was responsible for erection of coke ovens, benzol extraction plant, caustic soda works, application of gas engines to power generation, and, during the First World War, T.N.T. and ammonium nitrate plants. After that War, he was consultant in the construction of the Billingham plant for synthetic ammonia, for the designs of which he was largely responsible. It was a project on the grand scale, involving a capital expenditure of £25 millions. The boiler and power plant at Billingham, completed in 1929, was well forward of central power station design in Great Britain at that time. He retained a close consulting connexion with Imperial Chemical Industries until late in life. He was also chairman of the South Staffordshire Mond Gas Co., the plant of which he designed.

It was only about two years ago that Humphrey left England to reside at Hermanus, Cape Province, and even there at the age of eighty he was still exercised in several engineering schemes.

The First World War found Great Britain very ill prepared in the supply of explosives, and Lord Moulton, who was chairman of the Explosives Committee, early realized that a great expansion of chemical manufacturing capacity was required. Humphrey was one of the very few engineers available who had the necessary experience in chemical engineering, and through Brunner Mond's he was brought into the organization that Lord Moulton set up. He was responsible for many of the developments which saved Britain from disaster and helped to give an impetus to British chemical industry, which has ever since thrived and expanded. K. B. Quinan was leader of the Explosives Department's constructional programme; he, however, was an American subject, a chemical engineer who came from South Africa. To such men Britain owes a deep debt of gratitude. Humphrey described in the Melchett Lecture to the Institute of Fuel the activities with which he was connected in those days.

Humphrey's influence in training men as chemical engineers within the I.C.I. organization, and insisting on a fundamental approach to the engineering problems encountered, had a great effect on the efficiency of the whole industry. The benefit of his wide experience was generously given to those working with him, and he endeared himself to them.

Humphrey received a number of awards from the engineering institutions, the Willans (1906), the Watt (1913), and the Telford (1897) Gold Medals, the Franklin Medal of the Franklin Institute and the Paris Premium of the Institution of Electrical Engineers (1930). He had three sons and two daughters; one son married a daughter, and one daughter married a son, of Prof. A. V. Hill. He was a member of all three engineering institutions, Civil, Mechanical and Electrical; a Fellow and Melchett Medallist (1939) of the Institute of Fuel, and an honorary fellow of the Imperial College. A. C. Egerton

Dr. D. F. Twiss

By the death on May 23 of Dr. D. F. Twiss, the rubber industry has lost a distinguished pioneer scientific worker and a man universally esteemed by his colleagues in the industry. Born in Birmingham in 1883, Douglas Frank Twiss studied at Mason College and its successor, the University of Birmingham, where he graduated B.Sc. in 1902, afterwards carrying out research in organic chemistry under Prof. P. F. Frankland. During 1904–14 he was lecturer in chemistry at Birmingham Technical School (now Birmingham Central Technical College), and continued research work on organic sulphides and other sulphur compounds and selenides. Dr. Twiss became, indeed, a leading authority on the sulphur group of elements, and was joint author of vol. 7 (oxygen, sulphur, selenium, tellurium) of the well-known "Text Book of Inorganic Chemistry" edited by J. Newton Friend. He was awarded research degrees by the Universities of Birmingham (D.Sc.), and London (B.Sc.).

This early interest in sulphur and its organic compounds was a fitting preparation for Dr. Twiss's real life-work, which lay in the field of rubber chemistry, including vulcanization by sulphur. The opportunity to enter this field came in 1914 when Dr. Twiss was engaged by the Dunlop Rubber Co., Ltd., as its first scientific worker. During his thirty-two years as chief chemist there grew up under his leadership a research team that has made outstanding contributions to rubber science and manufacturing techniques.

Dr. Twiss's earlier work on rubber was concerned with vulcanization by sulphur, the action of organic accelerators of vulcanization, and the important influence of zinc oxide and other metallic oxides on their activity. Of even greater importance to the development of the industry, however, has been the work pioneered by Dr. Twiss on the production of rubber articles directly from the liquid latex, without the usual intermediate stage of coagulating to produce dry rubber which then has to be worked ('masticated') on heavy machinery to render it fit for further processing. From the work of Twiss and his colleagues on latex has developed an entirely new and important branch of the rubber industry, producing vast quantities of cellular (foamed latex) rubber for upholstery, as well as rubber gloves, thread, and hosts of other articles, using methods which in essence are of elegant simplicity, though demanding a rigid physico-chemical control over that complex and sensitive material, rubber latex.

In the midst of these activities Dr. Twiss yet found time to be a willing helper and wise counsellor to many organizations connected with the rubber industry, notably the Institution of the Rubber Industry and the Research Association of British Rubber Manufacturers. There are many who will remember with gratitude and admiration the unfailing help which Dr. Twiss's intensely logical mind was able to give on innumerable problems. Through his work for these organizations, Dr. Twiss did much to foster both technical education and co-operative research in the rubber industry. In recognition of his outstanding services, the Institution of the Rubber Industry in 1934 conferred on Dr. Twiss the Colwyn Gold Medal.

For a man of such attainments and influence, Dr. Twiss was modest and retiring to a degree, but his sincerity of purpose and his conscientious and painstaking discharge of any duty that he undertook—and these duties were many and varied—marked him out as a man above his fellows. His memory will always be an inspiration to those who had the privilege of knowing him. J. R. Scott

Prof. E. L. Watkin

The death of Ernest Lucas Watkin, emeritus professor of mathematics in University College, Southampton, has severed one of the few remaining links with the difficult time when the College was struggling not only to deserve the name of University College, but even to keep in existence.

Prof. Watkin took his degree from St. John's College, Cambridge, being seventh wrangler in the Mathematical Tripos of 1898, still remembered as 'Hudson's Year' for the galaxy of distinguished mathematicians who took the Tripos then. After a short time as lecturer in the University of Bristol, he was appointed in 1904 to the chair of mathematics at Southampton, which he held until 1930. Only those closely associated with him realized the burden of organization involved in a department in which many additional courses were necessary if the College were to survive, including heavy and increasing commitments to the technical side which is still part of the work of the College. He had great administrative ability, and though handicapped by persistent ill-health, carried out unflinchingly work which in these days would be shared by at least two people. His entire disregard of self brought him enthusiastic loyalty from his Department.

After retiring from the chair, he continued to act as deputy registrar and curator of the grounds of the College until increasing age and ill-health forced his permanent retirement.

Prof. Watkin's interests were unusually wide and all were useful to college life. He was an admirable gardener with a good knowledge of systematic botany which he was able to apply as curator of the grounds. He was president of the Chess Club, a strong supporter of all musical activities, an authority on the regulations of most varied and mixed bodies with examination and entrance requirements, and a repository of information on the past history of the College. He combined with all these a gift for friendship, a patient and understanding care for the difficulties of people who often proved tiresome and captious, and a loyalty to his chosen work which is past all praise. A. M. Trout

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We regret to announce the death of Prof. W. E. Agar, C.B.E., F.R.S., emeritus professor of zoology in the University of Melbourne, on July 14, aged sixty-nine.

NEWS and VIEWS

Expedition to Greenland

A Royal Air Force Coastal Command flying boat, which is visiting Greenland in the course of routine flying training, is taking a small party to carry out a preliminary survey for a more ambitious expedition planned for next year, when geological, glaciological, meteorological and biological work will be carried out. The present expedition, which is privately sponsored and has the approval of the learned societies, including the Royal Society, the Polar Institute and the Royal Geographical Society, will spend a month to six weeks in Greenland. The party is led by Commander (L) C. J. W. Simpson, and will include Capt. M. E. B. Banks, Lieut. F. R. Brooke and Lieut. Angus Erskine. While surveys of the mountainous coastal ranges of Greenland have been nearly completed, little is known of the interior. It is, however, known that in the region called Queen Louise Land in lat. 77° N. there is a range of nunataks 100 miles long, 40 miles wide and rising to about 7,000 ft. To reach this range entails crossing a 20-mile wide glacier. This year's party intends to land on a long lake near the coast and to make its way by a rubber boat to the glacier. With the aid of a Greenland trapper and dog sledges, it expects to cross the glacier and survey a second lake about three miles long that lies along the eastern edge of Queen Louise Land. It is hoped to find on this lake a site for a base camp for further exploration next year, and to discover whether this lake would offer suitable landing for float planes which may be used by the main expedition. It is also intended to bring back geological specimens and to reconnoitre a suitable sledging route through the mountains to the inland ice lying beyond to the westward.

Major Visible Antiquities in Great Britain before 1066

The Archæology Branch of the Ordnance Survey is to be warmly commended for producing a map of the principal visible ancient sites and monuments in Great Britain, of origin before A.D. 1066, which is designed not for the archæologist but rather for the tourist and all those interested in ancient history. The scale is 1/625,000 (or about ten miles to the inch), and this allows the map to be printed on two sheets, one for England south of the line running approximately from Scarborough to Windermere (and including the Isle of Man) and the other for the rest of England and Scotland (including the Scottish islands) (obtainable from the Ordnance Survey, Chessington, Surrey; 6*s.* 9*d.* each sheet). The map is in faded grey with the sites superimposed in black type, these being classified and marked with a distinguishing symbol according to the age group: Palæolithic, Mesolithic, Neolithic, Bronze, Iron, Roman, Dark Ages and uncertain; in addition, Roman roads and canals, and earthworks and frontier defences are shown. It must be stressed that in all cases the emphasis is on the visibility of the site or monument in question; thus, the only sections of Roman roads which are shown are those which are well preserved and recognizable as such and have not been merged into the modern road system. One or two exceptions to the rule of visibility have been made in the case of those sites which, though worked on and filled in, are exceptionally well known for the value to scholarship of the material they have yielded. As is pointed out in the preface to the sheets, the long forms of cairn and barrow have for the most part been allocated to the Neolithic period, and in the same way the round forms to the Bronze, a classification which is to some extent a convention but nevertheless a convenient one. The age group, 'Dark Ages', covers the period from the end of the Roman occupation up to 1066 and is necessarily a 'mixed bag'. Finally, a small number of museums of special interest have been marked, the most important of which is the Pitt Rivers Museum at Farnham. Both sheets contain an index of names for the whole map, and with each name is a brief description (one to a dozen words), age-group, Ordnance Survey sheet reference to the one-inch series of maps, and the National Grid reference point.

Israel National Committee for Theoretical and Applied Mechanics

An Israel National Committee for Theoretical and Applied Mechanics has recently been formed, with Prof. M. Reiner and E. Traum (both of the Hebrew Institute of Technology) as chairman and honorary secretary-treasurer, respectively. An application for admittance as an adhering body has been submitted to the International Union of Theoretical and Applied Mechanics; Prof. S. Goldstein, previously of the University of Manchester and now vice-president of the Hebrew Institute of Technology, Haifa, is a personal member of the general assembly of the International Union. The Committee held a scientific colloquium in Haifa at the Hebrew Institute of Technology during April 23–24. There were two general lectures: Prof. Goldstein gave a review of the present state of the statistical theory of turbulence, and Prof. F. Ollendorf (Hebrew Institute of Technology) dealt with the mechanics of the trajectories of the electrons in electron-lens cathode-ray tubes. The other papers dealt with two main subjects, namely, questions of capillarity and of elastic semi-liquids In the first group M. Ram (Ministry of Agriculture) considered the influence of a capillary film in the soil upon building foundations, while N. Klein (Rheological Laboratory of the Hebrew Institute of Technology) discussed the oil distribution in paper under the influence of gravity. In the second group, papers were given as follows: Dr. A. Katchalsky (Weizmann Institute of Science) presented the modern theory of cross-linked polymer gels; Dr. E. Alexander (Hebrew University) reported upon experiments with a modification of the Gardner mobilometer by means of which the time of thixotropic regeneration can be determined; Prof. Reiner showed how a contravariant measure of strain parallel with the usual covariant measure could account for the centripetal-pump effect in elastic liquids; and Miss I. Braun (Rheological Laboratory of the Hebrew Institute of Technology) demonstrated the effect in rubber toluene solutions.

Radiotherapy and Cancer

The work of the Medical Research Council's radiotherapeutic research unit on the experimental comparison between the effects of gamma-rays and X-rays is recorded in "Researches on the Radiotherapy of Oral Cancer" by Constance A. P. Wood and J. W. Boag (Medical Research Council Special Report Series, No. 267; pp. 148+30 plates; London: H.M. Stationery Office, 1950; 12*s.* 6*d.* net). By means of the disk contour-finder, described fully in this report and illustrated by means of photographs and drawings by P. Howard-Flanders, it is now possible to estimate the dose given and also its distribution in two planes. The histological work on the response of malignant tumours to irradiation, carried out at the Strangeways Research Laboratory, Cambridge, by Dr. F. G. Spear and Dr. A. Glücksmann, is described by these authors in Part 2 of the report and illustrated with photomicrographs. Important conclusions of the report are that the wavelength of the radiation *per se* had no significant effect on the clinical results, that there was no evidence that cancer of the primary site yielded more readily to radiation than did cancer of the glands, and that increase in the proportion of differentiating cells distinguishes epitheliomata responding favourably to radiation from those that failed to respond. The section of the report dealing with the future of research in radiotherapy contains valuable observations on the comparative value of radium beam therapy, high-voltage X-ray therapy and therapy with electron and neutron beams. To this section, Dr. L. H. Gray contributes a valuable article on the use of radioactive isotopes.

Termites and Building in the Tropics

AMONG the recommendations of the Commonwealth Entomological Conference in 1948 was that a simple manual should be prepared, designed for the practical builder and dealing with the protection of buildings and building material from termites. The Building Research Station and the Forest Products Research Laboratory, both of the Department of Scientific and Industrial Research, were asked to undertake the preparation of such a manual, and as a result "The Protection of Buildings and Timber against Termites" has now been published (Forest Products Research Bulletin No. 24; pp. 41+9 plates; H.M. Stationery Office, 1950; 1*s*. 9*d*. net). It is written by W. D. MacGregor, formerly conservator of forests, Nigeria and Sierra Leone, in collaboration with R. C. Fisher, officer in charge of the Entomology Section of the Forest Products Research Laboratory, and should prove of great value to all architects and builders who are concerned in the erection of buildings in countries subject to termite attack. A simple account of the biology and ecological classification of termites is followed by detailed instructions on prevention and control. The greatest emphasis is placed on preventive methods: the use of resistant timbers (indigenous timbers reputed to be resistant to termite attack are listed in an appendix), the impregnation of non-resistant timbers with preservatives, methods of building construction, termite barriers and the like, which will prevent access by termites, and notes on the maintenance of such protective structures. The economic losses sustained from the attacks of termites are enormous; the widespread adoption of the methods set out in this manual should go far towards preventing that serious wastage.

Aids to Science Teaching

ON behalf of Unesco the Ministry of Education has issued another volume in the series "Inventories of Apparatus and Material for Teaching Science". The series has been designed particularly to aid educationists in war-damaged and under-developed countries and takes the form of reference manuals from which the essential equipment necessary to teach science at the various levels may be selected. The lists are based on material not in use in the more highly developed countries. Each manual gives details of the modern curriculum to which the equipment it lists is related. Teachers are therefore given guidance about the kind of course they could undertake and also what equipment would be needed for administrative and experimental purposes. The first volume dealt with the teaching of science in primary, secondary and vocational schools, and the present one with the universities. It covers the subjects of botany, chemistry, geology, physics and zoology and also includes appendixes concerned with common abbreviations and conversion factors used in science, as well as a short list of suppliers of scientific instruments. Copies of the Inventory may be obtained from H.M. Stationery Office, price 12*s*. 3*d*.

British Hat and Allied Felt Makers Research Association: Annual Report

THE third annual report of the director of research of the British Hat and Allied Felt Makers Research Association, covering the year ended August 1950 (pp. 16; Manchester, 1951), records some progress in research, but at the same time directs attention to the fact that comparatively few firms seem to make regular use of the services the Association can offer in dealing with their day-to-day problems or in the provision of technical and scientific information. The fundamental research programme has continued largely on the same lines as in previous years. The particular groups of the keratin molecule which take part in the carrotting of fur have now been determined with some certainty, and evidence has been obtained on the mode of action between fur and mercuric nitrate/nitric acid carrotting solutions. From extensive measurements of the elastic and other properties of wool and fur felt, a scheme of quality assessment has been drawn up which not only gives a quantitative measure of the material properties but also provides a fibre factor which defines the condition of the individual fibres. This fibre factor can indicate differences in original raw materials or degradation or damage in processing. A study of the felting property of wool noils showed that, for any particular type and treatment of wool, there is a maximum degree of felting and that further treatment of the wool only results in a change in shape. On the technological side, methods of addition and the amounts of acid used in processing fur hoods have been reviewed, the damage to animal fibres in dyeing and other processes examined, and a survey of felting machinery begun.

St. Andrews University Chemical Society

THE *Journal* of the St. Andrews University Chemical Society for April 1951 (1, No. 5) contains a number of interesting short papers and provides abundant evidence that the Society is in a flourishing state. D. M. Dunlop describes an Arabic manuscript on alchemy in the University Library, Prof. John Read lectures on historical chemistry as an instrument of culture, Prof. R. D. Haworth on cycloheptane derivatives, and Prof. D. H. Hey on aromatic substitution. Other papers deal with various aspects of chemistry by experts in the fields concerned. The officers of the Society have been fortunate in having available a gift of paper, and they have made good use of it in producing a very attractive record of the lectures given to the Society.

Maritime Meteorology: Conference in Genoa

THE Geophysical Institute of the University of Genoa is organizing a meeting on maritime meteorology, to be held in Genoa during September 20–22, at the same time as the Columbus Celebrations. The meeting will be concerned with the main meteorological problems relating to navigation, with particular reference to the Mediterranean, and the principal themes will be: the vertical distribution of humidity in the air over the sea and over coastlines; the genesis of fogs and visibility at sea; winds at sea and over the coast and their influence on wave motion; and other relationships between the physics of the atmosphere and the physics of the sea. All meteorologists and oceanographers are invited to participate. Further details can be obtained from the Istituto Geofisico e Geodetico dell' Università, via Balbi 5, Genoa.

University of Sheffield: Appointments

The following appointments in the University of Sheffield have been announced: Dr. R. Wheeler Haines, to be senior lecturer in anatomy; G. C. Briggs and W. Johnson, to be lecturers in mechanical engineering; Dr. R. P. N. Jones and M. L. Meyer, to be lecturers in the Postgraduate School of Applied Mechanics.

University of Aberdeen

At a graduation ceremony held in the University of Aberdeen on July 12, the degree of Ph.D. was conferred on the following for the theses mentioned W. C. Bain ("The Propagation of Radio Waves of Very Low Frequency"); Miss M. I. Chalmers ("Protein Digestion and Metabolism in relation to Level of Nutrition"); T. L. Dodsworth ("An Investigation into the Feeding of Beef Cattle with particular reference to the Substitution of Grass Silage for Root Crops"); Miss G. M. Ellinger ("Studies of Factors affecting Bone Development in Rats and Chicks"); K. El Shazly ("Some Studies on Protein Metabolism in the Rumen"); O. C. Farquhar ("The Geology of the Arnage District: A Study of Polymetamorphism"); E. A. Fitzpatrick ("A Study of the Effect of the Nature of the Parent Material on the Development of the Soil Profile with Special Reference to an Area in North-East Scotland"); D. A. Jones ("The Production and Properties of Artificial Crystals"); J. D. Lawson ("Scale Models in Hydraulic Engineering"); F. H. C. Marriott ("The Analysis and Interpretation of Multiple Measurements"); P. A. Orkin ("Studies on Breathing and the Aspiratory Heart of Elasmobranchs"); W. Paul ("The Inter-action of Radiation and Matter"); E. A. D. White ("The Hydrothermal Crystallization of Lithium Aluminosilicates").

Institution of Electrical Engineers: Awards

The Council of the Institution of Electrical Engineers has made the following award of premiums for papers read or accepted for publication during the session 1950–51. Group A: *Kelvin Premium:* B. Adkins; *John Hopkinson Premium:* R. J. Clayton, Dr. D. C. Espley, G. W. S. Griffith and J. M. C. Pinkham. Group B, Non-Section Premiums: *Llewellyn B. Atkinson Premium:* J. H. Mason; *Extra Premium:* H. F. Church; Measurements Section Premiums: *Silvanus Thompson Premium:* Dr. A. H. M. Arnold; *Mather Premium:* J. G. Yates, D. H. Lucas and D. L. Johnston; *Extra Premiums:* E. H. Cooke-Yarborough and E. W. Pulsford; H. H. Rosenbrock and J. R. Tagg; Dr. D. Taylor, J. Sharpe and W. Abson; Humphry M. Smith; J. R. Boundy and S. A. Bergen; O. I. Butler; Radio Section Premiums: *Duddell Premium:* P. A. T. Bevan and H. Page; *Ambrose Fleming Premium:* Dr. J. A. Saxton, G. W. Luscombe and G. H. Bazzard *Extra Premiums:* E. A. Nind and E. McP. Leyton Caradoc Williams; Dr. L. Essen; W. S. Melville R. W. Douglas and Dr. E. G. James; H. B. Rantzen, F. A. Peachey and C. Gunn-Russell; D. G. Kiely, Instr. Lieut. A. E. Collins and G. S. Evans; Dr. A. W. Lines, G. R. Nicoll and Mrs. A. M. Woodward; Supply Section Premiums: *Sebastian de Ferranti Premium:* H. Leyburn and C. H. W. Lackey; *John Snell Premium:* T. F. Monahan; *Extra Premium:* A. C. H. Frost and W. Brittlebank; Utilization Section Premiums: *Crompton Premium:* M. J. J. Cronin; *Swan Premium:* W. D. Chesterman, D. R. Glegg, G. T. Peck and A. J. Meadowcroft; *Extra Premium:* T. H. Petch. Group C: *Heaviside Premium:* Dr. G. G. Macfarlane and Mrs. A. M. Woodward; *Paris Exhibition* (1881) *Premium:* D. B. Hogg; *Oversea Premium for Students and Graduates:* G. W. Donaldson; *Students' Premiums:* C. R. Bates; R. W. Gee; K. F. Tee; J. C. Shaw; P. D. Aylett; B. Berger, D. Bolton; E. J. R. Hardy; I. J. Shelley; D. S. Williams.

Announcements

The Alvarenga Prize for 1951 of the College of Physicians of Philadelphia has been awarded to Dr. George W. Thorn, Hersey professor of the theory and practice of physic, Harvard University Medical School, for his outstanding contributions to our knowledge of the role of the adrenal cortex in health and disease.

Scientific Report Series No. 13, "The Structure and Configuration of Sucrose", published by Sugar Research Foundation, Inc., New York (pp. 40; June 1950; free), contains an interesting historical review of the subject, with full references to literature. The text is by Dr. I. Levi and Prof. C. B. Purves.

British Standards Specifications Nos. 628–32 and 650–56 (1950) on vegetable oils, and 684 (1950) on methods of analysis of oils and fats, give the specifications of several vegetable oils, and standard methods of analysis of these, respectively. The first costs 6*s*. net and the other two 7*s*. 6*d*. net, in each case postage paid, obtainable from the British Standards Institution, Sales Department, 24 Victoria Street, London, S.W.1.

A symposium entitled "Chemical Shortages and the Efficient Use of Processing Solutions" has been arranged by the Scientific and Technical Group of the Royal Photographic Society, in collaboration with the British Kinematograph Society, and will be held on October 3 at Film House, Wardour Street, W.1, starting at 7.15 p.m. Particulars can be obtained from the honorary secretary of the Group (Mr. D. H. O. John, c/o May and Baker, Ltd., Dagenham, Essex).

No. 9 of the Reader's Guides, New Series, published by the County Libraries Section of the Library Association (Chaucer House, Malet Place, London, W.C.1), deals with "Chemical Technology" and can be obtained from the Publications Secretary of the County Libraries Section of the Library Association, County Library, County Hall, Trent Bridge, Nottingham (price 4*d*.), or free of charge through county or municipal libraries. This guide contains a classified list of books dealing with various aspects of chemical technology, including prices, which should be very useful to librarians of research institutions, college and school librarians, and others, as well as to public library officials.

TRANSAMINATION TO PYRUVATE AND SOME OTHER α-KETO-ACIDS

By E. V. ROWSELL
Biochemical Laboratory, University of Cambridge

UNTIL recently, it had become accepted that biological transamination was confined in its scope to the reactions : L-alanine + α-ketoglutarate ⇌ L-glutamate + pyruvate and L-aspartate + α-ketoglutarate ⇌ L-glutamate + oxalacetate.

It is now clear that in numerous organisms and tissues, enzymes exist catalysing the transfer of the α-amino groups of many other L-α-amino-acids to α-ketoglutarate to produce L-glutamate, and from L-glutamate to various α-keto-acids to produce their corresponding amino-acids[1-3]. Hitherto, however, experiments have indicated that either α-ketoglutarate or L-glutamate must be involved as one of the substrates in biological transamination reactions.

Experiments with insoluble particle preparations of rat-liver homogenates show that they are able to catalyse a direct transfer of the α-amino group from various L-α-amino-acids to pyruvate, to give alanine. Rat liver obtained from the animal immediately after death was homogenized in cold $M/10$ phosphate pH 7·8, and the insoluble particles of the homogenate washed several times by spinning down from re-suspension in the buffer, on the high-speed head of the cold centrifuge. The washed particles obtained from a rat liver weighing about 9 gm. were finally taken up to a volume of 15 ml. in phosphate buffer, $M/10$, pH 7·8. Incubations were carried out in test-tubes with the amino-acid under test at a final concentration of 0·03 M, and pyruvate 0·02 M, in a total volume of 2 ml., including 1 ml. of the particle preparation. The incubations took place anaerobically under an atmosphere of nitrogen, at 37° C., and usually for one hour's duration. The reactions were stopped by immersing the test-tubes in boiling water for three minutes, after which the denatured protein was spun down and the supernatants investigated by paper chromatography.

In order to reduce the time involved in the chromatographic investigations, a simple technique has been employed. Sheets of filter paper (7 in. × 4 in.), near the bottom edge of which the samples for amino-acid analysis had been spotted, were held between glass rods, and thus suspended from a glass tripod standing inside a desiccator which contained a thin layer of the chromatographic solvent. Within two or three hours the ascending boundary travelled far enough to separate the two amino-acids concerned, with the appropriate choice of solvents and filter paper. Phenol saturated with water, and propanol–water (4 : 1) have been mostly used. In order to avoid streaking of the spots, which otherwise occurs with phenol in these short runs, a stock of papers was maintained equilibrated in an atmosphere of phenol and water vapour. This technique also effects considerable economy in the consumption of chromatographic solvents, though it is obviously limited to investigations involving only one or two amino-acids.

Amino-acids which will transfer their amino-groups to pyruvate to give alanine, when incubated with these preparations, are L-leucine, L-phenylalanine, L-methionine, L-histidine and L-tyrosine. Control experiments in which pyruvate alone, and each amino-acid alone, were incubated with the washed particle preparations, gave no observable formation of alanine. Other control experiments were carried out with buffer substituted for the tissue preparation, and also with boiled tissue preparations; but in no case was there any non-enzymic formation of alanine. Similar controls have been carried out with negative results in all the experiments described below. Amino-acids which have been shown not to take part in this transamination to pyruvate are L-valine, L-aspartate, glycine and L-tryptophane, though the washed particles will catalyse transaminations between all the amino-acids mentioned, including these, and α-ketoglutarate.

No glutamate was observable on the chromatograms of these experiments and none was detectable in the homogenates, on testing manometrically with glutamic decarboxylase (washed suspensions of *Cl. welchii SR*12). It was nevertheless thought desirable to test the possibility that alanine might be produced by a coupling of two reactions, for example, L-leucine + α-ketoglutarate → L-glutamate + α-keto*iso*caproate, followed by pyruvate + L-glutamate → L-alanine + α-ketoglutarate, the whole process being catalysed by a trace amount of L-glutamate or α-ketoglutarate firmly adsorbed on the particles. If this were the mechanism of alanine production, one would expect that L-aspartate, more readily than any other amino-acid (with the exception of L-glutamate), would form alanine on incubation with pyruvate, since the rate of transamination to α-ketoglutarate is higher from L-aspartate than from any other L-α-amino-acid. However, although chromatograms showed that the particle preparations would catalyse an abundant synthesis of glutamate from L-aspartate and α-ketoglutarate, and of alanine from L-glutamate and pyruvate, no direct reaction of L-aspartate with pyruvate to give alanine was observed. Moreover, no aspartate was observed to have been formed when L-leucine and L-methionine were incubated with oxalacetate, which would be expected if L-glutamate

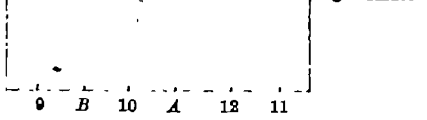

Fig. 1. Short-run chromatogram showing the formation of alanine from phenylalanine (9), leucine (10), and methionine (12), incubated with pyruvate in the presence of washed rat liver particles. None formed from valine and pyruvate (11). Markers containing 0·3 mgm./2 ml. (*A*), and 0·5 mgm./2 ml. (*B*), of both alanine and glutamate, run on the same paper for comparison. Water-saturated phenol on Whatman No. 1 paper

were acting as an intermediate carrier in the formation of alanine from pyruvate. It must be concluded that in the experiments described above there was direct transamination between the amino-acids used and pyruvate.

The supernatants of rat-liver homogenates from the first spinning have been clarified of all visible particles by repeated high-speed spinning and filtration. After prolonged dialysis they have been shown to be effective in catalysing the transamination to pyruvate from those amino-acids which are effective with the washed-particle preparations. These clear supernatant preparations will not catalyse transamination to α-ketoglutarate from L-leucine, L-phenylalanine, L-methionine, or L-valine, and thus constitute an obvious starting point for the purification of the pyruvate transaminase enzyme or enzymes.

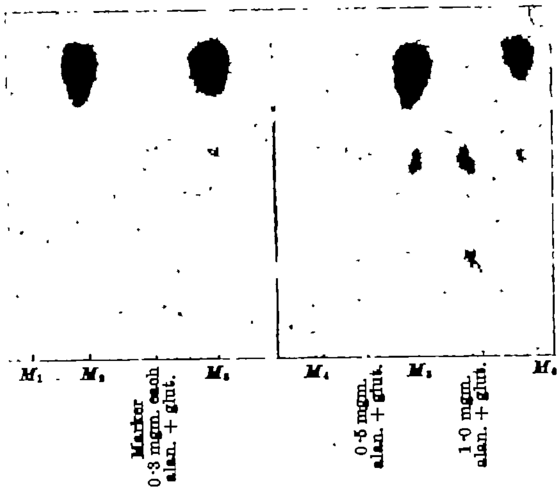

Fig. 2. Short-run chromatograms showing results with washed mouse liver particles. M_1, α-ketoglutarate alone. M_2, L-leucine + α-ketoglutarate. M_4, pyruvate alone. M_5, L-leucine + pyruvate. M_6, L-phenylalanine + pyruvate. Markers containing 0·3 mgm., 0·5 mgm. and 1·0 mgm. of both alanine and glutamate in 2·0 ml. Water-saturated phenol on Whatman No. 1 paper

The hypothesis that L-α-amino-acids are oxidized by the indirect process of transamination to α-ketoglutarate, followed by the oxidation of the L-glutamate thus produced, has been considered. Model experiments using tissue preparations and involving this sequence of reactions have been carried out by Braunstein and his co-workers[4]. The possibility that the oxidation of some L-α-amino-acids in some tissues takes place by the complicated route of transamination to pyruvate, followed by transamination from L-alanine to α-ketoglutarate, and this followed by the co-enzyme I – linked oxidation of L-glutamate, is one that must be considered.

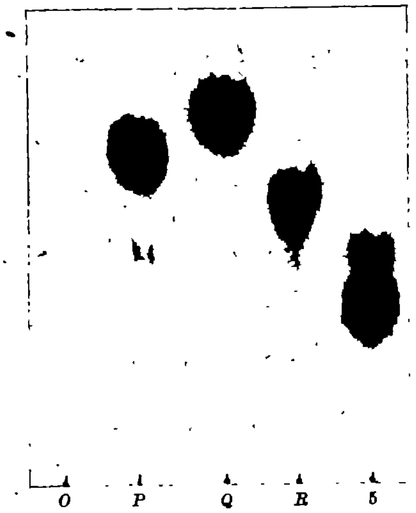

Fig. 3. Short-run chromatogram showing results of incubations with rat liver clarified supernatant. The substrates were α-keto-n-butyrate in each case, with buffer as control (O), L-phenylalanine (P), L-leucine (Q), L-methionine (R), and L-alanine (S). Propanol–water (4 : 1), on Whatman No. 1 paper

In some cases, both with washed-particle preparations and with supernatant preparations, experiments have been conducted in Warburg manometers, containing potassium hydroxide in the centre tube, to find out to what extent L-α-amino-acids are directly oxidized by atmospheric oxygen in these preparations. Washed-particle preparations which gave a synthesis of about 0·5 mgm. of alanine in one hour, under the conditions described above, from pyruvate with L-leucine, L-phenylalanine, and L-methionine, catalysed no oxygen uptake above that of the no-substrate control. Phosphate buffer replaced pyruvate to make up the volume for the manometric experiments. Fig. 1 shows the formation of alanine from L-phenylalanine, L-leucine and L-methionine after their incubation for 45 min. with pyruvate, and may be compared with the following figures for oxygen uptake obtained manometrically over the same period, using the same washed particle preparation :

Water control	11 μlit.
L-leucine	9 ,,
L-phenylalanine	8·5 ,,
L-methionine	8·5 ,,

Clarified supernatant preparations were no more effective in catalysing the direct aerobic oxidation of L-α-amino-acids.

	Pyruvate as amino-acceptor leading to formation of alanine with :				α-Ketoglutarate as amino-acceptor leading to formation of glutamate with .			
	L-leucine	L-phenylalanine	DL-methionine	L-valine	L-leucine	L-phenylalanine	DL-methionine	L-valine
Mouse-liver washed particles (Fig. 2)	+	+			–	–		
Whole dialysed pigeon-liver homogenate	+	+			+	+		
Pig-liver washed particles	–	–	–	–	+	+	+	+
Pig-liver dialysed supernatant	–	–	–	–				
Chicken-liver washed particles	–	–	–	–	+	+	+	+
Rat-kidney washed particles	–	–	–	–	+	+	+	+
Rat-kidney dialysed supernatant	–	–	–	–				

The reversal of the transamination to pyruvate has also been demonstrated. Incubation of washed rat-liver particles with L-alanine and α-keto-*n*-butyrate led to the formation of α-amino-*n*-butyric acid, while with α-keto*iso*caproate they gave leucine, and with phenylpyruvate they gave phenylalanine. (In these experiments the final concentration of L-alanine was 0·03 *M*; that of the keto-acid was 0·025 *M*. The incubation conditions and subsequent operations were the same in these experiments, and in all the experiments to be described, as those detailed above.) These syntheses were not effected when D-alanine or L-aspartate was substituted for L-alanine.

Other animal tissue preparations that have been examined, using the same experimental techniques, for transamination to pyruvate and α-ketoglutarate, are listed in the accompanying table; + denotes their ability, — their inability, to catalyse transamination with the substrates indicated. The whole range of amino-acids tested with each preparation is noted; it may be that other amino-acids would behave differently.

Experiments with dialysed supernatants of rat-liver homogenates show that they are able to catalyse transamination from L-phenylalanine, L-methionine and L-leucine, directly to α-keto-*n*-butyrate to produce α-amino-*n*-butyric acid (Fig. 3), from L-leucine to phenylpyruvate to give phenylalanine, and from L-phenylalanine to α-keto*iso*caproate to give leucine. In these experiments the L-amino-acids were at a final concentration of 0·03 *M* and the α-keto acids 0·025 *M*. (Sodium α-keto*iso*caproate and α-keto-*n*-butyrate were kindly provided by Dr. A. Meister.)

It is evident that biological transamination includes in its scope a much wider range of α-keto-acid acceptors than has hitherto been recognized. It is also obvious, even from the application of this qualitative method for the analysis of amino-acids, that big differences exist between different animal species and tissues in their transaminating ability. Many potential amino-group donors and keto-acid acceptors, including peptides and ketopeptides, will need to be investigated for their interaction in a wide range of organisms and tissues before the full scope of the transamination reaction can be appreciated.

I wish to thank Dr. D. M. Needham and Dr. F. J. R. Hird for their advice and encouragement during the course of this work, and to acknowledge a grant from the Medical Research Council.

[1] Cammarata, P. S., and Cohen, P. P., *J. Biol. Chem.*, 187. 439 (1950).
[2] Feldman, L. I., and Gunsalus, I. C., *J. Biol. Chem.*, 187, 821 (1950).
[3] Hird, F. J. R., and Rowsell, E. V., *Nature*, 166, 517 (1950).
[4] Braunstein, A. E., "Adv. Protein Chem.", 3, 1 (1947).

ULTRASONICS IN FLUIDS

UNDER the auspices of the Royal Flemish Academy and the United Nations Educational, Scientific and Cultural Organization, an international conference on ultrasonics was held in Brussels during June 7–9 under the presidency of Prof. A. van Itterbeek; the secretary was Prof. A. J. Rutgers. There were about one hundred participants representing most countries of Western Europe, the United States of America and Australia. It may indeed seem that workers in ultrasonics are insatiable in discussing their activities, since this congress followed so closely on the heels of those of Erlangen (1949) and Rome (1950); but the earlier meetings dealt rather with applications of ultrasonics, whereas this year's meeting was concerned entirely with physical measurements and theories.

The subjects proposed for discussion were the following: (*a*) absorption and dispersion in gases and in pure liquids; developments in the field of 'second viscosity of liquids'; (*b*) absorption in electrolytic solutions; relaxation time for ionic interactions; ultrasonic vibration potentials in colloidal solutions; (*c*) absorption in liquid mixtures or in liquids containing solid particles or gas bubbles; (*d*) absorption in liquid helium; 'second sound'.

On the first morning, a lively discussion soon developed on the significance of the 'streaming' of fluid from the surface of an ultrasonic emitter contained in a tube, and the vortices so set up, from the point of view of the dilatational viscosity, which Stokes invoked only to ignore. It was pointed out that similar circulations can be set up in a liquid at quite low frequencies, so that it may be difficult to distinguish any specific effect at high frequencies, when the 'second viscosity' would be expected to show itself. This leads to alternative explanations of the phenomenon, based on the equations of compressible and incompressible flow, respectively. Yet a third theory was adduced in the first category, in which the streaming due to the breakdown of shock wave-fronts was discussed.

A large proportion of the papers presented to the congress were concerned with relaxation phenomena in gases and liquids. On the theoretical side, much argument took place on the best way of representing anomalous absorption, whether by a complex coefficient of viscosity or by single or multiple relaxation times, usually of thermal type.

For water near 4° C., a configurational relaxation between two types of structure having different compressibilities seems best to represent the observed absorption/temperature curve. In applying these theories to actual fluids, with the possible exception of hydrogen, some data have to be taken from the experimental results and it is well, as one speaker reminded us, that we should be clear in our own minds when we are doing this.

On the experimental side, new results were presented for velocity and absorption in organic liquids and mixtures thereof, electrolyte solutions, liquid hydrogen and liquid helium. Besides the common variable-path interferometers and pulse techniques, some data were presented from measurements with the radiation pressure, probe microphone, hot-wire, reverberation and *Schlieren* methods. Interesting reports were also presented of experiments on scattering by solids or liquid bodies surrounded by other liquids, and of the setting-up of potential fields in colloids under the action of ultrasonics.

Measurements of ultrasonic absorption in the critical regions between gas and liquid on one hand and between solid and liquid on the other have recently been made. Glycerine in the neighbourhood of −10° C. exhibits the latter transition, showing a maximum of absorption to 30 Mc./sec. waves at this temperature. Some theories relating to relaxation in this quasi-solid state were advanced, though it is interesting to note that the existence of relaxation frequencies in solids was first discussed by Prandtl for the sonic range in 1928. The ultrasonic relaxations for liquids discovered later bear a close resemblance, in a different part of the gamut, to these.

The final morning was devoted to the propagation of sound in liquid helium II, wherein both acoustic and thermal waves ('first' and 'second' sound) may be propagated. The interactions of these two types and the effect of a temperature boundary-layer which forms at the walls of the containing vessel were discussed from the theoretical point of view by a number of speakers, while experiments were adduced relating to the discontinuity in velocity of 'first' sound at the lambda-point and the theoretical relation which would make this velocity equal to three times the velocity of 'second' sound as absolute zero is approached.

The papers (about thirty-five in all) presented to the conference will eventually be published (in English, French or German) in the *Mededelingen Koninklijke Vlaamsche Academie voor Wetenschappen* (Brussels). It is hoped that summaries of many of the papers will appear in a forthcoming number of the journal *Acustica*.

E. G. RICHARDSON

CATION EXCHANGE AND CLAY MINERAL STRUCTURE

A MEETING of the Clay Minerals Group of the Mineralogical Society, held at Rothamsted Experimental Station, Harpenden, during April 27–28, was largely devoted to a discussion on cation exchange and clay mineral structure, although some general papers were also read and discussed. On the evening of April 27 a lecture on the development of the fuller's earth industry, and the uses of fuller's earth from earliest times, was delivered by R. H. S. Robertson (Glasgow).

The discussion on cation exchange and clay mineral structure was introduced by Dr. D. M. C. MacEwan (Rothamsted), who, with the aid of models, outlined the structures proposed for montmorillonite by Hofmann, Endell and Wilm[1], and by Edelman and Favejee[2], and pointed out that this discussion was, in effect, an attempt to see how far the available data could help towards a decision as to the most probable structure.

Prof. H. Deuel (Zurich) described the preparation and properties of organo-silicon compounds, especially the silanols containing Si—OH groups, and pointed out that Edelman and Favejee have postulated such groups in clay minerals. The previous work of Berger[3], and others, has shown that clays can give organic derivatives, and Prof. Deuel himself has prepared a considerable range of such compounds using 1,2-epoxides, mustard gas, etc. Thionyl chloride gives extremely reactive clay chlorides, which react with, for example, alcohol to give esters, etc. The decrease in cation-exchange capacity after esterification corresponds exactly to the amount of ester groups introduced, and the original cation-exchange capacity returns on hydrolysis. Similar esters prepared from different clay minerals have different properties, an observation which may lead to the development of a method for separation of minerals. In the discussion, H. R. Samson (Rothamsted) suggested that the reactions might be due partly to the hydroxyl groups of decomposition products formed by reaction of the clay with drastic reagents such as thionyl chloride, or of $Al(OH)^{++}$, present in the hydrogen-montmorillonite. Dr. B. S. Neumann (Fuller's Earth Union, Ltd.) inquired whether free silica gel in the samples might not cause such reactions.

Recent attempts to distinguish between the two structures were described by M. J. Méring (Paris), who pointed out that, on the Hofmann–Endell–Wilm theory, structural water should amount to 5·1 per cent, while on the Edelman–Favejee one it should be 6·1 per cent. With normal analytical methods, it is difficult to distinguish between the final removal of sorbed moisture and the beginning of removal of structural water. However, Mlle. Glaeser's use of the Fischer reagent for determination of sorbed water seems promising. Surface areas of calcium- and sodium-montmorillonites with varying water contents and X-ray data for calcium-sodium-montmorillonites, etc., have also been examined. The results tend to favour the Hofmann–Endell–Wilm structure rather than the Edelman–Favejee one. In the discussion, P. Franzen (Amsterdam) suggested that application of the methods of M. Méring to the compounds of Prof. Deuel may lead to considerable further information.

The observation that lithium-montmorillonite loses water irreversibly at a much lower temperature (about 150° C.) than montmorillonite saturated with other cations was discussed by R. Greene-Kelly (Rothamsted). Méring's suggestion that the formation of O—Ca—O bonds[4] between the sheets in calcium-montmorillonite causes the sheets to be locked in position and therefore irreversibly dehydrated can scarcely hold for Li^+, although it might be that Li^+ would react with one of the hydroxyl groups. Attention was directed to other peculiarities of lithium-montmorillonite[5] and lithium-vermiculite[6], in the ensuing discussion, by Dr. R. C. Mackenzie and Miss A. A. Milne (both of Aberdeen). M. Méring stated that he has now abandoned the O—Ca—O hypothesis, while Prof. Deuel suggested that Si—O—Si links might be formed by condensation of two Si—OH groups in separate layers. He also suggested the study of irreversible dehydration in hydrogen-montmorillonite; but several speakers doubted the existence of this material.

Prof. D. McConnell (Ohio) communicated a paper on the calculation of the structural formula of montmorillonite, assuming three cations (silicon, hydrogen and aluminium) present in the tetrahedral layer, that is, partial substitution of $(OH)_4$ for SiO_4[7]. Some doubt was cast on the existence of tetrahedral hydroxyl groups by R. Greene-Kelly, who showed some thermograms for one sample of montmorillonite saturated with various cations, where the relative sizes of the two high-temperature endothermic peaks vary with the exchangeable cation. K. Norrish (Rothamsted) mentioned that Hendricks has suggested that the final endothermic peak may be due to isolated hydroxyl groups unable to condense until the final recrystallization takes place—a suggestion supported by Dr. S. J. Gregg (Exeter), who pointed out the difficulty in removing the last traces of a gas in many decompositions, for example, calcium carbonate, magnesium carbonate, etc. The possibility that hydroxyl groups in McConnell's structure would be partially dissociated and give rise to cation-exchange was suggested by Prof. Deuel.

Experiments on the effect of grinding on micas, described by Miss Milne and Dr. Mackenzie, showed that the cation-exchange capacity of muscovite increases to about 130 m.equiv./100 gm. after nine hours of grinding, remains constant at this value for about another nine hours and then tends to increase again. Corresponding changes observed in the X-ray data indicate almost complete breakdown of the structure by nine hours, with gradual recrystallization into illite thereafter. The cation-exchange capacity of biotite increases with grinding for twenty-four hours, and the lines in the X-ray patterns tend to become diffuse; peculiarities observed with vermiculite cannot yet be explained. In the discussion, R. W. Nurse (Building Research Station) pointed out the severe nature of dry grinding, while Dr. Gregg and Dr. G. W. Brindley (Leeds) both described work on the grinding of kaolinite and halloysite.

In the section devoted to general papers there were three contributions from Rothamsted. The technique employed there by H. L. Nixon and Dr. A. Muir for obtaining electron micrographs of clays was described and a number of excellent electron micrographs shown. In reply to Dr. G. Nagelschmidt (Sheffield), Dr. Muir confirmed that the hexagonal crystals in some of the micrographs are metahalloysite, this having been checked by X-rays. The theory of X-ray diffraction and absorption by oriented flakes and rolled specimens was discussed by K. Norrish and Dr. MacEwan. Equations giving the angular distribution of any particular crystal plane in terms of the distribution of particles have been derived, and the effect of orientation and flake shape on intensities calculated. The calculations give a method of determining the distribution of particles from the variation of intensity of a particular line at different settings of the specimen. Dr. Nagelschmidt and Dr. Brindley both stressed the importance of this theory in quantitative analysis and in structure determinations, and Dr. Brindley explained that, in certain cases, the distribution of particles is obtainable from one photograph. In the third paper, Dr. MacEwan presented a detailed table in which clay mineral types are classified on structural grounds[8]. Use is made chiefly of an extension of the significance of existing names; for example, there are three groups, depending on the number of O, OH layers in the structure, and these are divided into thirty-three sub-divisions through the major divisions: kaolinoids (or kaolin minerals), micas, montmorillonoids, vermiculites and chlorites. This classification was compared with other attempted classifications. In the discussion, Dr. Brindley spoke of the necessity of consideration of such schemes in reaching any definite ruling on nomenclature.

Adsorption isotherms of carbon tetrachloride, water and oxygen, as well as density in carbon tetrachloride, have been used by Dr. Marjorie J. Brown (Exeter) and Dr. Gregg to investigate changes induced in kaolinite on heating. In the region where the water-loss becomes largely irreversible (400–490° C.), the morphology of the grains cannot be greatly changed, since the surface area increases only slightly. A slight decrease in area is observed at about 720° C.; but even at 1,000° C. both area and sorption are still appreciable. H. R. Samson gave some optical evidence supporting the small area change in the 400–500° C. region. Dr. Brown, in reply to Dr. G. Nagelschmidt, indicated that this work is to be extended to montmorillonites saturated with various cations.

Although cold-precipitated hydrated ferric oxide appears to be widespread in soils and clays[9], the conditions necessary for its formation have not yet been determined. The conditions under which it can be formed and is stable in the laboratory were described by Dr. Mackenzie. The changes occurring in the mineral with changes in the mode of preparation have been studied by X-ray, electron diffraction and other methods, and some suggestions were made as to possible modes of origin in Nature. Dr. Neumann reported that similar changes can be obtained with hydrated aluminium oxides, the *endothermic* peak temperature increasing as the precipitation temperature is raised.

The discussion both on the special subject and on the general papers was very valuable and stimulating, but it was obvious that at present no definite agreement as to the correctness of either the Hofmann–Endell–Wilm or the Edelman–Favejee structure can be arrived at. Prof. McConnell's hypothesis has attractive features as a compromise; but at present it is apparently open to some objections, and only if these are overcome can it be accepted.

R. C. MACKENZIE

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NEW DEVELOPMENTS IN VISCOMETRY

COLLOQUIUM AT BIRMINGHAM

A COLLOQUIUM on "New Developments in Viscometry" was held by the British Society of Rheology on May 11 in the Department of Chemical Engineering, University of Birmingham. The discussion was introduced with a paper by Dr. R. S. Higginbotham (Shirley Institute, Manchester) and J. J. Benbow (Dunlop, Ltd.) entitled "Some Novel Viscometers for Rapid Measurements under Defined Conditions". Dr. Higginbotham spoke at first on the historical development of rotatory viscometers, including the cone and plate types, mentioning their limitations and discussing procedures for obtaining rheological constants of starch pastes, thick suspensions and soft solids in general over a wide range of shearing stress. A precise knowledge of these constants, including the extent of changes due to thixotropy and dilatancy, is of great importance in selecting and controlling the manufacture of materials in textile printing. Electrical viscometers of the cone and plate types, robust in design and of simple operation, have been designed and found useful for control purposes.

Dr. P. S. Williams (Paints Division, Imperial Chemical Industries, Ltd.) described a new design of co-axial cylinder viscometer with the torsion wire replaced by a strain-gauge assembly holding the inner cylinder. Intended for research purposes with high-concentration suspensions, it has been built to a simple and robust design with a self-centring journal bearing. Results obtained with fine suspensions and gels of silica spheres were discussed with reference to thixotropic changes after different periods of shearing.

Dr. G. F. Eveson and G. H. Higginbotham, of Prof. S. G. Ward's laboratory, Mining Department, Birmingham, discussed results obtained with fine dispersions of spheres in a lead acetate–glycerol medium using different kinds of viscometers, with special reference to the sigma phenomenon which appears to be absent when some types of viscometers are used, due presumably to the kind of flow prevailing. Experiments have been carried out using different gaps between rotating cylinders, allowing for a wide range in the ratio of particle size to length of annular gap. Similar results for slip at the cylinder walls have been obtained under the various conditions. Special research viscometers for dealing with settling suspensions and methods of analysing the results obtained were next described. Following further discussion by the meeting, under the chairmanship of S. F. Freeman (Mars, Ltd.), of proposed new viscometers, visits were made to the laboratories of the University where rheological work was proceeding.

E. W. J. MARDLES

UNIVERSITIES' FEDERATION FOR ANIMAL WELFARE

SILVER JUBILEE

By PROF. A. N. WORDEN

THE British Science Guild, which derived from the British Association for the Advancement of Science, was formed for the purpose of promoting the application of scientific methods and results to public affairs. In 1926 its honorary secretary was C. W. Hume and its most active member Sir Richard Gregory, then editor of *Nature*. The Guild has since been re-absorbed into the British Association; but one of its unofficial offspring, the University of London Animal Welfare Society, or ULAWS (now expanded into the Universities' Federation for Animal Welfare, or UFAW) is still very much alive and has recently celebrated its jubilee by a dinner held in London. It was Major Hume's thesis that the right relations between man and his fellow creatures were a proper study for the attention of university people as such. His first aim in founding the University of London Animal Welfare Society was to secure the support of veterinarians and zoologists; but the veterinary profession was at that time largely at variance with animal welfare movements. A contemporary vivisection controversy found the Society attacked by the anti-vivisection societies and suspected by experimentalists of harbouring in its ranks those of the category since dubbed 'crypto-antivivs'.

Major Hume's refusal to bow before these attacks, or to be discouraged by the initial apathy of the majority of those whose support he solicited, was steadfast. By 1939 hundreds of members and thousands of subscribers had been enrolled, funds from legacies and broadcast appeals had accrued, and the movement had been extended to other universities. In the same year it was decided that the now extensive educational efforts should be backed by original work, and a Scientific Investigations Committee was accordingly formed. Small grants were made for work on rabbit ecology, at the Bureau of Animal Population, Oxford, and for some studies on euthanasia in dogs in the Department of Pharmacology at the same University.

War, the early demise of the Federation's secretary and the destruction of its offices by enemy action naturally hampered many projects. On one enterprise, however, work was continued, and by 1943 it was possible to begin the preparation for publication of a standard text-book upon the care and management of laboratory animals. The support of research workers for such a work was world-wide. Literally hundreds of scientific workers offered their support and the subsequent book, published some four years later, obviously filled a very real need. Only the anti-vivisectionist Press failed to accord it a most favourable reception.

Shortly after the conclusion of hostilities, the Federation made a substantial grant for research on rabbit ecology and control by the Department of Animal Health, University College of Wales, Aberystwyth. It had long been felt that trapping, while a barbarous procedure, was probably an unsound practice from the agricultural point of view, but scientific proof was wanting. These studies continued for more than four years, and attracted the interest and collaboration of official bodies. One of the county agricultural executive committees initiated a widespread attempt at rabbit control based upon methods investigated by the workers in the Department of Animal Health. The reports of the extensive investigations upon control measures, and upon the damage to pastures inflicted by rabbits, are at present being prepared for full publication. The information available by 1950 was placed before the Home Office Committee on Cruelty to Wild Animals. It is evident from its report (Cmd. 8266) that the Committee was duly impressed by the evidence given. The objective presentation to a departmental committee by an animal welfare organization of factual scientific material must have been something of a novelty; but it is, of course, this very combination of humanitarian outlook and scientific approach that characterizes the Universities' Federation for Animal Welfare and places it in the category of a scientific society.

Substantial support has more recently been given to investigations relating to the electrocution and electro-anæsthesia of animals. At present these studies are being undertaken by a veterinary physiologist attached to the Neuropsychiatric Research Centre, Whitchurch Hospital, Cardiff, in the hope of yielding much-needed information on the painlessness or otherwise of electrocution and electro-stunning apparatus now in use, and upon the future possibilities of electroplectic anæsthesia.

Yet another problem supported by the Federation is that of the humane destruction of whales. Here much of practical value has already been achieved in work undertaken at sea by one of the British whaling companies, but the full results are not yet available for study.

These original investigations, while forming a heavy burden upon the slender funds of any charitable organization, have not been pursued to the detriment of educational work at home or abroad. The *UFAW Courier* is widely read, and a great deal of lecturing is carried out by members of the staff and by co-operating men of science. Before the War, membership was extended so as to include not only university men and women but also those members of the learned professions who were not university graduates.

From the first twenty-five years there is therefore much of which the Federation has cause to be proud. Its officials feel, however, that it is still extremely young. They note with satisfaction the birth of kindred ideas elsewhere. The recent formation in the United States of an Animal Care Panel, by veterinarians and scientific workers engaged in animal experimentation, is one such example. From its "temporary war-time address" (284 Regent's Park Road, Finchley, London, N.3) the Federation has built up extensive relationships that bode well for the future treatment of animals. There is no shortage of problems, and even though in some veterinary and laboratory circles there still remains a suspicion of anything termed 'animal welfare', this prejudice will finally be broken down by further deeds. In respect of the laboratory world alone, it is fair comment that the Federation's activities have tended to aid both the well-being of the animals themselves (which is largely a husbandry problem) and the value of them for experimental purposes. The Federation is concerned not with the sterile argument of whether experiments on living animals are justified, but with the best conditions in which laboratory animals may be maintained. Dr. E. C. Morland, formerly editor of the *Lancet*, wrote to Major Hume after the publication of the "Handbook" to congratulate the Federation for ". . . mediating with rare insight between two irreconcilable combatants. It relieved my mind of the misery of watching it go on, year in and year out and, it seemed, for ever. Accept the thanks of one who knows."

CARNEGIE TRUST FOR THE UNIVERSITIES OF SCOTLAND

ANNUAL REPORT FOR 1949–50

THE outstanding feature of the forty-ninth annual report of the Carnegie Trust for the Universities of Scotland*, which covers the academic year 1949–50, is the increased expenditure on research schemes, the total of £34,088 being the largest thus far required in the history of the Trust for postgraduate study and research. From surpluses at its disposal from the eighth quinquennial distribution to the universities and colleges, the Committee made extra grants of £13,000 each to St. Andrews and Aberdeen, and £20,000 each to Glasgow and Edinburgh. From the beginning of the year under review, the value of the research scholarships was raised from £250 to £300, the senior scholarships from £400 to £450, and the fellowships from £700 to £800 with a possible further £50 for exceptional expenses. Expenditure on these awards now exceeds £12,000 a year, and the Committee proposes in future to invite nominators to these scholarships to say privately whether a trial year in the first place is desirable. During this trial the scholarship would be £200 and would be tenable at the parent university under close supervision of the nominator or other member of the university department in which the scholar proposes to work.

Block grants to the four Universities for research at home or abroad by members of staff have been extended, from October 1950, by a tentative scheme to involve not more than fifteen specially selected members of the university staffs in each year who will be given leave of absence for three to twelve months to prosecute lines of research on which they have already made such progress that conference with workers in the same fields in other countries is highly desirable. Six of these awards each year will be for travel to, and maintenance in, the United States. The Committee is also continuing, particularly in co-operation with the publications committees of the universities, its system of guaranteeing against loss books which are the fruit of sustained research on the part of their authors, but which are of a nature likely to have only a limited public. Further assistance has also been given to learned societies in Scotland in the publication of their transactions and journals, as well as, through the universities, to the Third Statistical Account.

Awards of fellowships, scholarships and grants for 1950–51 are detailed in the report, which also includes, besides reports on the work of investigators under the research scheme during the year 1949–50 and from the superintendent of the laboratory of the Royal College of Physicians, lists of publications by fellows, scholars and recipients of grants and of assisted papers, together with details of assistance to students and an abstract of accounts for 1949–50. Assistance to students has been confined to those who, for adequate reasons, had no bursary from a local education authority or whose circumstances and exceptional merit enabled the Committee to give assistance under Clause B of the Trust Deed. The average payment per beneficiary was £21, as against £15 in previous years, and three hundred students benefited. The Committee notes with regret a severe decline in repayments by former beneficiaries, only £1,160 having been repaid as against £5,379 in the peak year of 1946–47.

CHEMISTRY AT THE UNIVERSITY OF SYDNEY

GIFT FOR NEW BUILDING

AN anonymous donor has recently presented to the University of Sydney a sum of £100,000. This, according to the official announcement by the vice-chancellor, Prof. S. H. Roberts, has been "given and accepted on the sole condition that it is to be used for the building of the first wing of a new Chemistry School, and in the hope that it will stimulate other donors".

Chemistry in the University of Sydney has a history going back a century, beginning with the arrival in 1852 of the Hon. John Smith—previously assistant professor of chemistry in Marischal College, Aberdeen—as "Professor of Chemistry and Experimental Physic". About 1874 a separate chair of chemistry was instituted, with Archibald Liversidge as its first occupant. Following him have been C. E. Fawsitt (1907–46) and R. J. W. Le Fèvre (1946–). From 1913 there has also been a chair of pure and applied organic chemistry, all four holders of which—Sir Robert Robinson, John Read, James Kenner, J. C. Earl—are now living in Great Britain.

Of the laboratories set up by Smith no signs remain. Those now in use are grouped around a nucleus laid out in 1889 by Liversidge. At intervals, various temporary and permanent additions have been made, so that in 1951 chemistry has available some 100,000 sq. ft. of floor space. This is not at all conveniently or efficiently arranged. In the University of Sydney a large number of students take chemistry in the earlier years of their degree courses, and a particularly heavy commitment is what, in Great Britain, would correspond to Intermediate B.Sc. classes. For example, during the 1947 session laboratory facilities for some 2,100 such students had to be provided. Although by now (1951) this number has become approximately 1,100, it is not expected to become smaller in the foreseeable future.

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* Carnegie Trust for the Universities of Scotland. Forty-ninth Annual Report (for the Year 1949–50), submitted by the Executive Committee to Trustees on February 26, 1951. Pp. iv+70. (Edinburgh: Carnegie Trust for the Universities of Scotland, 1951.)

Indeed, from 1953 onwards, it is anticipated that enrolments at Australian universities will rise by perhaps 1,000 per annum until about 1958, and thereafter by about 2,000 per annum until they reach a peak in 1965. These forecasts are based partly on the jump of the Australian birth-rate occurring in the late 1930's following the depression, and upon the growing flow of migrants to the Dominion. Furthermore, it is hoped that many South-East Asian students will in the future go to Australia for higher education or postgraduate work. It is intended, therefore, to utilize the present benefaction to proceed as soon as possible with the erection of a sufficient part of the eventual building to accommodate the large group of elementary students just mentioned, and thus enable them to leave the present factory-like, fibro-cement, temporary laboratory they now occupy.

Completion of a new Chemistry School must be necessarily dependent upon the provision of funds. It will be a development of benefit indirectly to a number of other departments of the University. These, at present working under extreme difficulties because of shortage of space and lack of modern facilities, will be able then to expand into much of the accommodation previously used by chemistry.

VOLUME TABLES FOR ESTIMATING TIMBER IN GREAT BRITAIN

FOR a century and a half at least on the Continent of Europe, for example, in Germany and France, volume tables have been in existence which enabled the forester and the timber merchant to calculate the volume of timber in crops of standing trees of various age classes, without having actually to measure the crops. These tables were based on a large number of measurements of selected areas of the same age, situation and soil, and so forth, carried out over a number of years and in blocks of forest which had passed through more than one rotation of careful management.

In tropical forest regions the first attempt to prepare volume tables was begun in India. The difficulty here was that the forests were virgin ones and not regular crops grown by man for at least one rotation, and allowances had to be calculated and allowed for. The user of the table therefore had to make certain allowances to the figures of volumes contained in the table. The Forestry Commission has been undertaking work of this description in Great Britain, and last year it published general volume tables for oak, beech, Scots pine and European larch*; other tables are promised for birch, Corsican pine, Japanese larch, Norway spruce, Sitka spruce and Douglas fir.

The volume tables for broad-leaved species, including the one for beech, give average hoppus (or 'cubic foot quarter-girth') volumes over bark for trees of a given breast-height quarter-girth (abbreviated as B.H.Q.G.) and timber height. Breast height is taken at 4 ft. 3 in. above ground level (on the upper side of the tree on slopes) and volumes are measured, in lengths coinciding with 'stops', from ground-level to timber height, that is, an over-bark top diameter of 5–6 in. or to the point where the stem loses itself in the crown, whichever comes first. A 'stop' is a point on the stem at which there is a sudden change in diameter or a pronounced bend. No allowance is made for the stump, and branch wood of all dimensions is ignored.

The volume tables are intended to assist foresters, landowners and others in estimating the cubic contents of standing timber; but, in order to achieve this purpose, their uses and limitations must be clearly understood. Trees with identical breast-height girths and heights may differ from one another in the rate of taper. The tables cannot therefore be relied upon to give accurate estimates of individual tree volumes; they can only be expected to give satisfactory estimates for the aggregate volumes of a group of trees or of a whole stand. Even whole stands may differ from one another in stem form, although usually in a lesser degree, and it is therefore always advisable when first using a general volume table under a given set of conditions to test it on a number of felled stems grown under those conditions. If the table shows a definite bias, volume table estimates of standing timbers on that site will have to be adjusted accordingly.

Unless a stand is very small, it is usually not necessary to apply the volume table to every single tree. In old hardwood stands it is probably best to measure the breast-height quarter-girth and to estimate the timber height of every *n*th tree, the value of *n* being chosen so that there will be at least one hundred such trees; for example, if there are five hundred, every fifth tree would be measured. The volume of the stand is then obtained by multiplying the total volume of the measured trees by *n*. In young hardwood stands and conifer stands of all ages, in which stem-length varies less erratically, it is usually best to girth all trees in order to determine the mean girth—that is, the girth corresponding to the mean basal area of the stand—and then to measure the heights of a number of trees near that mean girth in order to get a mean height. The volume for this mean girth and height, as derived from the volume table, multiplied by the number of stems, gives an estimate of the standing volume of the crop.

When estimating the volume of standing timber in large stands or whole forests, these or similar methods will usually be applied, not to the whole area but only to a representative sample of it. It requires a knowledge of sampling theory and of local conditions to find the most efficient sampling technique in any particular case; but for many practical purposes and for working plan enumerations in particular, a ten per cent sample consisting either of parallel strips $\frac{1}{2}$–1 chain wide or of small circular plots, spaced at regular intervals over the whole area, will often give efficient and unbiased estimates of adequate precision.

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* Forestry Commission. Forest Record No. 5: General Volume Table for Oak in Great Britain. By F. C. Hummel and W. T. Waters. Pp. 12. 4d. net. Forest Record No. 6: General Volume Table for Beech in Great Britain. By F. C. Hummel and W. T. Waters. Pp. 12. 4d. net. Forest Record No. 8: General Volume Tables for Scots Pine in Great Britain. By F. C. Hummel, T. W. Irvine and J. Jeffers. Pp. 28. 9d. net. Forest Record No. 9: General Volume Tables for European Larch in Great Britain. By F. C. Hummel, T. W. Irvine and J. Jeffers. Pp. 26. 9d. net. (London: H.M. Stationery Office, 1950.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Oxygen Affinities of Respiratory Blood Pigments in *Serpula*

Serpula, a marine annelid worm, is the only animal known to possess two respiratory pigments in its blood, namely, chlorocruorin and hæmoglobin[1].

The hæmoglobins of mammals and of a variety of invertebrates have a considerably higher affinity for oxygen than the chlorocruorins of Serpulimorpha[1,2], a high affinity meaning that the pigment is oxygenated at a low pressure of oxygen. If, therefore, a mixture is made of an oxychlorocruorin and human oxyhæmoglobin, and then oxygen is progressively removed from the solution, a spectroscope shows that the α-band of oxychlorocruorin vanishes before the α-band of oxyhæmoglobin. But when the naturally mixed pigments in the blood of *Serpula* are gradually deoxygenated, the two α-bands disappear simultaneously. This means either that the hæmoglobin of *Serpula* has an unusually low affinity for oxygen, like that of the chlorocruorins hitherto examined, or that the chlorocruorin of *Serpula* has an abnormally high oxygen affinity.

This interesting point has remained unsettled since the time that the duplicity of the *Serpula* blood pigment was discovered, owing to the difficulty of finding big specimens of *Serpula*, which in most places is not an abundant serpulid. I have, however, now been fortunate in getting several moderately large live individuals of *S. vermicularis* L. from Plymouth. The worms were cut up in water and the liquid centrifuged, giving a solution with the brown colour characteristic of the blood of this genus. It is known that the relative quantities of the two blood pigments in *Serpula* vary with the age of the animal; in the solution which was prepared this time the two α-bands were equal in intensity. To a small optical glass tube containing about 0·5 ml. of the diluted *Serpula* blood, enough human blood was added to double (approximately) the intensity of the α-band of oxyhæmoglobin. Then a very small crystal of sodium dithionite was dropped in to remove most of the dissolved oxygen from the solution. The result was that, viewed with the microspectroscope, the α-band of oxychlorocruorin was seen to vanish, while the intensity of the α-band of oxyhæmoglobin was about halved. It is clear that only the human respiratory pigment remained in the oxygenated state; the hæmoglobin of *Serpula* was deoxygenated, together with the chlorocruorin. On aeration the bands reverted to their initial strengths. The experiment, which was repeated four times, showed that the chlorocruorin of *Serpula*, like other chlorocruorins, has a low oxygen affinity, and that likewise the hæmoglobin of *Serpula* has a low oxygen affinity. In this property the latter pigment differs from the hæmoglobins of other invertebrates[2] but resembles those of some fishes[3].

The hæmoglobin of *Serpula*, like all other hæmoglobins, contains protohæm. The chlorocruorins have their own peculiar hæm, chlorocruorohæm[4], and their proteins differ from globin of hæmoglobin[5]. It may well be that in the hæmoglobin of *Serpula*, protohæm is united to the protein of chlorocruorin and that this endows it with its low oxygen affinity.

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June 1.

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Density of Bottom Animals on the Ocean Floor

Our knowledge of the density (number and weight per sq. m.) of bottom animals in deeper waters is very scanty, since very few quantitative samples have hitherto been taken, and none at depths exceeding 1,000–1,400 m. It may therefore be of interest that the Danish Deep Sea Expedition in the *Galathea* has succeeded in taking thirteen quantitative samples with a 0·2 Petersen grab off the West African coast at depths between 820 m. and 3,782 m. The weight and number of species and specimens per sample are given in the accompanying table.

Locality	Depth (m.)	Weight of living animal per sample (gm.)	No of species	No. of specimens
Off Takoradi	1,480	0·3	3	9
Off the Congo	2,680	0·1	1	1
,, ,,	1,480	0·3	8	3
,, ,,	820	0·9	4	6
,, ,,	985	0·2	2	2
,, ,,	1,150	0·2	1	1
,, ,,	1,460	0·4	4	4
Off Angola (Lobito)	3,782	0·62	4	6
,, ,,	2,430	0·42	2	2
,, ,,	1,508	0·3	4	7
,, ,,	1,200	0·6	6	17
,, ,,	1,006	0·8	4	4
,, ,,	985	0·5	4	8

Summarizing these results, it will be seen that the average weight of living animals in the six samples off the Congo from between 820 m. and 2,680 m. is 0·37 gm. per sample, that is, 1·85 gm. per sq. m. The number of species is on an average 2·5 per sample, that is, 12·5 per sq. m., and the number of specimens 3 per sample, that is, 15 per sq. m. These figures seem surprisingly high compared with those hitherto found at depths of about 1,000 m. in the Mediterranean, off Scotland and off Greenland. If the figures for the Angola coast are considered, the average weight per sample represents 0·5 gm., that is, 2·5 gm. per sq. m., with 3 species and 7 specimens per sample, that is, 15 and 35 respectively per sq. m., which seems to be a very high figure considering the fact that the depths are between 1,000 m. and 4,000 m.

There seems to be a difference between the deep sea off the Congo and off Angola, since the density of specimens appears to be distinctly higher off Angola. This is in good agreement with the fact that the productivity of the sea increases towards the south due to the influence of the Benguela Current and the upwelling water.

If we consider the results of the investigations with the Petersen grab in more shallow waters and compare the tropical part of West Africa (off the Volta and off the Congo) with subtropical African waters (off Angola and off Walvis Bay) there is a very striking difference. Off the Volta and off the Congo the number of living animals per sq. m., even at small depths, 20–200 m., is very low, about 30–40 gm. per sq. m. at depths of about 10–20 m., falling to 1–10 gm. at greater depths. Off Lobito and the Cunene River the figures are somewhat higher, about 40–100 gm. at more shallow depths, 5–10 gm. at greater depths. Off Walvis Bay the figures are quite different, namely, 150–300 gm. living animals per sq. m. down to about 100 m., and thus resembling the order of magnitude in North European waters, while the density off the tropical parts of the African coast is much lower than that in the North Sea, in Iceland waters, etc.

Our experience from the first part of the Expedition is that there are no technical difficulties in taking quantitative samples with the 0·2 Petersen grab at depths of 4,000 m. and more, and it is now planned to carry through such sampling in the different deeps of the oceans as well as off the different coasts of the continents for the purpose of comparing the density of the fauna in the different parts of the oceans.

R. SPÄRCK

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March 16.

Inhibition of the Biosynthesis of Tobacco Mosaic Virus by Thiouracil

SUBSTANCES capable of inhibiting specifically the formation of viruses are of obvious practical and theoretical interest. In the case of plant viruses, the composition of which are relatively simple and known, the opportunity exists of correlating the structure of an inhibitor with that of virus constituents and thereby gaining some insight into the problem of the biosynthesis of virus.

With this in view, we have investigated the effect of a series of substances on the rate of formation of tobacco mosaic virus in isolated tobacco leaf tissue. Of these, one, thiouracil, has proved to be a potent inhibitor at extremely low concentrations. The inhibitory effect is partially reversed by uracil, one of the pyrimidines which can be isolated from tobacco mosaic virus nucleic acid. The experimental procedure and results are briefly described here.

A healthy tobacco (*N. tabacum*, var. White Burley) leaf, 13 in. long, was detached from the plant and inoculated by rubbing with a solution containing 200 μgm. of purified tobacco mosaic virus per ml. The leaf was placed under a bell jar and maintained at 24° C. in 120 ft.-candles of fluorescent lamp illumination for 24 hr. Disks of blade tissue 12 mm. in diameter were then removed from the leaf, washed in sterile distilled water and floated on one-half strength Vickery's solution containing various concentrations of thiouracil in Petri dishes. These were maintained under sterile conditions at the above temperature and light intensity. Periodically, four disks were removed and analysed for tobacco mosaic virus by the method already described[1]. As we have previously shown, leaf tissue maintained in the absence of thiouracil under these conditions is capable of synthesizing amounts of tobacco mosaic virus comparable with those found in intact inoculated plants.

The effect of thiouracil on the amount of tobacco mosaic virus formed 220 hr. after inoculation is shown in Table 1. Complete inhibition of synthesis of tobacco mosaic virus is attained at a concentration of $4 \cdot 3 \times 10^{-5}$ *M* thiouracil. In all concentrations of thiouracil, the tissues remained turgid and epidermal cells exhibited protoplasmic streaming for as long as 300 hr. after inoculation. Hence, the effect of thiouracil on the formation of tobacco mosaic virus cannot be ascribed to death of the tissue. A series of experiments comparable to that described in Table 1 has been carried out with the same result.

Table 1. EFFECT OF URACIL AND THIOURACIL ON THE BIOSYNTHESIS OF TOBACCO MOSAIC VIRUS IN TOBACCO LEAF TISSUE

Leaf	Uracil ($M \times 10^{-5}$)	Thiouracil ($M \times 10^{-5}$)	Time of analysis hours after inoculation	Virus present (μgm./100 mgm. tissue wet weight)
A	0	0	220	289
A	0	0·9	220	227
A	0	1 7	220	75
A	0	4 3	220	10
A	0	6 9	220	13
A	0	8 6	220	13
B	0	0	212	202
B	0 9	4·1	212	20
B	4·7	4 1	212	59
B	9 3	4·1	212	180

That the inhibitory effect of thiouracil is partially reversed in the presence of uracil is also shown by Table 1. These are results of an experiment similar in detail to that described above, except that disks were floated in nutrient containing the concentrations of uracil and thiouracil stated.

In a separate experiment similar to those cited above, the infectivity of homogenates (10 ml. of phosphate buffer, *p*H 7·0, per 100 mgm. of tissue) of inoculated leaf tissue cultured in nutrient medium containing various concentrations of thiouracil was determined by the half-leaf method using *N. glutinosa*. As shown in Table 2, the inhibition of virus formation caused by thiouracil is apparent from the reduced infectivity of tissue cultured in the presence of this substance.

Table 2. INFECTIVITY OF HOMOGENATES OF VIRUS-INOCULATED TISSUE CULTURED FOR 312 hr IN VARIOUS CONCENTRATIONS OF THIOURACIL

Thiouracil conc. ($M \times 10^{-5}$)	Local lesions formed: Average No./half-leaf	Per cent of control half-leaf
0	12	19
2 0	12	22
4 0	6	14
7 0	4	9
10 0	1	3

Note *N glutinosa* half-leaves were rubbed with phosphate-buffer (*p*H 7 0) homogenates containing 10 mgm. of tissue per ml Control halves were rubbed with solution containing 40 mgm. of virus per ml Lesion counts are averages for 8 half-leaves

These results suggest the possibility that thiouracil blocks synthesis of tobacco mosaic virus by interfering with some aspect of uracil metabolism which is normally essential for formation of the virus. This effect may be due to interference with the incorporation of uracil into the virus particle, or to an inhibition of a process more remotely related to the biosynthesis of the virus. The possibility also exists that virus-inoculated leaves may accumulate some precursor of tobacco mosaic virus under the influence of inhibitory concentrations of thiouracil. These aspects of the problem are now under investigation.

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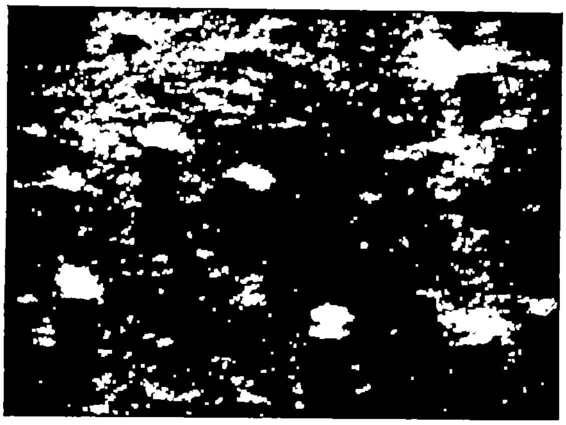
Structure of Sannhemp (*Crotalaria juncea* Linn.) Mosaic Virus with the Electron Microscope

A MOSAIC virus of sannhemp (*Crotalaria juncea* Linn.) was crystallized[1] at the Indian Agricultural Research Institute following the method suggested by Bawden[2]. Later, the virus was crystallized, employing the method of Markham and Smith[3] used for isolation and crystallization of turnip yellow mosaic virus. Control experiments conducted with the expressed sap of the leaves of healthy sannhemp plants and subjected to treatment similar to that given to the infective sap showed that no such crystalline substance could be obtained from healthy material. Solutions of the crystalline preparation indicated positive results in every inoculation test, and typical symptoms were produced on sannhemp plants. Raychaudhuri and Ramamoorty[4] studied the light-absorption curve of 0·11 per cent crystalline solution of sannhemp mosaic virus in a centimetre layer of the solution on a Hilger Spekker spectrophotometer *E*2, and observed two maxima, at 2770 A. and 2632 A., and a third one at 2958 A., with an inflexion point at about 2146 A. A preliminary study has now been made of the size and shape of the structures considered to be virus particles, as observed in the electron-micrographs of the crystalline preparation. The micrographs have been made with the electron microscope installed in the Institute of Nuclear Physics at Calcutta[5].

A micrograph of sannhemp mosaic virus shadowed with gold is reproduced herewith. A drop of the solution of crystalline virus in sterile water was dried on the collodion film mounted on the usual steel mesh. This was then shadowed with gold at angles ranging from $\tan^{-1}\frac{1}{5}$ to $\tan^{-1}\frac{1}{10}$. Several micrographs have been made of such shadowed specimens, and that reproduced is typical. This is a negative print: shadows are dark and the virus particles appear white. These electron micrographs seem to indicate that this virus consists of spherical particles. The measured diameter of the spherical particles varies from 40 to 26 mμ, the majority having a diameter close to 33 mμ. Further work is in progress.



Electron micrograph of shadowed sannhemp virus at a magnification of 38,000 diameters

The size and shape of different plant viruses crystallized so far are shown in the accompanying table for purposes of comparison.

Virus	Shape	Approximate size
Tobacco mosaic (ref. 6)	Rod	15 mμ × 300 mμ
Tomato bushy stunt (ref. 7)	Spherical	26 mμ
Tobacco necrosis (ref. 7)	,,	20 mμ
Southern bean mosaic (ref. 8)	,,	26 mμ
Squash mosaic (ref. 9)	,,	30 mμ
Turnip yellow mosaic (ref. 10)	,,	22 mμ
Sannhemp mosaic	,,	33 mμ

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Isolation of 17-Hydroxycorticosterone and 17-Hydroxy-11-dehydrocorticosterone from Hog Adrenals

THE isolation of 17-hydroxycorticosterone and 17-hydroxy-11-dehydrocorticosterone from hog adrenals has been described by Kuizenga *et al.*[1,2]. The method described involved many stages and an extensive series of benzene–water partitions to effect the separation and isolation of these compounds, the fractionation being followed by means of biological assays.

In this communication we wish to report a simplified method for the preparation of concentrates of these compounds from hog adrenals, involving only four stages, and for the isolation of these compounds from such concentrates by a simple chromatographic technique, giving yields higher than those previously recorded. The following details describe a typical experiment.

33 kgm. of frozen hog adrenals was minced into 66 litres of 99 per cent acetone and extracted by stirring for several hours. After filtration, and re-extraction with 66 litres of 80 per cent v/v aqueous acetone, the acetone extracts were bulked and concentrated *in vacuo*, below 40° C., to remove most of the acetone. The aqueous concentrate was successively extracted with three half-volumes of petroleum ether (60–80°) to remove the fatty material and finally with three one-volumes of chloroform B.P. The chloroform, after drying over anhydrous sodium sulphate, was concentrated to dryness, *in vacuo*, giving 11 gm. of a thick oily extract.

35 gm. of purified wood pulp ('Solka-flok') was impregnated with propylene glycol by immersing the pulp in a 25 per cent v/v propylene glycol/chloroform mixture, filtering the pulp on a Buchner filter and allowing it to dry in the air to remove the chloroform. The pulp was then dry-packed into a chromatographic tube, 35 cm. long × 3 cm. diameter. The 11 gm. of concentrate was mixed with untreated wood pulp and the mixture packed on top of the column. Elution of the column was effected by means of toluene and 100-ml. fractions were taken. An aliquot of each fraction was taken after concentration *in vacuo* and run on paper strip chromatograms as described by Zaffaroni *et al.*[3]. An improved method of impregnating the paper strips with propylene glycol is to soak the strips in a 25 per cent v/v propylene glycol/chloroform mixture and then allow them to dry in air to remove the chloroform and give an even distribution of the propylene glycol on the strip. Control strips were prepared with 17-hydroxycorticosterone and 17-hydroxy-11-dehydrocorticosterone to act as markers and to permit an estimation to be made of the quantities of the compounds present. The bulk of the extract containing fatty material came through the column in the early fractions and contained no detectable amounts of 17-hydroxycorticosterone or 17-hydroxy-11-dehydrocorticosterone. The fractions containing these compounds were united and concentrated to dryness *in vacuo*. The concentrate was dissolved in a small volume of carbon tetrachloride and three volumes of petroleum ether (60–80°) added. The insoluble precipitate produced, weight 151 mgm., was found to contain substantially the whole of the 17-hydroxycorticosterone and 17-hydroxy-11-dehydrocorticosterone present in the original concentrate put on the column.

The crude material was redissolved in chloroform and the solution applied as a narrow band to two sheets of filter paper, 9 in. square, previously impregnated with propylene glycol. The sheets were transferred to a chromatographic tank, using toluene as the mobile phase. The positions of the respective bands were determined by cutting out a narrow lengthwise strip of paper and spraying with ammoniacal silver nitrate solution or iodine solution. Strips corresponding to these bands were cut across the paper sheets and eluted with chloroform, the solution being washed with water to remove the glycol, dried to remove traces of water and finally concentrated *in vacuo*. 11 mgm. of 17-hydroxycorticosterone and 97 mgm. of 17-hydroxy-11-dehydrocorticosterone were obtained, their identity being proved by the usual means, including infra-red spectroscopy.

Attempts were made to convert other steroids present in the cortical extract, in particular, those in the fast-running fractions from the column described above, into 17-hydroxycorticosterone or 17-hydroxy-11-dehydrocorticosterone by incubating at 37° C. with preparations of adrenal tissue under a variety of conditions. No evidence of such biosynthesis was obtained. Our experience in this connexion leads us to support the view that only 17-hydroxy-11-desoxycorticosterone (Reichstein's *S*), which appears to be present in the cortex in minute quantities, is converted by adrenal enzymes into 17-hydroxycorticosterone and 17-hydroxy-11-dehydrocorticosterone.

This chromatographic method of isolation can be effectively applied to urine extracts. With urine extracts, however, two other unidentified bands reacting with the ammoniacal silver nitrate are obtained, one near the origin and the other in front of the 17-hydroxy-11-dehydrocorticosterone.

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Nature of the Factor in Soil-extract Responsible for Bacterial Growth-stimulation

Soil-extract is a valuable constituent of media for the growth of many soil bacteria. A medium containing only agar and aqueous soil-extract will give much higher plate counts from soil than any other medium in common use. Lochhead and Chase[1] showed that one-third of the bacterial cultures isolated from soil in soil-extract agar were unable to grow in a liquid medium containing a wide selection of amino-acids and vitamins, unless soil-extract was also added. They tentatively concluded that several different growth-promoting substances were involved. Some work on the nature of the soil-extract effect is briefly summarized here.

Dilution plates (1 : 500,000) were made from various soils in an agar medium containing soil-extract (25 per cent), peptone (0·05 per cent) and yeast-extract (0·05 per cent). Many of the cultures obtained from colonies on these plates would not grow initially in a casein–salts–vitamins medium, but a large proportion grew, either initially or eventually on subculture, in a medium containing 0·5 per cent peptone (Difco 'Tryptone') and 0·3 per cent yeast-extract (Difco). A number of cultures would not grow in this medium, or in several others tested, including that of Proom and Woiwod[2], but vigorous growth was obtained in the 'Tryptone' – yeast-extract medium if it were supplemented with aqueous soil-extract. Several of these cultures have been used as test organisms in the work now to be described.

Extracts of a number of Hertfordshire soils, prepared by autoclaving (15 lb./in.^{2} for 1 hr.) equal weights of soil and distilled water, were all active when added to the basal 'Tryptone' – yeast-extract medium in 25 per cent concentration. Acetone or alcohol extracts were inactive. Extracts made with sodium hydroxide (0·1 or 0·01 N) were inactive; but extracts made by autoclaving or refluxing the soil with 0·3 per cent hydrochloric acid were highly active. Sulphuric acid extracts were usually inactive. Soil from untreated and farmyard manured plots in Broadbalk field, Rothamsted Experimental Station, were compared by the hydrochloric acid method of extraction; both soils gave active extracts, 0·5–1·0 per cent in the medium being sufficient to give good growth of all test organisms. Water or hydrochloric acid extracts of a number of acid heath soils were inactive.

Treatment of active extracts with cation-removing base-exchange materials ('Soucol', 'ZeoKarbs 215' and '216') removed activity; treatment with 'De-acidite' or charcoal had no effect. If sodium hydroxide were added, the solution heated and the resultant precipitate removed, all activity disappeared. If the extract were evaporated to dryness, the active material could be taken up from the residue by water but not by ether. Water extracts of the dry residue ashed by fusion or with concentrated sulphuric acid were inactive, but extracts of the residue after wet ashing with perchloric acid were active. On the basis of these results, a number of likely ash constituents were tested and it was found that calcium chloride would replace the soil-extract. If the calcium chloride were added to the basal medium before autoclaving, results were frequently unsatisfactory, but if sterilized separately and mixed with the sterile peptone – yeast-extract medium, good growth was always obtained. Experiments with various test organisms indicated that minimal requirements of calcium chloride varied from 2·5 to 50 p.p.m. All soluble salts of calcium tested were effective. Strontium could replace calcium with all cultures; magnesium replaced calcium with some cultures. It seems likely that one or more of these cations are responsible for the effect of soil-extract.

The amount of calcium supplement required to allow growth in a 'Tryptone' – yeast-extract medium is related to the concentration of 'Tryptone' (see table). This suggests that the calcium may not be acting as a simple nutrient but may more probably be acting as an antagonist to some toxic substance present in the peptone. This view is supported by the discovery that different brands of peptone require different concentrations of supplementary calcium to promote growth.

The exacting organisms used in this work are Gram-negative; they appear to be plump rods when studied in heat-fixed films or chains of banded rods when stained in acid Giemsa. Growth is slow bu substantial on nutrient agar; if the agar is replace by silica-gel, growth is negligible. No growth take place in liquid media unless soil-extract or the cation mentioned above are added. Some cultures ar pigmented.

Growth of three cultures after 12 days at 25° C. in media containing 0·3-per cent yeast-extract and varying concentrations of 'Tryptone' and calcium chloride (+++ = vigorous growth; ++ = moderate growth; + = slight growth, – = no growth)

Culture No	'Tryptone' (per cent)	Concentration of calcium chloride (p.p.m.) 0	5	10	20	50	100
173	0·2	–	–	–	+++	+++	+++
	0·5	–	–	–	+++	+++	+++
	1·0	–	–	–	–	+++	+++
	2·0	–	–	–	–	–	–
352	0·2	–	–	–	+++	+++	+++
	0·5	–	–	–	+++	+++	+++
	1·0	–	–	–	–	+++	+++
	2·0	–	–	–	–	+	++
362	0·2	–	–	–	–	+++	+++
	0·5	–	–	–	–	–	+++
	1·0	–	–	–	–	–	–
	2·0	–	–	–	–	–	–

Permission to obtain samples of soil from Rothamsted Experimental Station is gratefully acknowledged I am indebted to my colleague Dr. E. B. Vischer fo advice and assistance in the chemical part of thi investigation.

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Multiple Infection of Clover Plants by Strains of the Nodule Organism in the Field

The possibility of obtaining, under experimental conditions, a simultaneous association of a leguminous plant with different strains of the nodule organism has been investigated by previous workers, with somewhat varying results[1]. So far as I am aware, the only published observations of multiple infection of a given legume plant in the field by strains of the nodule organism of different nitrogen-fixing powers are those included in the recent paper by Purchase and Vincent[2] which refer to clover plants under Australian conditions. Prior to the publication of this paper, I had begun an investigation of this aspect in clover plants growing in the west of Scotland.

A detailed study has been made of the strains of the nodule organism associated with six plants of red clover taken from hill-farm land near Aberfoyle, Perthshire, ten isolations of the organism being made from each plant, from different nodules. The effectiveness of these isolations in nitrogen fixation was tested on plants of red clover grown in aseptic culture in test-tubes containing an agar rooting-medium free from added combined nitrogen. The detailed procedure was similar to that described by Bond and McGonagle[3], except that the effectiveness of the isolations was assessed by comparison with a standard effective strain, taking the dry weight attained by plants as the basis for assessment. Isolations producing plants having a dry weight of not less than seventy per cent of that of the standard plants were classed as effective, those producing plants of dry weight not exceeding twenty per cent of that of standard plants were classed as ineffective and the remainder were classed as intermediate.

After statistical treatment of the data there is clear indication that each of the plants examined had associated with it at least two strains of the nodule organism, usually an effective and an ineffective type. In three plants there were possibly three or four strains present, differing in their powers of nitrogen fixation. Further investigations are being made to determine whether this multiple infection is prevalent in legumes in the field. If this is confirmed, it will help to explain the observation (by Dr. G. Bond) that when isolations of the nodule organism are made from single nodules from each of a number of clover plants growing in a given area, although both effective and ineffective strains may be obtained, the plants yielding the latter show no very marked difference in nitrogen status from those yielding effective strains. To some extent this can be explained by the fact that under field conditions the plant is not entirely dependent on the nodules for its nitrogen nutrition. In addition, as a result of multiple infection, in a particular area, the proportion of nodules produced by effective and ineffective strains may tend to be similar on all plants, resulting in fairly uniform vigour.

It may be of interest that some of the effectiveness tests were carried out during the winter months, the natural light then available being supplemented with artificial light from a battery of 'daylight' fluorescent tubes arranged as described by Low[4]. The intensity of the artificial light alone at plant-level (12 cm. below the fluorescent tubes) was approximately 300 ft. candles, the light being supplied for sixteen hours each day. Very satisfactory growth was obtained under these conditions, the dry weight attained by the plants being only slightly inferior to that of plants grown in summer.

I am indebted to Dr. G. Bond for his advice during the course of this investigation and to the Botany Department, University of Glasgow, for the use of the fluorescent lights.

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Myxobacteria Mistaken for Nitrifying Bacteria

THE nitrifying bacteria, like the sulphur micro-organisms, have been studied almost entirely from a physiological aspect. With the exception of *Nitrosomonas* and *Nitrobacter*, the descriptions of the various genera have been copied from those given by the original investigators[1]. This has led to the description of nitrifying genera with the morphological characters of Myxobacteria, with which the cultures were, apparently, contaminated.

Although enrichment cultures similar to those originally devised by Winogradsky have been used by subsequent workers, only *Nitrosomonas* and *Nitrobacter* species have been isolated. The remaining five genera now listed[2], with the exception of *Nitrosocystis*, seem never to have been observed again. In my opinion, fruiting bodies of *Sorangium* were mistaken for colonies of nitrifying bacteria, and were described in the three genera, *Nitrosocystis*, *Nitrosogloea* and *Nitrocystis*.

The descriptions and photomicrographs by H. and S. Winogradsky show that these genera are almost identical with one another. All three form large aggregates composed of numerous cysts. In some of the species, the cysts appear to be surrounded by a small sheath; but in every case they are composed of numerous, tightly packed, spherical or oval resting cells. This appearance is identical with that observed in *Sorangium* species.

Similarly, Winogradsky's photomicrographs of stained preparations of the disintegrated cysts of these genera closely resemble the appearance in *Sorangium*. Each shows the peculiar bean-shaped or wedge-shaped, capsulated structures arranged in pairs or tetrads, when stained by classical methods. My own cytological observations on *Sorangium* show, however, that this appearance is due to the fact that the microcyst wall is not readily stained. The microcysts actually contain a central vesicular nucleus, and are spherical or slightly oval in shape. Comparison of the photomicrographs of living and stained preparations of *Nitrosogloea*, for example[3], show that this is also the case in the 'nitrifying' genera. The young cysts, photographed *in situ*, show tightly packed, spherical cells, which are not seen in the stained preparations.

The difficulties involved in obtaining pure cultures of nitrifying bacteria are well known. Although the inorganic medium prevents the growth of many micro-organisms, those Myxobacteria which are predatory on other bacteria could appear in the enrichment cultures. Examination for contaminants by the standard technique of inoculation into meat infusion broth fails to demonstrate their presence.

Winogradsky seems to have been unfamiliar with this group of the Myxobacteriales, because they are not mentioned in his soil studies[1]. The myxobacterial swarm is often difficult to detect, although the coloured fruiting bodies are visible to the naked eye.

Imsenecki has also suggested that *Nitrosocystis* is a species of *Sorangium* and has demonstrated that these Myxobacteria are common contaminants on cultures of nitrifying bacteria[4].

Nitrosocystis has been regarded by some workers[5,6] as a hard-colony variant of *Nitrosomonas*. In one instance[5], there is no evidence that the cultures employed were pure, and in the other[6] the brief description of the hard colonies in no way resembles the original descriptions of *Nitrosocystis*.

It would seem, therefore, to be almost certain that three of the genera of nitrifying bacteria now listed are invalid. They were, in fact, Myxobacteria of the genus *Sorangium* which were contaminating the cultures of *Nitrosomonas*.

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Microbiological Oxidation of Ammonium and Thiocyanate Ions in Soil

AMMONIUM sulphate[1] and sodium thiocyanate[2], when perfused through chalked soils neutralized by calcium carbonate, are metabolized by the growth of specific groups of soil microflora on the soil crumb surface to nitrate and ammonium sulphate respectively.

Thiocyanate is a known inhibitor of bacterial growth and poison[3,4] and is frequently found in sewage wastes. It has been reported to be highly toxic to the nitrification micro-organisms[5]. This inhibitory influence on the growth of the nitrifying micro-organisms in soil has been confirmed using the Audus modification[6] of the original soil perfusion technique[7].

Thiocyanate at a high concentration of 0·01 *M* when perfused through an enriched nitrifying soil has been found, however, to have only a partially inhibitive influence on the oxidation of ammonium sulphate, inhibiting the oxidation of ammonium-nitrogen to nitrite-nitrogen by 24 per cent and nitrite-nitrogen to nitrate-nitrogen by 62 per cent (see table). This is of interest, as it has been reported[1] that other sulphur compounds, thiourea and methionine, are highly toxic to the nitrification process.

20 gm. soil 1–4 mm. + 0 5 gm. precipitated chalk perfused with 200 ml. solution	After two days perfusion		
	Nitrite-nitrogen (µgm./ml.)	Nitrate-nitrogen (µgm./ml.)	Total nitrogen (µgm./ml.)
(1) Control, *N*/140 ammon. sulphate	0	100	100
(2) Control + *M*/100 sod. thiocyanate	38	38	76

The thiocyanate, after being perfused through a partially enriched nitrifying soil for four to five days, is metabolized to ammonium sulphate by a specific group of thiocyanate-oxidizing micro-organisms which grow in the soil, and it is thus possible to have a soil enriched with the three specific groups of soil microflora, the thiocyanate-oxidizing bacteria and the two groups of nitrifiers oxidizing ammonium ions and nitrite ions respectively. Using such a soil, it is possible to study the interrelationships of the three groups with respect to the utilization of their specific metabolites. Such a study has been made and the results are shown graphically in Figs. 1 and 2. The graphs demonstrate the biological oxidation of ammonium cations and thiocyanate anions in soil enriched with two groups, the nitrifiers, and soil enriched with the three groups, the nitrifiers and the thiocyanate oxidizing micro-organisms.

Using enriched nitrifying soils, ammonium cations are rapidly oxidized to nitrate, very little nitrite formation being observed (Fig. 1*a*), while thiocyanate (Fig. 1*b*), when perfused through a similar soil, is not metabolized until after a lag phase, when growth of its specific oxidizing micro-organisms takes place and the build-up of nitrite is observed, due to the oxidation by the nitrifying organisms already present in the soil of the ammonium cations formed.

When both groups are present (Fig. 2), ammonium cations are immediately metabolized to nitrite and to a lesser extent to nitrate. With the rapid growth of nitrate-forming micro-organisms, however, both ammonium cations and nitrite anions are rapidly metabolized to nitrate anions (Fig. 2*a*). Thiocyanate, when perfused (Fig. 2*b*), is immediately metabolized at a constant rate to ammonium sulphate, which in turn is metabolized via nitrite to nitrate as in Fig. 2*a*. These latter two oxidations are slightly inhibited until the thiocyanate is completely oxidized.

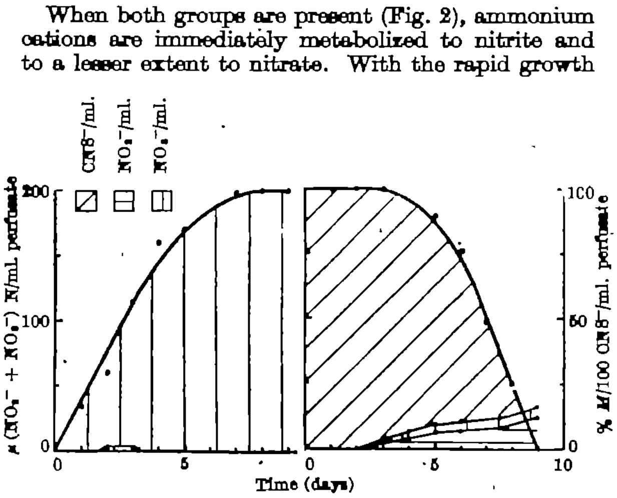

Fig. 1. 20 gm. soil (sieved, 1–4 mm.) + 0 5 gm. precipitated chalk. Enriched with nitrifying micro-organisms by previous perfusion with 200 ml. *N*/70 ammonium sulphate. Washed with distilled water and re-perfused with 200 ml. of (*a*) *N*/70 ammonium sulphate, and (*b*) *M*/100 sodium thiocyanate

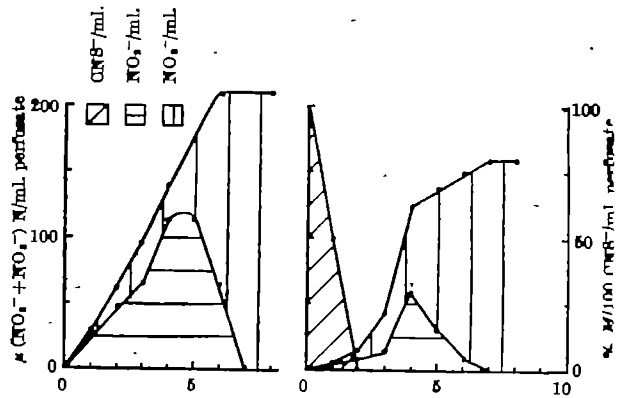

Fig. 2. 20 gm. soil (sieved, 1–4 mm.) + 0·5 gm. ppt. chalk. (Enriched with nitrifying and thiocyanate oxidizing micro-organisms by previous perfusion with 200 ml. *N*/70 ammonium sulphate and later perfusion with 200 ml. *M*/100 thiocyanate.) Washed with distilled water and re-perfused with 200 ml. of (*a*) *N*/70 ammonium sulphate and (*b*) *M*/100 sodium thiocyanate

Thus, the inhibitive effect of thiocyanate on nitrification in soil is not permanent, and it is more toxic to the nitrate forming organisms than to the nitrite-forming group. The exact nature of its action is unknown. The experiments emphasize the usefulness of the soil perfusion technique in the study of dynamic biochemical processes occurring in the soil, and in the study of interrelationships of specific groups of micro-organisms as they occur in Nature.

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A Pronounced Sex Difference in Recombination Values in the Sixth Chromosome of the House Mouse

The loci *be* (belted), *Ca* (Caracul), and *N* (naked) constituting the sixth linkage group in *Mus musculus* are closely linked and in the order *be*—*Ca*—*N*. Linkage of *Ca* and *N* was established by Cooper[1]. He obtained the recombination values 2·64 per cent in males and 0 per cent in females, the difference not being significant on the total number of mice bred (335). Murray and Snell[2] discovered the factor *be* and established the order *be*—*Ca*—*N*. On combining their own data with those of Cooper, they obtained a significant sex difference (probability 0·043) for the segment *Ca*—*N*, there being 12 recombinants out of 392 mice bred from backcrossed heterozygous males, while no recombinants were found among 158 mice bred from heterozygous females. For the segment *be*—*Ca* they obtained the recombination value 11·49 per cent, with no significant difference between the sexes.

In 1947 the genes *be* and *Ca* were introduced into tocks existing in this Department by means of mice sent by Dr. Snell from the Jackson Laboratory, and were combined with *N* in various associations. In 1949 I set up three-point backcross matings in order o redetermine the linkages simultaneously in the two segments and to investigate further the sex differences in the recombination frequencies. The experiment is still in progress, but the data so far accumulated exhibit a marked excess of recombination in the males over the *be*—*Ca* segment, and confirm the earlier indications in the *Ca*—*N* segment.

The backcrosses are of four types, *A*, *B*, *C* and *D*, n which the homozygous parents are *be*++/*be*++, and the heterozygous parents are respectively:

(*A*) +*Ca N*/*be*++ (*B*) *be Ca N*/+++
(*C*) *be*+*N*/+*Ca*+ (*D*) ++*N*/*be Ca*+.

All types (except *A*, where male matings have not yet been set up) comprise matings both of female heterozygotes and male heterozygotes. It is proposed to achieve balancing between males and females as the experiment proceeds. The recombinant offspring of each type of mating fall into three classes, (1), (2) and (1,2), corresponding respectively to recombination in *be*—*Ca* only, to recombination in *Ca*—*N* only, and to simultaneous recombination in both segments. Table 1 shows the numbers in each class observed out of a total of 1,053 mice bred to date.

Table 1

Mating type	Female parent heterozygous (1)	(2)	(1,2)	Bred	Male parent heterozygous (1)	(2)	(1,2)	Bred
A	1	1	0	27	—	—	—	—
B	0	2	0	80	26	6	0	204
C	3	0	1	32	18	4	0	133
D	10	2	0	256	29	8	0	321
Totals	14	5	1	395	73	18	0	658

The observed percentage recombination values for the three segments *be*—*Ca*, *Ca*—*N* and *be*—*N* are thus as given in Table 2.

Table 2

	be—*Ca*	*Ca*—*N*	*be*—*N*
In females	3·80	1 52	4·81 per cent
In males	11·09	2 74	13·83 per cent

A χ_1^2 test applied to the four-fold tables for *be*—*Ca* confirms that the marked difference between the sexes in recombination frequency over *be*—*Ca* is significant at a level more extreme than 0·001 ($\chi_1^2 = 17·2$).

On the number of mice bred, the difference for the short segment *Ca*—*N* is not yet significant ($\chi_1^2 = 1·64$). However, when the new data for this segment are combined with those of Cooper and those of Murray and Snell, significance is achieved with a χ_1^2 equal to 5·18.

It is interesting to contrast the present situation in which two adjacent segments show the same property —recombination more frequent in the male—with that obtaining in the *A*—*un*—*we*—*pa* region of the fifth chromosome. Table 3 shows the results of a four-point backcross experiment (still in progress in this Department), which Prof. R. A. Fisher and Dr. A. R. G. Owen have kindly made available to me.

Table 3

	A—*un*	*un*—*we*	*we*—*pa*	Bred
Recombination in females	4·44	7·29	4 05 per cent	2,502
In males	4·43	4·42	2·39 per cent	2,263

Here the adjoining segments *un*—*we* and *we*—*pa* show a sex difference which is in favour of the female, in contrast to the position in the sixth chromosome. Moreover, the adjoining segments *A*—*un* and *un*—*we* exhibit a notable discontinuity in behaviour. The sex difference is marked and significant in *un*—*we* but entirely absent in *A*—*un*.

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Effect of Ascorbic Acid on Skin Permeability in Adrenalectomized Rats

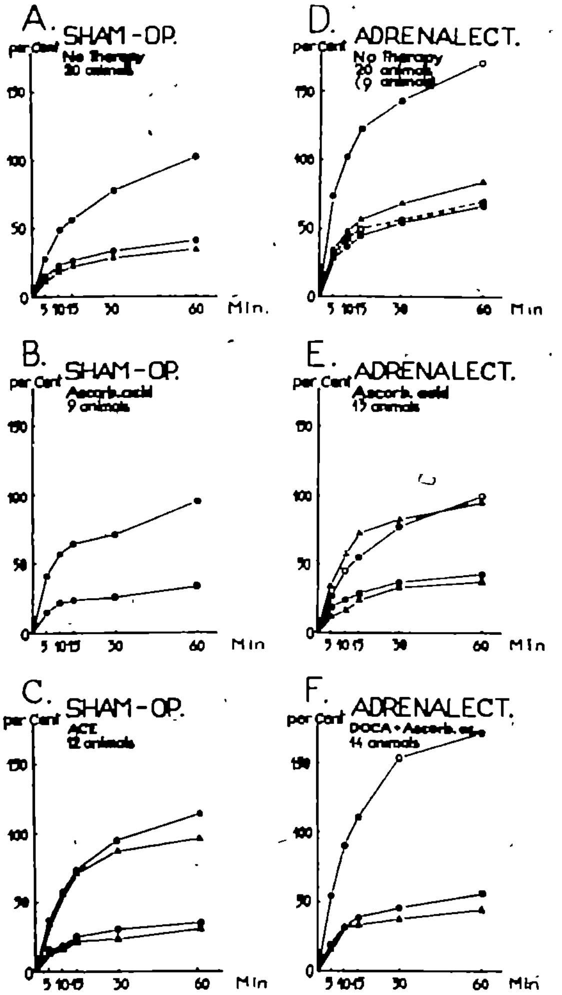
In recent years, facts have accumulated about the composition of the ground substance of the connective tissue proper. In loose connective tissue, this amorphous matrix consists of a highly viscous gel built up by acid mucopolysaccharides like hyaluronic acid and mucoitin sulphuric acid. The ground substance obviously is a very labile structure in respect of its physical and chemical composition. Among the agents that may have an influence on the composition of the interfibrillar gel, the adrenocortical hormones and ascorbic acid have attracted much attention.

With the aid of the spreading technique applied to dermal connective tissue of rabbits and mice, Opsahl *et al.*[1-3] have reported experimental results of a significant enhancing effect of adrenalectomy on the rate of spread of india ink in the skin of living animals. They were also able to show that adrenocortical extract restricted the spreading in intact animals. Animals exposed to a moderate stress likewise showed a restriction of dermal spreading, possibly due to a physiological effect of the adrenocortex hormone.

Several workers have ascribed an important role to ascorbic acid in the metabolism of the ground substance of connective tissues. Thus, restricted production of metachromatic substance in connective tissue of scorbutic animals is reported by various investigators[4,5]. So far as we know, no spreading tests have hitherto been performed for studying the effect of ascorbic acid in connexion with adrenal steroids.

In the course of investigations of hormonal effects on the ground substance of loose connective tissue, we have carried out experiments with a standardized spreading technique on adrenalectomized rats given deoxycorticosterone acetate and ascorbic acid as substitution therapy. Some preliminary results from these experiments are reported in this communication.

In our investigations the rate of dermal spreading of Evans blue and hæmoglobin was studied in the skin of living anæsthetized rats, and in skin flaps cut out from the same animals and injected supravitally. The results are shown in the accompanying diagrams. The pronounced increase of the spreading rate in the adrenalectomized rats is clearly shown in *D* when compared with the sham-operated controls (*A*). These results were obtained both in living skin and



Dermal spreading rate within one hour after injection of 0·10 ml. indicator solution (○●, Evans blue; △▲, hæmoglobin). The areas of the weals were calculated as regular ellipses.

—○—○—, —△—△— } weals in living skin *in situ*

—●—●—, —▲—▲— } weals in cut-out skin-flaps ('dead skin')

- - - ○ - - - ○ - - -, 9 animals tested 6 hr. after adrenalectomy. ACE = adrenocortical extract; DOCA = deoxycorticosterone acetate. Ordinates, percentage increase in weals; abscissæ, time after injection of indicators

'dead' skin six days after the operation. When, however, the spreading rate was measured within a short time after the operation (in this case six hours) no such effect of the operation was demonstrable in living skin (*D*, dotted line). This is presumably due to a stress effect of the anæsthesia and the operation, both of which may induce an output of adrenocorticotrophic hormone and thus of corticosteroids.

Ascorbic acid and deoxycorticosterone acetate, used in the clinic as substitutes for cortisone[6], were given together (*F*) in order to find out whether these substances had any effect on the spreading rate. The dosages used were 1 mgm. deoxycorticosterone acetate and 10 mgm. ascorbic acid per day administered intramuscularly. As a control, 10 mgm. ascorbic acid alone was administered both to sham-operated (*B*) and to adrenalectomized animals (*E*). Another group of intact, sham-operated animals was givén 0·1 ml. adrenocortical extract per day (corresponding to 5 gm. cortex substance) intraperitoneally. The injections were started in immediate connexion with the operations, and continued with one injection every day until the spreading test on the sixth day after operation. This scheme was followed with all the groups except for the one tested six hours after adrenalectomy (*D*, dotted line).

The administration of ascorbic acid only (*E*) had a rather unexpected effect. The dose given seems to inhibit the 'barrier-breaking' effect of the adrenalectomy entirely. The animals given ascorbic acid thus showed the same rate of spreading as the sham-operated, untreated controls (*A*). Furthermore, this effect is valid for both living skin *in situ* and 'dead' skin flaps. Any important effect on the circulation can thus be ruled out. The combined treatment with deoxycorticosterone acetate and ascorbic acid has a rather small effect on 'dead' skin and none at all on living skin (*F*). In the sham-operated animals neither ascorbic acid (*B*) nor adrenocortical extract (*C*) showed any effect on the spreading.

The results given here do not offer any definite explanation of the peculiar effect of ascorbic acid on adrenalectomized rats. It is supposed by some workers[7] that the effect of adrenocortical hormones on the ground substance of connective tissue primarily concerns the activity of hyaluronidase present in the tissue. The ascorbic acid may act as an inhibitor of the hyaluronidase, which is possibly activated in animals deprived of their adrenals. Such an inhibiting effect of ascorbic acid can be demonstrated *in vitro*.

These investigations are being continued, and a detailed description will appear elsewhere.

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Antigens in the Developing Newt Embryo

IMMUNE sera have been prepared in rabbits against isolated tissues of stages of embryonic *Triton alpestris*. The tissues used were: whole gastrula (crescent-shaped blastopore), archenteron roof, and ectoderm (both from early yolk-plug stages). The antisera were used both for interfacial precipitin tests and, diluted, as stock culture media of the same osmotic pressure as Holtfreter's solution; these media contained 1 : 5 to 1 : 20 parts of serum.

The experiments have involved the dissection of some six thousand embryos; but as most of the material has to be used for preparing immune sera or for absorption, the number of explants cultured is not as large as would be wished, and it seems best to sum the results from the two seasons 1949 and 1950; tests show that the figures of deaths and survivals for these years may be considered to come from the same sample.

A total of 579 explants were set up. The results in some of the classes are as follows. Of 104 explants into untreated antisera, 82 died within 48 hours (the majority within 36); of 64 in normal serum, 12 died within the same period; of 29 gastrulæ in anti-gastrula serum, 19 died, and 4 showed defective development; of 24 in anti-gastrula serum absorbed with blastulæ, 17 died, 3 showed inhibited development; 1 in 21 and 1 in 7 died in, respectively, normal serum and normal serum plus blastula extract; of 28 morulæ in anti-gastrula serum, 25 died—2 as gastrulæ of inhibited development—the remaining 3 developed normally; and of 33 morulæ in anti-gastrula serum absorbed with blastula, 18 died, 11 showed inhibition of growth (2 of these survived for more than 48 hours), and 4 were unaffected.

Those classed as exhibiting inhibition of growth remained in general large-celled, with the blastopore forming a slight depression or small pit; in some cases, a dorsal lip was produced which bulged outwards, but there were no lateral lips. The dorsal lip did not appear to be invaginated for any distance.

These figures suggest the appearance of an antigen or antigens at or during gastrulation.

Turning to explants from the late gastrula: of 42 explants of archenteron or ectoderm into both anti-archenteron and anti-ectoderm antisera, 33 died; of 23 explants into control serum, 10 died; of 17 explants* into homologous antiserum absorbed with heterologous tissue, 14 died; and of 17 explants into heterologous antiserum absorbed with homologous tissue, 8 died.

These figures suggest the possibility that archenteron and ectoderm contain one or more antigens in common, but also one or more specific to each.

This season it is hoped to continue the study of the origin of new antigens and their subsequent fates by testing these two antisera with antecedent tissues (blastula ectoderm) and subsequent derivatives (for example, neural plate and neurula ectoderm) after appropriate absorptions.

A full account will be published elsewhere.

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Estimation of Radioactive Hydrogen as Tritiobutane in the Geiger Counter

A METHOD for the assay of tritium has been described by White, Campbell and Payne[1], who convert radioactive water into methane by means of aluminium carbide and then 'count' the methane in the proportional counter. Since this method necessitates additional proportional electronic equipment, I have found it more convenient to assay tritium in the form of radioactive butane, which can be 'counted' in the Geiger region and which, moreover, being condensable at liquid air temperature, is easily manipulated in a vacuum system.

Half the hydrogen of water can, of course, be incorporated into a selected hydrocarbon by reaction with the appropriate Grignard reagent. Butane was chosen in this case because Powell and Reid[2], in their work on the isomerization of butanes, actually prepared tritiobutane and reported it to be a good counter gas.

As carbon-14 is usually assayed in this Department by means of an internal beta-counter with graphite cathode and Neher–Harper quench circuit, this was the equipment first used for testing the properties of butane as a counter gas. At a pressure of 14 cm. mercury, some counters of this pattern show a well-defined Geiger region and a long, flat plateau; but as the proportion doing so is only about one in five, others, with passive iron cathodes, were tried. Of these a much higher proportion have a good characteristic provided the cathode is thoroughly outgassed; but some selection is still necessary. A good counter of this type (20th Century *GA*. 10*M*) containing *n*-butane at a pressure of 14 cm. mercury has a starting voltage of 3,000 volts and a plateau extending over 800 volts with negligible slope. External quenching appears to be essential.

At this pressure the counter contains about 12 standard millilitres of gas, which is the volume of butane theoretically obtainable from the action of 10 mgm. water on the Grignard reagent. As 10 mgm. is about the amount of water obtained from the combustion of convenient quantities of biological materials, a method for the conversion of water to butane on the 10 mgm. scale has been developed.

About 1·5 ml. of a freshly prepared 2*N* ethereal solution of *n*-butyl magnesium bromide is pipetted rapidly into a 10-ml. tube fitted with a *B*-10 standard socket. The tube is plugged on to a *B*-10 cone beneath a stopcock connected with the high-vacuum system, both joint and stopcock being lubricated with silicone grease. The total space beneath the stopcock is about 15 ml. The ether is removed from the Grignard reagent by distillation *in vacuo* with gentle warming. The whole tube is then baked out for two hours at 120°–130° on open pumps. This removes the last traces of ether which would otherwise dilute the butane formed at the next stage. A blank determination carried out by heating the reagent so prepared for an hour at 120° with the stopcock closed should yield no more than 150 µl. of gas.

The tube is allowed to cool and 10–20 mgm. of radioactive water condensed into it by means of liquid air. The tap is closed and the tube heated at 120°–130° for an hour. Tritiobutane is produced almost quantitatively (90–95 per cent of theoretical yield). It is purified by distilling through a *U*-tube cooled to − 78°. A suitable aliquot is measured out, condensed into the counter and the pressure adjusted to 14 cm. with inactive butane. Radioactive butane has not been found to contaminate the counter and a constant background counting-rate is observed between assays.

The method has been checked by assaying a stock solution of radioactive water (containing about 2 µC. per ml.) and various dilutions of it. The specific activity of the butane prepared from these various dilutions was, within experimental error, proportional to the dilution. This indicates that at these tritium concentrations no isotopic separation occurs during the reaction.

The accompanying table shows the results obtained when these samples of radioactive water were assayed. The calculated specific activity shown for each sample in column 5 is based upon the experimentally determined activity of the stock solution itself.

Water sample (% stock)	Vol. butane assayed (ml.)	Activity (c.p.m.)	Specific activity (c.p.m. per ml.)		Error (per cent)
			Obs.	Calc.	
10	8·85	1,353	153	153	0
20	3·70	1,152	312	306	+2·0
40	2·59	1,554	600	612	−2·0
60	1·005 0·860	908 802	915	918	−0·33
80	0·805	972	1,210	1,224	−1·7
100	0·645	987	1,530	—	—

It would obviously be an advantage if a large excess of dry Grignard reagent could be prepared and then used several times. Unfortunately, it has been found that the butane produced by the action of a second sample of water on a once-used tube of reagent is contaminated by radioactivity from the first sample. This may be due to the fact that the yield is never quite quantitative. Furthermore, the yield on the second occasion is considerably reduced. However, using fresh reagent for each experiment, the method can be conveniently applied to routine tritium assays. The tubes of reagent are prepared in batches of six and baked out together on a manifold prior to use.

Thanks are due to the Calor Gas Company for supplying pure *n*-butane, and to 20th Century Electronics for their very helpful co-operation in designing and selecting counters.

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Solution of the Thomas–Fermi–Dirac Equation

The fundamental equation of the Thomas–Fermi–Dirac statistical atom model[1] is the so-called Thomas–Fermi–Dirac equation

$$\psi'' = x\left[\left(\frac{\psi}{x}\right)^{1/2} + \beta\right]^3, \tag{1}$$

where ψ'' denotes the second derivative of ψ by x, β represents the constant $\beta = 3^{1/3}/(32^{1/3}\pi^{2/3}Z^{2/3})$ and Z the atomic number. This equation was solved by Umeda[2] for all neutral atoms with the boundary conditions derived by Brillouin[3]:

$$\psi(0) = 1, \quad \psi(x_0) = 0, \quad \psi'(x_0) = 0, \tag{2}$$

where x_0 corresponds to the border of the atom. The second and the third boundary conditions are equivalent to the minimization of the energy of any single electron in the statistical atom. This requirement and the boundary conditions resulting from it are, however—as has been already mentioned by Jensen[4]—not in agreement with the statistical point of view, according to which the *total* energy of the statistical atom has to be a minimum, which is not equivalent to the minimization of the energy of the single electrons.

From the minimum-principle of the total energy of the neutral statistical atom, the following boundary conditions are obtained:

$$\psi(0) = 1, \; \psi(x_0) = \frac{\beta^2}{16}x_0, \; x_0\psi'(x_0) - \psi(x_0) = 0. \tag{3}$$

It can be seen easily that the solutions obtained by these boundary conditions differ only at the outer parts of the atom from the solutions of Umeda, and even there only to a small extent. The solution of the Thomas–Fermi–Dirac equation with the boundary conditions (3) may therefore be determined from Umeda's solutions in the following way. The solution is put into the form:

$$\psi(x) = \psi_u(x) + k\varepsilon(x), \tag{4}$$

where ψ_u denotes the solution of Umeda and $k\varepsilon$ is small compared to ψ_u. By k we denote a numerical factor independent of x. Putting this expression into (1) and expanding the right-hand side in terms of powers of $k\varepsilon$, one obtains for ε, by neglecting the terms of second and higher powers of $k\varepsilon$, the linear differential equation

$$\varepsilon'' = \frac{3}{2}\left[\left(\frac{\psi_u}{x}\right)^{1/4} + \beta\left(\frac{x}{\psi_u}\right)^{1/4}\right]^2 \varepsilon. \tag{5}$$

Singularities apart from $x = 0$ do not appear here, because the solution is of interest only between $x = 0$ and $x = x_0$, and the solution ψ_u disappears only at Umeda's x_0; this is larger than our x_0, which is determined here with the boundary conditions (3).

If one solves this equation with the boundary conditions

$$\varepsilon(0) = 0, \qquad \varepsilon'(0) = 1 \tag{6}$$

the first of the boundary conditions (3) is fulfilled and also it follows that the constant k determines the initial slope of ψ, for it is:

$$\psi'(0) = \psi'_u(0) + k. \tag{7}$$

The constants k and x_0 are determined from the second and the third boundary conditions (3). These calculations can be extended also to positive ions and spherical symmetrically compressed atoms.

The calculations are very simple and have been carried out by us for the atoms neon ($Z = 10$), argon ($Z = 18$), krypton ($Z = 36$), xenon ($Z = 54$) and radon ($Z = 86$), and for the single and double positive ions of these atoms. The tabulated solutions as well as the values of k and x_0 will soon be published in the *Acta Physica Hungarica*. By interpolation, solutions for further atoms can be obtained. The deviation of our solutions for argon, krypton and xenon from the exact solutions computed numerically by Jensen, Meyer-Gossler and Rohde[5] is less than 2 per cent.

We should like to express our thanks to Prof. Kwai Umeda for his kindness in having sent us his tabulated solutions.

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Decomposition of Formic Acid by Periodate

Since the introduction of periodic acid as a reagent for glycols[1], it has been widely employed for elucidating the constitution of many organic compounds[2]. In recent years valuable information has been obtained in the study of polysaccharides by oxidation with periodic acid[3]. Under suitable conditions, one molecule of formic acid is liberated from a non-reducing end-group, and two from a reducing end-group[4]. Determination of the formic acid set free may give an idea of the chain-length of a polysaccharide, while the consumption of periodate per repeating unit is useful in locating the position of hydroxyl groups therein. It is therefore necessary to know whether or not formic acid itself is attacked by the reagent under experimental conditions.

While oxidizing hemicellulose from jute fibre (a methoxyuronic acid–xylan complex) with a saturated aqueous solution of potassium periodate (*p*H 4·1) at ordinary temperature, it has recently been observed that the amount of periodate consumed per gram of the hemicellulose is never constant, but increases with time. In order to see if the formic acid thus liberated is decomposed by periodate, 'Analar' formic acid of varying strengths was treated with periodate solution in the same way as hemicellulose, and the amount of periodate present in the reaction mixture was determined periodically by titration with sodium arsenite in presence of sodium bicarbonate[5].

Table 1. AMOUNT OF *N*/10 SODIUM ARSENITE (C.C.) REQUIRED FOR 10 C.C. OF THE REACTION MIXTURE (POTASSIUM PERIODATE AND FORMIC ACID)

Time (hr.)	Strength of formic acid in the reaction mixture *N*/20	*N*/50	*N*/80	*N*/100
0	1·80	1·80	1·80	1·80
48	1 0	1·05	1·10	0·85
96	0·65	0·80	1·0	0·85
168	0·20	0·55	0·70	0·70
216	Nil	0·30	0 60	0·50
264	Nil	0 10	0·35	-0·25

In more dilute solutions, formic acid appears to be unaffected by periodate (vide Table 2). It seems necessary, therefore, to maintain a strength of *N*/500 (or less) for formic acid in the final reaction mixture while using unbuffered periodate for oxidation.

Table 2. AMOUNT OF *N*/10 SODIUM ARSENITE (C.C.) REQUIRED FOR 10 C.C. OF THE REACTION MIXTURE (POTASSIUM PERIODATE AND FORMIC ACID)

Time (hr.)	Strength of formic acid in the reaction mixture *N*/100	*N*/500	*N*/750	*N*/1,000
0	3·70	4·0	4·0	4·0
24	3·10	3·85	3·95	3·85
72	2·30	3·75	3·80	3·90
144	2·10	3·80	3·95	3·95

A practically constant value for the consumption of periodate per gram of the jute hemicellulose was obtained using the periodate in acid solution buffered at *p*H 3·09 with sodium acetate and hydrochloric acid.

In such a solution, formic acid of *N*/20–*N*/100 strength remains practically unaffected by periodate, as will be seen from Table 3.

Table 3. AMOUNT OF *N*/10 SODIUM ARSENITE (C.C.) REQUIRED FOR 10 C.C. OF THE REACTION MIXTURE (POTASSIUM PERIODATE AND FORMIC ACID) BUFFERED AT *p*H 3·09

Time (hr.)	Strength of formic acid in reaction mixture *N*/20	*N*/50	*N*/80	*N*/100
0	2 80	2·80	2·80	2·80
24	2 70	2·75	2·70	2·80
72	2·60	2·70	2·70	2·60
144	2·70	2·80	2·70	2·80
192	2 70	2 70	2·60	2·70
264	2 70	2·75	2·75	2·75

Iodine was set free whenever there was little or no periodate left in the system. It would appear, therefore, that potassium iodate is reduced by formic acid to iodide (which with iodate gives iodine in acid solution) in absence of periodate. This is supported by the fact that a saturated aqueous solution of potassium iodate at room temperature (31° C.) readily reacts with formic acid and sets free iodine; but in presence of potassium periodate it liberates no iodine. This is not apparently in agreement with the observation of Halsall, Hirst and Jones[6].

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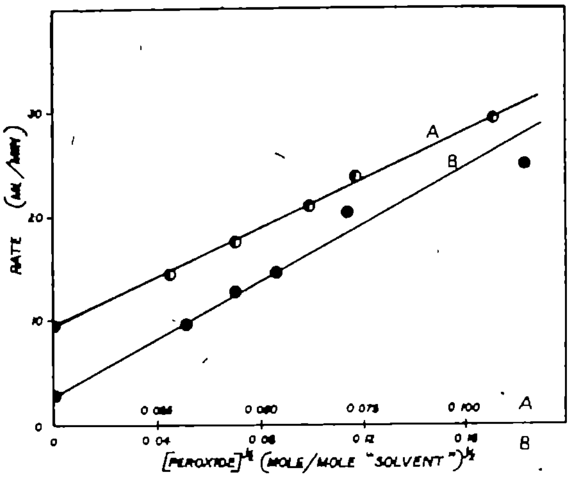
Mechanisms of Oxidation of Benzaldehyde

THE early work of Bäckström[1] demonstrated the chain character of both the photochemical and the 'thermal', that is, dark, oxidation of benzaldehyde to peroxide in the liquid phase. We have studied the kinetics of the thermal reaction in benzene solution at 31° C., and have found it to be catalysed by di-benzoyl peroxide. The increase in rate $\Delta\rho$ above that of the uncatalysed reaction ρ_0 is proportional to the square root of the concentration of dibenzoyl peroxide, as shown in the accompanying graph.



Variation of initial rate of oxidation of benzaldehyde in benzene solution with concentration of dissolved di-benzoyl peroxide at 31·0° C. and 620 mm. mercury oxygen pressure.
1 mole 'solvent' refers to 1 mole (benzaldehyde + benzene), that is, ($N_{\text{benzaldehyde}} + N_{\text{benzene}}$) = 1.
Curve *A*, $N_{\text{benzaldehyde}} = 0·224$; curve *B*, $N_{\text{benzaldehyde}} = 0·182$.
Rates are expressed in ml. oxygen (25° C., 760 mm. mercury)/min. mole 'solvent'

With constant concentration of di-benzoyl peroxide, the dependence of $\Delta\rho$ on both oxygen and benzaldehyde concentrations is such as is required by the mechanism shown by Bolland and collaborators[2] to occur in the peroxide-catalysed oxidation of olefines, namely:

$$\begin{array}{ll} Bz_2O_2 \rightarrow R^- & RO_2^- + RO_2^- \rightarrow \\ R^- + O_2 \rightarrow RO_2^- & R^- + R^- \rightarrow \\ RO_2^- + RH \rightarrow RO_2H + R^- & RO_2^- + R^- \rightarrow \end{array} \left.\vphantom{\begin{array}{l}a\\b\\c\end{array}}\right\} \text{Inactive products}$$

where $RH = C_6H_5CHO$.

The evidence leaves little doubt that the peroxide-initiated oxidation of benzaldehyde occurs by such a free-radical mechanism, the chains being terminated by mutual interaction of two radicals.

It is also clear, however, that the reaction which takes place in the absence of added peroxide (and of light) does not occur by this mechanism. This follows from the fact that the total rate of reaction in presence of di-benzoyl peroxide is given by:

$$\rho = \rho_0 + \Delta\rho = \rho_0 + \kappa[Bz_2O_2]^{1/2},$$

where ρ_0 is the rate of the peroxide-free reaction and κ is a constant for constant [RH] and [O_2] (see graph). If, on the other hand, the peroxide-free reaction occurred by the same mechanism as the peroxide-initiated reaction, the dependence of ρ on [Bz_2O_2] would be of the form

$$\rho = \kappa^1[\varphi + k[Bz_2O_2]\,]^{1/2},$$

φ being the (constant) rate of 'spontaneous' initiation, that is, of initial production of R^- or RO_2^- from benzaldehyde and oxygen, and k the specific rate of initiation by di-benzoyl peroxide. This is not the case. The peroxide-initiated reaction is therefore superimposed on the thermal reaction, which proceeds by a different chain mechanism.

In the presence of di-benzoyl peroxide, the oxidation of benzaldehyde thus takes place simultaneously by two distinct mechanisms. A similar result has been obtained by George[3] with tetralin containing di-benzoyl peroxide. It appears that, at least with benzaldehyde and tetralin, the occurrence of the free-radical mechanism set out above is dependent on the presence of decomposing peroxide, or of some other sufficiently energetic initiator[4].

M. F. R. Mulcahy

Division of Tribophysics,
Commonwealth Scientific and
Industrial Research Organization,
University of Melbourne.

I. C. Watt

Chemistry Department,
University of Melbourne. Feb. 23.

[1] Bäckström, *J. Amer. Chem. Soc.*, **49**, 1460 (1927); ***Medd. K. Vetenskapsakad. Nobelinst.***, 6, No. 15 (1927).

[2] Bolland and Gee, *Trans. Farad. Soc.*, **42**, 236 (1946). Bolland, *Proc. Roy. Soc.*, A, **186**, 218 (1946); *Trans. Farad. Soc.*, **44**, 669 (1948); *Quart. Rev. Chem. Soc.*, **3**, 1 (1949).

[3] George, *Proc. Roy. Soc.*, A, **185**, 337 (1946). George and Robertson, *Trans. Farad. Soc.*, **42**, 227 (1946).

[4] See, for example, George, *Trans. Farad. Soc.*, **42**, 210 (1946). George and Robertson, *ibid.*, **42**, 217 (1946). Bamford and Dewar, *Proc. Roy. Soc.*, A, **198**, 252 (1949).

A Simplified Coupled Filter System for Adsorption Chromatography

Hagdahl[1] has described an improvement in adsorption technique of Tiselius and Claesson[2], whereby much clearer fronts are obtained by the use of small filters which are easily packed. These can be coupled together by means of short distance-pieces with narrow bore which act as front straighteners. The parts of the column are entirely of stainless steel, which combines the necessary degree of rigidity with resistance to attack from solvents. It has, however, been found that in the presence of certain adsorbent materials such as carbon, such steel is not completely resistant to solutions buffered at very low pH.

A more reliable container for the adsorbent can be made from 'Perspex'. The mechanical properties of this material, however, do not lend themselves to the construction of column components which require repeated screwing and unscrewing. A simplified model has therefore been designed which combines all the advantages of Hagdahl's original apparatus with much greater ease of production and assembly. The filters made from 1-in. diameter 'Perspex' rod are a sliding fit into an external jacket of stainless steel, and are held in position between a lower locking collar and the base of the solvent reservoir. For optimum performance the length of each filter is at least five times the diameter (Hagdahl[3]), and each filter in a set is constructed so as to be twice the volume of the one beneath it. The distance pieces are all ¼ in. in length, and are pierced by a 1/32-in. hole. The filters vary in size from 79·2 mm. × 15·9 mm. to 23·8 mm. × 4·76 mm. internal dimensions, giving volumes of approximately 5,000 mm.³ and 125 mm.³. (These sizes are such that the necessary holes can be bored in a normally equipped workshop using standard British drills in 1/16-in. sizes.)

The overall length of each filter exceeds the internal by ¼ in. to allow for the insertion of a perforated disk to assist in the support of the adsorbent.

For carrier displacement adsorption chromatography[4], in which it is not necessary to make accurate and continuous observation of changes in refractive index of the eluate, a mixer as described by Hagdahl[1] is not required. In place of this a front straightener section terminating in a jet is placed at the bottom of the series of coupled filters for direct delivery into a fraction collector. After the individual filters have been filled under suction, they are introduced into the outer jacket starting with the jet, and adding distilled water after the addition of each subsequent section. The jackets are 1/16 in. shorter than the pile of filters and distance pieces, and when the upper end of the jacket is screwed into the base of the solvent reservoir, the filters are compressed into a completely fluid-tight column. Jackets of 14¾ in., 11 in. and 8 in. length enable columns of 9,875, 4,875 and 1,875 πmm.³ volume to be assembled, thus affording adequate variation in size of column for most purposes.

Columns of this type have proved of considerable use in the quantitative separation of mixtures of small amounts of aromatic acids. A description of this work will be published elsewhere. I wish to thank both Mr. L. Hagdahl and Prof. A. Tiselius for most helpful advice and encouragement.

David A. Hall

Department of Medicine,
School of Medicine, Leeds.

[1] Hagdahl, L., *Acta Chem. Scand.*, **2**, 574 (1948).

[2] Tiselius, A., and Claesson, S., *Arkiv för Kemi, Min. Geol.*, (15B), 18, 1 (1942).

[3] Hagdahl, L. (private communication).

[4] Tiselius, A., and Hagdahl, L., *Acta Chem. Scand.*, **4**, 394 (1950).

Adsorption of Water and Methanol on Coal

In a recent issue of *Nature*[1], an address by Sir Charles Ellis was summarized. From the data and theories of various authors, an attempt was made to depict the structure of coal. While we are in general agreement with these ideas, we have information that makes one feature of the theory seem doubtful. The concept that coal is a porous system of high surface area is a major feature of the theory. This idea is largely derived from measurements of heats of wetting in methanol and from adsorption isotherms of methanol and water on coal[2]. Although measurement of heats of wetting is probably not a very accurate method of determining surface area, the surface areas obtained approximate to those obtained using adsorption isotherms of the vapours of the same liquid used in the heat of wetting measurement.

Results obtained in this laboratory (see table) indicate that the true surface area of coal is probably not measured by adsorption of methanol and water. These polar adsorbents are not physically adsorbed in the usual sense, and hence are not amenable to the usual Brunauer–Emmett–Teller treatment for derivation of surface area.

Coal	Surface areas* from isotherms of: Nitrogen −195° C. m.²/gm.	Water 25° C. m.²/gm.	Methanol 25° C. m.²/gm.
Lignite	3·5	290	307
High-volatile bituminous	1·5	94	115
Low-volatile bituminous	0·4	35	112
Sub-bituminous	1·6	310	408

* Computed from the simple Brunauer–Emmett–Teller equation, *J. Amer. Chem. Soc.*, **60**, 309 (1938), with the cross-sectional area of adsorbate molecules estimated in the usual manner.

It will be noted from the table that the surface areas measured by adsorption of nitrogen are quite small, scarcely more than could be accounted for by the external surface area. The surface areas measured by methanol and water are 50–200 times larger than the nitrogen Brunauer–Emmett–Teller areas and are in the range of values published by workers at the British Coal Utilization Research Association laboratories[2,3].

This type of behaviour is known for other materials. Studies of natural and synthetic polymers, particularly proteins and starch[4-6], have established that the adsorption of polar molecules does not give a measure of surface area but is probably related to the number of polar groups present in the adsorbent. However, the adsorption of argon or nitrogen gives surface areas of the same magnitude as those estimated from the average particle size[4,6,7]. These studies on synthetic and natural polymers suggest that water and other polar molecules actually penetrate the polymer and sorb on polar groups of the sorbent. Presumably, this phenomenon also occurs with coal. In addition, recent adsorption studies on carbon blacks indicate that the amount of adsorbed water[8-10], ammonia[8], or methanol[9,10] per unit area (as determined by nitrogen adsorption) increases as the oxygen content of the black per unit surface area.

These results will be published more fully elsewhere. In view of the information presented herein, we feel that a portion of the theory regarding the structure of coal should be modified.

J. A. Lecky
W. Keith Hall
Robert B. Anderson

Synthetic Liquid Fuels Branch,
Bureau of Mines,
Bruceton, Pennsylvania.
Jan. 31.

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[1] *Nature*, **166**, 583 (1950).

[2] Proceedings of a Conference on the Ultra-fine Structure of Coals and Cokes (British Coal Utilization Research Association, 1944).

[3] Bangham, Franklin, Hirst and Maggs, *Fuel*, **28**, 231 (1949).

[4] Benson and Ellis, *J. Amer. Chem. Soc.*, 70, 3563 (1948); **72**, 2095 (1950).

[5] Shaw, *J. Chem. Phys.*, **12**, 391 (1944).

[6] Hellman and Melvin, *J. Amer. Chem. Soc.*, **72**, 5186 (1950).

[7] Zettlemoyer, Chand and Gamble, *J. Amer. Chem. Soc.*, **72**, 2752 (1950).

[8] Emmett and Anderson, *J. Amer. Chem. Soc.*, **67**, 1492 (1950); also unpublished data.

[9] Pierce and Smith, *J. Phys. and Coll. Chem.*, **54**, 354 (1950).

[10] Lecky (unpublished data).

Vegetative Propagation by Root Cuttings

Early in December 1949, we attempted the propagation by root cuttings of *Lagerstrœmia indica*, previously submitted for a fortnight to the action of low temperatures (0°–2° C.) or to a dry atmosphere (relative humidity, 50 per cent) for one or two weeks. Immediately after each of these treatments, the cuttings were put in a rooting medium of equal proportions of sand and garden soil, in a greenhouse, together with controls. All the cuttings were planted upright, as recommended by the Kaiser-Wilhelm Institut.

Two months later, the first examination of the cuttings was made, and it was found that the percentage of best rooting occurred with cuttings previously submitted to dehydration for one week. Cuttings treated by other methods were much more weakly rooted, possibly because of harmful effects of excessive duration of the treatment.

The control cuttings developed better than either those submitted to two weeks of dehydration or those subjected to the action of low temperatures, but not so well as those submitted to one week of dehydration. This seems to us natural, since the tests were made during the season favourable for this type of cutting.

One month afterwards, that is, three months after the experiment started, another inspection showed that the best rooting again belonged to the group of cuttings subjected to one week of dehydration (82 per cent), that the other two treatments had a poor percentage of rooting (8 per cent for cuttings subjected to two weeks of dehydration and 0 per cent for those subjected to low temperature) and that the controls rooted normally (42 per cent), as was expected, because the season was favourable for the propagation by this type of cutting. The advantage of the seven days dehydration treatment was again remarkable as regards average number of roots and their average length.

Encouraged by these results, we carried out new attempts late in March, a season not commonly used for the propagation of this type of cutting. Cuttings of *Pyrus communis* sub-sp. *boreana* were used, together with *Lagerstrœmia indica*, in these experiments. With the *Pyrus*, we found that, at the end of a month and a half, 70 per cent of those previously submitted to two weeks of dehydration had rooted, 48 per cent of those dehydrated for seven days, and no rooting at all of cuttings submitted to the low temperatures or of the controls. With the *Lagerstrœmia*, we obtained the following results. At the end of a month and a half, 38 per cent in the group subjected to one week of dehydration had rooted, 12 per cent of those dehydrated for two weeks, and no rooting at all of the cuttings submitted to the low temperatures and 2 per cent of the controls.

From these observations, we can draw the following conclusions:

(1) Better rooting of root cuttings of these plants is obtained, due to interception of the polar transportation of auxins[1] by means of dehydration.

(2) Seven days treatment gives the best results in the conditions under which these experiments were carried out.

(3) When polar transportation of auxins is intercepted, the rooting process becomes independent of the season in which the cuttings are planted.

These conclusions offer an explanation of the observation that the best results with root cuttings are generally obtained in the open air and not in greenhouses.

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Lisbon.
Jan. 23.

[1] Marques de Almeida, Carlos Rebelo, "Acerca do transporte polar das auxinas" (1950).

Northward Distribution of *Gammarus pulex* (L.)

Since the discovery that *Gammarus lacustris* Sars occurred in the fresh waters of the mainland of Scotland[1], and that the form previously identified as *G. pulex* was most probably this species, there seems to have arisen a tendency to assume that the former species replaces the more familiar *G. pulex* in that area.

However, mutual exclusion by no means occurs and the two species overlap to a marked extent. *G. lacustris* ranges from the north of Caithness and Sutherland southward to at least the Highland Line. *G. pulex*, on the other hand, ranges north through the *G. lacustris* area and has been found in Inverness-shire at Rothiemurchus in water of pH 6·2 at Drumintoul spring. The water of this spring has an alkalinity of 2·7, reckoned as parts calcium carbonate/10^5 (estimates made by the late A. C. Gardiner). This is a somewhat unexpected environment for *G. pulex*.

Farther north and close to Inverness itself, *G. pulex* has been taken from the water-supply source of Leys Castle, where the pH is 6·6. This water flows into a small ornamental lake the sides of which have been concreted and the vegetation of which suggests that the water is alkaline. This lake also contains *G. pulex* abundantly.

The species has been taken from a small stream at Poolewe in the west of Ross-shire. In this stream no *Gammarus* could be found in 1943, when specimens identified as *G. lacustris* were introduced from a neighbouring loch; but the specimens taken from the stream (and now recorded as abundant) and sent to me for examination in 1945 were *G. pulex*.

Thus, so far as I know at the moment, the most northerly limit of the range of *G. pulex* in Scotland is a little south of the border of Sutherland. However, work is at present being carried out on the eastern side of that county, which has not apparently been investigated.

It will be seen from the foregoing that the factors which limit the northward range of *G. pulex* are not at all obvious, and it would not surprise me to find that this species occurs, albeit sparsely, in both the northern counties.

In assessing the distribution of these amphipods, one has to take cognizance of the fact that populations are apt to fluctuate enormously and suddenly, so that conclusions drawn as to the absence of a species after the most careful search may, in a year or two, be reversed by the appearance of abundant specimens. Lochs Poll a' Chnoic and Sgeirach near Stoer, W. Sutherland, both lost their population of *G. lacustris* in this sudden and inexplicable manner; in the case of the former, a population of many year standing disappeared between April and August 1947.

D. M. Reid

Science Schools,
Harrow School,
Middlesex.

[1] Reid, D. M., *Ann. Mag. Nat. Hist.*, 6, 11 (1940).

New Forms of *Spartina townsendii* (Groves)

Within the past few years there has appeared i the Dovey Estuary a number of plants of *Spartin townsendii* differing markedly from the usual form and among these, two very distinct forms ar especially noticeable. One is very dwarf (3–4 in above ground) and with brownish leaves and sheath and flowering only sparsely. The other is variegate and has a leaf-blade with usually a yellow media portion and a band of green tissue along either side the flowering of this form is also sparse. As migh be expected, the dwarf-brown form does not occu in the fully-meadowed spartinetum. It is fairl widely distributed as small plants and as patches o up to 6–8 ft. in diameter in the more recently colonize and semi-open areas towards the upper end of th estuary, and among the *Spartina* which is invadin the grazed glycerietum.

The variegated form is restricted to a comparativel small area of 3–5 acres, and less than a dozen plant have been found, none being more than a few inche in diameter. It would appear, therefore, that thi form is either of more recent origin than the dwarf brown form or that it is incapable of persistence fo more than two or three years.

It is curious that so far the variegated form, whic is no smaller than a poorly grown specimen of th normal form, has not been found to occur elsewhe than within the limits of a patch of dwarf-brown although no connexion between them has been foun below ground. Consequently, its behaviour when fre from competition has yet to be studied. It is no intended to investigate this point and other aspect of the ecological relationship between these form while their cytology will be investigated by Pro P. T. Thomas.

The dwarf form has also been found by one of u in the Severn Estuary near Chepstow, and ther again only in the recently colonized zones. Althoug about twice the height of the dwarf form in the Dovey its relation to the normal form remains the same since on the mud of the Severn site even the norma form grows to about twice the height achieved o the sands of the Dovey.

While some degree of variatión has been recorde by other observers, particularly in regard to anthocya pigmentation, such marked variation as is recorde here does not appear to have been described els where, and the observations so far made suggest th possibility that these new forms represent the di integration of the formerly stable hybrid polyploi

E. H. Chater
H. Jones

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University College of Wales,
Aberystwyth.
March 10.

FORTHCOMING EVENTS

Monday, July 23—Wednesday, July 25

Institute of Physics, Industrial Radiology Group (at 47 Belgrave Square, London, S.W.1).—Summer Meeting.

Tuesday, July 24—Friday, July 27

British Institution of Radio Engineers (at University College, Southampton).—Radio Conference, Sessions 3 and 4: Radio Communication and Broadcasting; Radio Aids to Navigation.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant (Grade B) **in Chemistry** at Constantine Technical College—The Director of Education, Education Offices, Woodlands Road, Middlesbrough (July 28).

Assistant (with a first-class honours degree in science or the equivalent) **to the Divisional Chief Scientist**—The Divisional Establishments Officer, National Coal Board, Northern (N. and C.) Division, First Floor, Ellison Buildings, Ellison Place, Newcastle-upon-Tyne (July 28).

Assistant Lecturers in Electrical Engineering—The Registrar, The University, Manchester 13 (July 28).

Head of the Engineering Department, Nigerian College of Arts, Science and Technology, Ibadan—The Secretary, Advisory Committee on Colonial Colleges of Arts, Science and Technology, 15 Victoria Street, London, S.W.1 (July 28).

Assistant in Mathematics—The Secretary, The University, Aberdeen (July 31).

Demonstrator in Zoology—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (July 31).

Engineer I at a Ministry of Supply establishment in Lancashire, to be responsible for the organization and technical administration of the inspection of electrical and allied equipment ordered by the Atomic Energy Division—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.288/51A (July 31).

Experimental Officer (Botanist) and **Experimental Officers** (Zoologists or Chemists) for freshwater fisheries research at the Brown Trout Research Laboratory, Pitlochry, Perthshire—The Establishment Officer (Room 364), Scottish Home Department, St. Andrew's House, Edinburgh 1 (July 31).

Principal of the Melbourne Technical College—The Agent-General for Victoria, Victoria House, Melbourne Place, Strand, London, W.C.2 (July 31).

Scientific Officers in the Chief Scientist's Division, Ministry of Fuel and Power, London, for fundamental and applied research on problems affecting the production and utilization of fuel and power—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.466/51A (July 31).

Senior Scientific Officer or **Scientific Officer**, and **Scientific Officers** (Zoologists), for marine fisheries research at the Marine Laboratory, Aberdeen—The Establishment Officer (Room 364), Scottish Home Department, St. Andrew's House, Edinburgh 1 (July 31).

Demonstrator in the Department of Chemistry and Biochemistry—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (August 1).

Lecturer in Engineering Mathematics (including pure and applied mathematics and mathematical physics), and a **Lecturer in Medical Physics** (to act also as Assistant Physicist to Aberdeen Royal Infirmary)—The Secretary, The University, Aberdeen (August 1).

Chemists in the Materials and Analytical Section of a Ministry of Supply research and development establishment near London, (*a*) with experience of paints, varnishes and/or plastics, (*b*) with experience of paper and paper products and textiles—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.476/51A (August 4).

Mechanical Engineers and **Naval Architects** (Senior Experimental Officer grade) in Ministry of Supply headquarters, London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.387/51A (August 4).

Principal Research Officer, Wildlife Survey Section of the Commonwealth Scientific and Industrial Research Organization, Canberra—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3464 (August 11).

Assistant Keeper (with a university degree in history or classics and a knowledge of either local history or general archæology) in the **Department of Archæology and Local History**—The Director, City Museum and Art Gallery, Birmingham 3 (August 13).

Lecturer or a **Senior Lecturer in Veterinary Hygiene**—The Registrar, The University, Leeds 2 (August 13).

Assistant Lecturer in Geography at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (August 15).

Chair of Physics in University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (August 15).

Lecturer in Electrical Engineering—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks, endorsed 'Lecturer in Electrical Engineering' (August 15).

Lecturer in Mechanical Engineering—The Principal, Wigan and District Mining and Technical College, Wigan (August 21).

Psychologists, Senior Psychologists, Principal Psychologists and **Senior Principal Psychologists**, in the Admiralty, War Office, Air Ministry and Prison Commission—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 75/51 (August 23).

Electronic Engineers in the Ministry of Supply, to work near London or at provincial stations on the development and design of electrically operated systems for a variety of applications, including weapons, telecommunications and radar equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.134/51A (August 24).

Lecturer in Veterinary Histology—The Registrar, The University, Liverpool (August 31).

Physicist, to work primarily on problems in agricultural meteorology—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (August 31).

Research Assistant (with a good honours degree in chemistry, with physics, and some knowledge of a biological subject) to work on physico-chemical aspects of biochemical and immunological problems—The Secretary, Lister Institute, Chelsea Bridge Road, London, S.W.1 (August 31).

Senior Lecturer in the Department of Physics, Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 1).

Chair of Mining—The Registrar, The University, Sheffield (October 6).

Assistant Director of the Botanical Gardens, Singapore—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27059/261.

Assistant Lecturer in the Department of Mathematics—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

Civil Engineers (with a degree in Civil Engineering and/or corporate membership of the I.C.E.) in the Chief Engineer's Department of the Rhodesia Railways—The London Agent, Rhodesia Railways, 11 Old Jewry, London, E.C.2.

Lecturer in Telecommunications—The Head of the Electrical Department, Polish University College, 4 Egerton Gardens, London, S.W.3.

Mechanical Engineer in the Public Works Department, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Mechanical Engineer—4/8'.

Physicist (previous experience in the medical or biological application of ionizing radiations is desirable), and a **Junior Zoologist** (with an interest in experimental zoology and/or cytology)—The Director, Medical Research Council Radiobiological Research Unit, Atomic Energy Research Establishment, Harwell, Didcot, Berks.

Physicist, to undertake research work and theoretical studies into problems associated with the design and operation of nuclear reactors, an **Organic Chemist**, to take charge of a team engaged on organic chemical research, and an **Inorganic Chemist**, to carry out research work on chemical and radiochemical problems associated with atomic energy development, in the Research and Development Branch, Windscale Works, Sellafield, Cumberland—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for.

Physicists or Mathematical Physicists: (Ref. A.133/51A/BB) **Principal Scientific Officer** with experience of radar systems analysis and war-time operational research (a strong mathematical bias is desirable); (Ref. A.134/51A/BB) **Senior Scientific Officer** for theoretical investigations (a knowledge of statistical methods is desirable); **Aeronautical Engineer**: (Ref. C.217/51A/BB) **Senior Scientific Officer** with experience in planning and analysis of flight trials and application of results to project design (a knowledge of servo mechanism theory and practice is required); **Physicists, Mathematicians or Engineers**: (Ref. A.135/51A/BB) **Senior Scientific Officer** with research experience involving arithmetical applications of mathematics in the analysis of physical data, and the formulation of problems for solution by automatic computing machinery (a knowledge of aerodynamics an advantage); (Ref. A.136/51A/BB) **Senior Scientific Officer** with wide experience of methods of measurement in physics or engineering research, experience and up-to-date knowledge of electronics, at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

Principal Physicist to be responsible for the research work of a physics laboratory applying physical methods to the study of metals and to the development of methods of control of new metallurgical processes, and a **Physical Metallurgist** to be responsible for the research work of laboratories engaged on metallographic, crystallographic and physical metallurgical investigations—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for.

Research Assistant for isotope research (work will involve autoradiography, radioactive counting and maintenance of equipment, and animal experiments)—Mr. G. Rigby-Jones, Middlesex Hospital, London, W.1.

Research Assistant for microbiological assays of vitamin B_{12}, folic acid and L. citrovorum factor—The Registrar, King's College, Newcastle-upon-Tyne.

Research Manager (with a first- or second-class honours degree in physics, or equivalent) at the Research and Development Branch, Windscale Works, Sellafield, to take charge of a group of laboratories engaged on applied research work covering a wide field in general and nuclear physics and biology—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting ARA/6.

Research Officer (with degree in physics, or equivalent) for work on problems in connexion with the use of fuel in domestic appliances, with particular reference to smoke elimination—The Assistant Secretary (Ref. A.23), British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey.

SENIOR EXPERIMENTAL, EXPERIMENTAL, and ASSISTANT EXPERIMENTAL OFFICERS, to undertake and assist with experimental work involving a wide range of chemical and physical atomic energy development problems, and a SENIOR EXPERIMENTAL OFFICER to design and assemble special electronic equipment for research groups working on atomic energy development problems, at the Research and Development Branch (Applied Research), Windscale Works, Sellafield—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for.

SENIOR IRRIGATION ENGINEER, and an ASSISTANT IRRIGATION ENGINEER, in the Public Works Department, North Borneo—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/68.

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EDUCATION AND INDUSTRIAL EFFICIENCY

In a paper on the strategy of industrial research, read before the Midlands Section of the Oil and Colour Chemists' Association last November (see *J. Oil Col. Chemists' Assoc.*, 34, 234; 1951), Mr. M. H. M. Arnold maintained that, in spite of the expansion of effort in industrial research in Great Britain during the past thirty years from very few up to tens of thousands of persons, of whom probably 5,000 are science graduates, with few exceptions British industry as a whole has shown little change in the past twenty or thirty years. He said that few firms could attribute their commercial success to their research departments, and that the position of the average research department, in authority, status and financial endowment, is low. He attributed this unsatisfactory position mainly to lack of an integrated approach to industrial problems. There is, he said, a false cleavage, largely traditional, between scientific, technical and economic aspects. He does not think that the size of a firm is often a decisive factor in success in research, except with very small firms; but he argued strongly for greater receptivity to new, and especially speculative, ideas, and also for greater care in general economic and technical appreciation before undertaking any expensive experimental work. In particular, he is sceptical about the value of research directed towards improving a craft process: in that field he believes that progress can only come by bulk production.

While the main thesis that industrial achievement in Great Britain compares poorly with our achievements in academic research is scarcely open to challenge, Mr. Arnold's analysis was not without critics during the ensuing discussion. If, however, he overstressed some of his points, his protest against waste of scientific man-power on work that is intrinsically unlikely to be profitable should be taken seriously. In essence, it strengthens the case argued elsewhere for strengthening the scientific and technical information services at the disposal of industry.

It would not appear from the examination of the three years experience of their working recently made by *Planning* (PEP Broadsheet No. 326) that the four development councils created under the Industrial Organization and Development Act of 1947 have contributed appreciably towards improving industrial efficiency, or linking industry more closely with the public it serves. Objections to such statutory bodies do not, indeed, appear to extend to statutory levies for research; but the inquiry made by PEP affords little evidence that either statutory or voluntary councils of this type are likely to make any real contribution to industrial development. The Cotton Board is an exception in that it is acknowledged, on the whole willingly, by the cotton industry and exerts a considerable persuasive influence there. However, PEP comments frankly that, even so far as the pooling of experience is concerned and the bringing of the least efficient firms up to the level of the more efficient, it is still uncertain that a development council is the best type of body for carrying out the changes that may be needed.

The decisive factor in industrial efficiency and in industrial research alike is that of leadership, of the supply of scientific workers, technologists and administrators of sound judgment, wide outlook and understanding, capable of selecting the right targets and organizing efficiently. As the Percy Report observed in 1945, the failure to secure the fullest possible application of science to industry is in part a failure in education; this point was stressed independently recently, first by Mr. F. Scholefield, president of the Society of Dyers and Colourists at the Society's annual dinner, and by Sir John Maud in his paper to the Royal Society of Arts on "A Century of British Education". Sir John regards the situation, indeed, as a major problem of British education: however much room there may be for reasonable men to differ about the best means of achieving our goal, the provision for technological education in both university and technical college which we in Britain have inherited must be vastly improved if we are to avoid just and bitter censure from coming generations of our countrymen.

Sir John Maud recognizes that both the universities and the technical colleges have much to contribute: the best universities have their tradition as the common home of science and the arts, research and teaching, of recluses and men of the world, their tradition of independence and inflexible attachment to the highest standards of scholarship; the best technical colleges have an inheritance of intimate association with industry. He said he is confident that we shall find ways both of conserving the peculiar virtues of our various institutions for higher technological education, and, at the same time, of learning from the different experience of the United States, Switzerland, Germany and other countries. Dr. C. J. T. Cronshaw, at the Society of Dyers and Colourists' annual dinner, spoke no less confidently on this point; but he also insisted that a first-class technologist must be also a first-class scientist: arbitrary division between science and technology, he said, is unwise, and he thinks the only method of training technologists is to train scientific men and give them, within the industry itself, the opportunity to become technologists.

Mr. Scholefield, while accepting as justified Dr. Cronshaw's emphasis on the importance of science, inclined to support the view that alternative methods of training technologists are also possible. The divergence between the two views would doubtless be clarified if the meanings of the terms used by the speakers were defined precisely, and particularly exactly what is meant by 'technology'. There are obvious limits to the extent to which technology in the sense of day-to-day practice can be learnt anywhere except in the industry itself, and Dr. Cronshaw's insistence on the importance of science is in keeping with all that was said at the Home Universities Conference last December as to the qualities for which industry looks first in its recruits from the universities, and the desire for graduates of mature education as distinct from merely high technical ability.

An important part of a liberal education is the knowledge that it conveys to the student, often through the literature and history, of the traditions ideas and beliefs that prevail in his society. It helps too, in the formation of sound judgment and in giving due weight to the human qualities to which Dr. D. W. Hill directed particular attention in a paper on the chemist as administrator last Octobe (*J. Roy. Inst. Chem.*, 74, 447; 1950). Such knowledge and judgment cannot be acquired in the range o technological studies, and in this sense science and technology do not provide a liberal education, as Lord Cherwell and others contend. Even Sir Graham Savage, in an address on the future development of higher technological education to the Union of Educational Institutions on June 8, supported this dubious proposition; though he urged, too, that industry can only be efficient if it is manned and directed by a staff in which highly trained and efficient technologists are fully represented.

Sir Graham appeared to be thinking primarily o the receptivity of industry to new scientific and technical ideas; but how essential such humane knowledge and judgment are to anyone who aspires to play a leading part, even as technologist, in the world to-day, can scarcely be better demonstrated than in the study of the composition of the boards of nationalized industries which the Acton Society Trust has just issued under the title "The Men on the Boards"*. This pamphlet disposes effectively of the wilder charges against members of the boards, and indeed gives a firm rebuke to those who make unfounded charges; but it indicates that, by and large, failure has occurred just at this point.

Members of national boards have been chosen simply for their ability and experience in industrial and administrative affairs, and it is manifest that business ability is not enough. Ignoring factors peculiar to single boards, the general review leads to the conclusion that national boards have not succeeded to any marked extent in dispelling the traditional suspicions of employees and in opening up an era of harmonious co-operation. Sometimes they have failed to raise important topics for consultation until after decisions have been made; and again, requests from the employee side to discuss certain matters have been rejected out of hand Some boards have taken a narrow view of their responsibilities in such matters as the provision of training and research, and have been reluctant to experiment in this field. Training programmes have frequently been limited in scope and have ignored the need for giving the employee a wider knowledge of the structure of his industry and his responsibilities as a citizen in that context.

Again, there is evidence that the boards have failed to appreciate the unique character of the task of running an entire industry on a monopolistic basis, and of the need for working out fresh solutions for the completely new set of organizational problems which arise. They have not always shown the imaginative approach and willingness to experiment with new atterns of organization and communication for which the situation calls. In general, they have also een reluctant to explain themselves to the public.

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* The Men on the Boards: a Study of the Composition of the Boards of Nationalised Industry. (Nationalised Industry Series, 4.) Pp. iii+22 (Claygate: Acton Society Trust, 1951.) 2s.

For such reasons the Acton Society Trust suggests hat what is required is a trustee board composed f people of many types of ability, and selected articularly for their imagination, adaptability and readth of vision. They must be competent to take he review of wide issues which is an essential part f their duties. Equally, the organization must rovide for more effective contact with employees.

In this study there are no illusions as to the diffiulty of obtaining a sufficient range of experience for he task; and the suggestion is advanced that a small permanent commission, with a qualified staff, should be constituted for appointing members to the public boards. But one of the important features of this tudy is the implication it has for other fields. Part of the responsibility for the failure of the national boards lies clearly on the inability of the trade unions hemselves to provide men from their membership of the necessary vision and judgment. The very growth in power of the trade unions makes the question of wise leadership for them a national and not a sectional issue; yet at the same time the series of sporadic unofficial strikes have emphasized the inherent weakness of their present organization.

It is in such a context as this that the question not merely of higher technological education but also of higher education generally, whether full-time or extra-mural, needs to be considered. It is not a question of selecting and training men or women specifically for leadership. It is rather one of providing the education which will ensure that those called to positions of responsibility in any walk of life are so equipped that they can bring to their task, not merely technical or scientific knowledge and practical experience, but also wide vision and the understanding of the human issues which will prevent sectional from prevailing over national interests. Only men and women so equipped are capable of the clear and balanced thinking which is required both in handling the problems of organization and policy in undertakings of the scale of nationalized industry, and in the selection of the right targets for research and development.

AUSTRALIAN GEOLOGY: A REGIONAL SYNTHESIS

The Geology of the Commonwealth of Australia
By the late Sir T. W. Edgeworth David. Edited and much supplemented by Dr. W. R. Browne. Vol. 1. Pp. xx+747+58 plates. Vol. 2. Pp. iv+618+plates 59–84. Vol. 3. 5 maps. (London: Edward Arnold and Co., 1950.) 3 vols., £12 12*s*. 0*d*. net.

THESE volumes, unequalled among regional surveys of comparable dimension for their scope and range of completeness, mark a major event in the annals of Australian geology and form a fitting monument to the memory of Sir Edgeworth David, their chief architect. For this stupendous undertaking, begun a quarter of a century ago and now at last brought to completion, no one was so fitted as Sir Edgeworth David himself. His own personal researches had covered an amazingly wide field embracing geological problems in every State of the Commonwealth, and he had, through half a century, made himself familiar by extended travel with the field-work of his colleagues in every corner of the continent of Australia.

As the first product of Sir Edgeworth David's labours a large coloured geological map of the Commonwealth on a scale of 1 : 2,990,000, together with a slender volume of explanatory notes, had been issued in 1932. The book itself, however, remained unfinished at the time of his death in 1934 and the task of completing it fell to his colleague, Dr. W. R. Browne. The long delay in its appearance has been due in part to the Second World War, when publication proved impossible, and to the further revision which was deemed advisable at its close, to bring the manuscript so far as possible abreast of the more recent advances. This revision has, in fact, involved rewriting part of the original text, and geologists owe Dr. Browne a debt of gratitude for his unselfish devotion to a labour which must have been beset by many difficulties.

The book is in three volumes: the first, of 747 pages, deals with historical geology, including a chapter on the geology of Australian New Guinea, while the second (618 pp.) treats of the physiography and economic geology. The third volume contains the coloured geological map issued in 1932 together with a map of Australian New Guinea (1 : 2,500,000) which, though previously published by the Directorate of Army Research, had not become generally available.

The pattern of treatment in the section on historical geology is the description of the formations by States, each chapter presenting a geological distribution map of the period and concluding with an extensive bibliography.

The final chapter of the first volume attempts a review of the tectonic history of the continent of Australia, considering its relations with Asia, the framework within or about which it was built and the events leading up to its present isolation.

The main impression given by these volumes is one of great completeness, of a story which has not only summarized the whole wealth of published data but has also essayed to provide the vitalizing threads of synthesis. Occupying as they do not less than one-sixth of the area of the continent and forming the repositories of leading ore deposits, Pre-Cambrian formations come to play a major part in Australian geology. Their description covers a hundred pages of the first volume, and the geology of their economic products is lucidly discussed in many chapters of Volume 2.

The correlation of the various divisions of this vast Pre-Cambrian terrain is beset with intricate problems and, as might be expected, stratigraphic and structural knowledge of the more complex areas is best known from centres of active mining. It is clear from these accounts that in Australia, as elsewhere, an immense field of research on the older rocks lies open to the investigator.

An admirable description is given of the widespread Upper Pre-Cambrian series, which holds a major glacial horizon and appears to pass in many places conformably into fossiliferous Cambrian, thus suggesting that parts of the series are Lipalian in the sense of Walcott, bridging the time between the Pre-Cambrian and the Palæozoic.

During much of Palæozoic time and later, the Australian continent is pictured as bounded east and west by geosynclines.

In particular, the attention of the reader is arrested by the account of the great tectonic depression known (and so named by Schuchert) as the Tasman geosyncline, covering at various times much of eastern Australia and Tasmania. The synthesis of events that gave growth and change to this majestic structure forms a central theme in the discussions of the Palæozoic System, and the detailed account of its structure, its repeated orogenies and synchronous or subsequent granitic epochs form one of the most fascinating sections of the book.

The magnificent vista thus skilfully revealed will give added stimulus to the prosecution of major groups of researches, providing, for decades to come, lines of investigation for workers in all departments of the science.

In the long geological history of Australia so clearly depicted, it is pleasing to find that measured emphasis is given to the place of vulcanism and plutonic igneous activity, with an attempted assessment of their role in the stratigraphic and tectonic record. Knowledge of the vulcanicity is perhaps most detailed among the Tertiary lava floods of eastern Australia, where petrological investigation has been more intensively carried forward. The book is enriched by an up-to-date chapter on Australian New Guinea prepared by officers of the Australasian Petroleum Co. One of the more interesting disclosures emerging from recent study of this region, and here recounted, is the refutation of the long current interpretation of the occurrence of over-thrusts of Alpine type among the younger folded rocks; on the contrary, the mountain-building movements are now recognized as being primarily vertical rather than horizontal.

The section on physiography, a work of 141 pages in the second volume, provides an exemplary account of the main features of the geomorphology of the continent of Australia. The larger section of the volume, however, is devoted to economic geology, commencing with a general account of the distribution of ores in space and time and their close relation to the epochs of plutonic intrusion.

Thereafter each of the chief metals is described in chapters divided by States. Important sections deal with coal, lignite and oil shale, and the descriptions conclude with a survey of artesian basins which cover in the aggregate upwards of one-third of the area of Australia, the largest in regions of low rainfall. The results of the prolonged study of these basins, the problems of their stratigraphy, structure and chief aquifers, and of the flow and salinity of their waters, are very completely set out with copious reference to the extensive researches devoted to this field. Many other fascinating topics, which in the limits of a short review it is impossible adequately to consider, are lucidly expounded in this monumental treatise.

Here will be found the discussion of such diverse subjects as the evidence for no less than five ancient glaciations, three of them of major extent and duration; the nature of the correspondence between recorded diastrophisms and those of extra-Australian regions; the rise and extinction of the distinctive land flora of the Carboniferous and the controversial problem of the Permian boundary; the status of the Papuan geosyncline; the disruption of the Australasian continent; and the antiquity of man.

The topics are legion, and it would appear that n significant study devoted to the regional geology ha escaped summary. The book without doubt wi endure as the chief reference work on Australia geology for many years. In the concluding sentenc of the introduction the study is described—and wel described—as at once a stocktaking and an interpretation. That it also forms a secure foundation o which the student of to-morrow may build Dr Browne may be emphatically assured, and ca proudly so claim. The impressive work marks, indeed a vantage point in the history of advance in regiona geology with which the names of David and Brown will always be associated.

C. E. TILLEY

THE TEACHING OF COLLOID CHEMISTRY

Kurzes Lehrbuch der Kolloidchemie

Von Dr. B. Jirgensons und Dr. M. Straumanis. Pp. viii+282. (Berlin, Gottingen und Heidelberg Springer-Verlag, 1949.) 21.60 D. marks.

THE importance of a sound knowledge of colloid science to the chemical technologist has resulted in more attention being paid to this subject in university courses in recent years. A number of excellent monographs and larger volumes aimed mainly at the already trained worker exist, but there are few treatments written frankly for the student This compact work by Drs. B. Jirgensons and M Straumanis is therefore welcome. It is unpretentious it is a university text-book and nothing more, but it is a good one. The authors have known what to leave out as well as what to put in. The student is guided logically through what can be pedagogically an awkward subject, and the introduction to modern physical techniques comes early. This is a good point, as it is unwise to overload the new student with all the classical burden; it is better to present him early on with a sound framework into which he can fit further facts and observations as he comes across them.

The descriptions of experimental techniques are of just the right standard: the main features and underlying theory are given, and the reader is guided to the essential literature. In a second edition, the opportunity might be taken to include a short section on the low-angle X-ray scattering method for particle-size determination in the 100-A. range. At the same time, the section on the X-ray line-broadening method could be slightly amplified to cover the intensive discussions on this subject which occurred in Great Britain during the war years.

As might be expected, the book to some extent reflects the barrier of the war period. This could easily be remedied in a new edition which, while broadened to embrace recent American and British advances, should not lose the present book's high quality of presentation. In my opinion, this short book of some 280 pages would be well worth translating into English for the benefit of the many students who find difficulty in reading German. It does not compete with recent larger works which can give a much fuller and more thorough treatment than is attempted by Jirgensons and Straumanis. Its attractive features are its succinctness, its wise selection of material and the exceptional clarity of treatment.

D. P. RILEY

SCIENCE AND TECHNOLOGY OF POWDER METALLURGY

Treatise on Powder Metallurgy

By Dr. Claus G. Goetzel. Vol. 1: Technology of Metal Powders and their Products. Pp. xxvii+778. 10s. Vol. 2: Applied and Physical Powder Metallurgy. Pp. xviii+910. 144s. (New York and London: Interscience Publishers, Inc., 1949–50.)

COMPARATIVELY little is generally known of the increasingly important part played by the products of powder metallurgy in industry. Possibly the publication of this encyclopædic treatise on the subject may conduce to a wider knowledge of the subject, especially in engineering circles. Powder metallurgy is defined as the art of producing metal powders and objects shaped from individual, mixed or alloyed metal powders, with or without the inclusion of non-metallic constituents, by pressing or moulding objects which may be simultaneously or afterwards heated to produce a coherent mass, either without fusion or with fusion of a low-melting constituent only.

The earliest products on a commercial scale were porous oil-impregnated bearings of bronze. To-day the most important materials produced are cemented carbide tools which in a few years have revolutionized the operations of cutting, grinding, machining and milling, and have accelerated production and effected economies beyond any expectation of engineer or manufacturer; at the same time the products of powder metallurgy have suggested solutions to many outstanding problems in the production of high-temperature resistant materials, to mention only one group of potentialities.

The Second World War enormously accelerated progress in every department of powder metallurgy, and workers therein have felt the lack of any comprehensive survey which would correlate theory and practice and at the same time attempt an over-all picture of the development and progress which have been so notable a feature of the past decade. The two volumes by Dr. C. G. Goetzel most admirably fill that void. Vol. 1 covers the technology of the processes of the art, discusses the underlying principles and provides a historical review. Methods of powder production and the characteristics and properties of powders are discussed in detail. Methods of testing powders are described, and attention is given to the widest range of commercial powders. The behaviour of powders under pressure and the moulding of powders into solid form are dealt with, followed by a discussion of dies, punches, presses, and, after consideration of hot pressing, the principles of sintering and its practice, including furnaces and atmospheres as well as finishing treatments. Vol. 2, divided into two parts, deals first with applied powder metallurgy and supplies the fullest account extant of the happenings and progress of the past ten years. The sections cover refractory metals and alloys, hard metals and compositions, electrical and magnetic materials, ferrous and non-ferrous materials for structural parts, porous products, friction materials and dental alloys. The second half of the volume, on physical powder metallurgy, describes and discusses the important phases of the physical metallurgy of metal powders, comparing the physical properties of sintered and fused industrial alloys and metals. An excellent survey is given of sintered metals and alloys for potential industrial use; the stress analysis of sintered metal structure and an appraisal of testing methods provide material of outstanding practical value, while there is a full and most useful review of theories of bonding and sintering.

A section is devoted to the future of powder metallurgy, and it is perhaps the future that should be stressed, for no other technique has such potentialities or holds out such promise as powder metallurgy. Not only does it overcome the handicaps that are inherent in the limitations imposed by the necessity for melting and then cooling-down molten metal, but also it overcomes the incompatibilities arising from widely divergent melting points, large variations in electrical or heat conductivity, and the differences between metallic and non-metallic bodies. It can produce unique materials, and these two volumes by Dr. Goetzel provide a guide and a commentary comparable with the best that is available in any other subject. Moreover, the documentation is of a high order and is to be supplemented by a third volume which will comprise a classified and annoted bibliography covering both literature and patents.

H. W. GREENWOOD

OPERATIONAL CALCULUS

Operational Calculus based on the Two-Sided Laplace Integral

By Dr. Balth van der Pol and Dr. H. Bremmer. Pp. xiii+415. (Cambridge: At the University Press, 1950.) 55s. net.

ALTHOUGH operational calculus is not derived from anything fundamentally new in mathematics, it is nevertheless a comparatively modern technique. Since its recognition as a valuable weapon, both in pure mathematics and mathematical physics, much literature has appeared, ranging in scope and manner of presentation from the practical text-book to the erudite treatise. In almost all cases where the analytical background has been worked out in detail, the author has adopted one of two main courses: either following Heaviside in using an operator $1/p$ defined as a definite integral; or by using the so-called Laplace transform $\int_0^\infty \exp(-pt)f(t)dt$, or in some instances $p\int_0^\infty \exp(-pt)f(t)dt$. It is not intended here to compare the advantages and disadvantages of these alternatives (which are, of course, mathematically equivalent), but to discuss briefly a third method of attack based on the replacement of the one-sided integral, quoted above, by a two-sided one of similar character, namely, $p\int_{-\infty}^\infty \exp(-pt)f(t)dt$.

It is at once clear that this modification of the Laplace transform does not basically affect the ideas and methods of procedure encountered in the one-sided case. We still have, for example, a unique 'image' $\varphi(p)$ derived from the 'original' $f(t)$ by the integral transformation, and a complex inversion-integral enabling us, in certain cases, to determine explicitly the original of a given image. Furthermore, we are still in possession of the fundamental asset of the operational calculus in that we can study the properties of many apparently quite intractable and often discontinuous functions of a real variable t by means of their smooth, analytic (and therefore much simplified) images in the p-plane. What, therefore, are the advantages of the two-sided transform, and what are its corresponding disadvantages, if any?

Three advantages are summarized by the authors, in their preface, as follows: the class of functions $f(t)$ suited to operational treatment becomes much larger; the transformation 'rules' are considerably simplified; and the entire treatment becomes more rigorous. On the other hand, the disadvantages are mainly of a theoretical kind, being for the most part concerned with the precise stipulation of the strip of convergence $\alpha < \mathbf{R}(p) < \beta$ for which a particular relationship is valid, and are therefore often of little interest or importance to the more practical student. It would seem to be well worth while to illustrate the above remarks by means of actual examples, where possible. Using the symbol $\sim$ for the equivalence of $f(t)$ and $\varphi(p)$, it can easily be shown that $\exp(-\alpha|t|) \sim 2\alpha p/(\alpha^2-p^2)$, while in the one-sided theory there is no proper image. Again, $\exp(-\alpha t^2)$ $(\alpha > 0)$ $\sim \sqrt{(\pi/\alpha)}p \exp(p^2/4\alpha)$ for all p, a much more compact result than the one-sided image $1/2 \sqrt{(\pi/\alpha)}p \exp(p^2/4\alpha) \operatorname{erfc}(p/2\sqrt{\alpha})$. Yet another example of a much simplified image is afforded by $1/(1+e^t) \sim -\pi p/\sin \pi p$ instead of one involving logarithmic derivatives of the gamma function. As regards the simplification of the transformation 'rules', one may quote an extremely elegant form of the 'shift' theorem, namely, $f(t+\lambda) \sim \exp(\lambda p)\varphi(p)$ for all real λ, while Borel's 'composition' theorem becomes

$$\frac{1}{p}\,\varphi_1(p)\varphi_2(p) \sim \int_{-\infty}^{\infty} f_1(u)f_2(t-u)du,$$

a valuable improvement on the old form on account of the constant upper limit of integration. There is, admittedly, a compensating difficulty here, in that a common strip of convergence is sometimes not available, but this is easily obviated by use of the 'shift' theorem in the majority of cases. It would be outside the scope of a review to attempt to deal seriously with illustrations of the authors' third contention that the entire treatment becomes more rigorous, and so it must suffice to say that there are numerous places in the text where such illustrations are presented.

The book is divided into sixteen chapters, covering an unusually wide range of 'operational activity', beginning with an introduction by way of the Fourier transform, followed at once by a detailed survey of the elementary 'images' and rules. Special attention is then focused on the Heaviside 'unit' function and its derivative, Dirac's δ or 'impulse' function, both of which play an important part in the two-sided theory. After further chapters concerned with theoretical development, the authors deal very thoroughly with linear differential equations (including those with variable coefficients) and their many applications to electrical circuits, networks and filters.

Many special functions, in particular those of Bessel and Legendre, and the polynomials of Hermite and Laguerre, are then discussed, and there are also chapters dealing with difference equations and integral equations. Finally, we have partial differential equations, both in one variable and severa variables, with the introduction of a *simultaneou* operational calculus enabling the reader to study a new treatment of Green's functions, potential theory and Maxwell's electromagnetic equations.

Appendixes are supplied containing a summary o the general rules (aptly described by the authors as the 'grammar') and a classified 'dictionary' of the images of the more familiar functions, all of which is absolutely indispensable to anyone intending to make a systematic use of the operational calculus, either in mathematics or physics.

By way of criticism, it must be pointed out that as the work is a translation from a series of lectures in Dutch, the language is from time to time somewhat clumsy and stilted, and there are even instances in which a wrong word has been used. Such imperfections, however, are of little consequence in a book of this kind, where a large part of the text is purely symbolic. The excellent reproduction has regrettably resulted in a price that may well be outside the range of many an impoverished student, but those whose purse can still rise to the occasion will be amply rewarded by the possession of a copy.

J. H. PEARCE

ANIMAL PSYCHOLOGY

Handbook of Psychological Research on the Rat

An Introduction to Animal Psychology. By Norman L. Munn. Pp. xxvi+598. (Boston and New York: Houghton Mifflin Co.; London: George G. Harrap and Co., Ltd., 1950.) 35s. net.

A FEW years ago, Dr. N. L. Munn produced a book called "Psychology: The Fundamentals of Human Adjustment". It immediately won its way to high popularity in many universities in the United States and in Great Britain. It is a good general introduction to psychology.

The author's success is likely to be repeated with this new work, particularly if those who recommend it direct attention to its sub-title, which does not appear on the spine or the front cover of the book It is, indeed, a handbook of psychological research on the rat, with a bibliography of 2,500 references, but it is much more than that: it is a fine, scholarly record of numerous investigations that display clearly the foundations of the psychologist's claims to be a man of science and to be able to make a contribution to science that other scientific workers cannot make. The non-psychologist who seeks a straightforward illustration of this point will find it in the section (pp. 272–278) that deals with studies of 'delayed reaction'.

Although most of the book is taken up with work on sensory and learning processes, about a quarter of it is devoted to 'abnormal and social behaviour'. This is a welcome sign that rat psychologists are throwing off the tendency to narrow-mindedness that for many years has restricted the scope of their investigations and has incidentally deprived many non-laboratory psychologists of the advantages of close contact with them. One notable recent development in this field has been experimentation on the effects of electroconvulsive shock. As Dr. Munn remarks (p. 441): "Although the first study of electroconvulsive shock on rats was published in the present decade, the literature is already extensive and new studies are pouring in". Among the investigators who have become prominent in this area is Dr. Roger W. Russell, formerly of Pittsburgh, who has recently succeeded Sir Cyril Burt as professor of psychology in University College, London.

The summary and conclusions on abnormal behaviour (p. 463) and social behaviour (p. 473) will appeal very much to a wide range of readers, though they tend to give the gloomy impression that rats are on the whole no more regardful of other rats than are human beings of each other. Thus (p. 475): "The clearest instances of what might be regarded as truly cooperative behaviour are those in which two rats learned to take turns in sitting on a platform so that each could feed without receiving an electric shock".

Dr. Munn's italicized postscript (p. 476) gives an excellent indication of the content of his book. "We have seen that the rat is an exceedingly useful tool for the investigation of a wide range of problems having relevance for human psychology. Of especial significance from this standpoint are the findings on: (1) physiological aspects of motivation, (2) contributions of sensory processes in learning, (3) the role of brain processes in learning, retention, and reasoning, (4) effects of drugs and vitamins on the learning process, (5) equivalence of stimuli in perceptual response, (6) evaluation of learning theory, (7) effects of nutritional conditions upon abnormal behaviour, (8) conflict as an etiological factor in behaviour disorders, (9) analysis of the procedures and outcomes of shock therapy and (10) objectification of psychoanalytic mechanisms. In some of these fields the research is well advanced and rather definite conclusions are possible. . . . In others, and particularly the last-mentioned, research is in its initial stages."

Alec Rodger

BIRDS OF PARADISE AND BOWER BIRDS

Birds of Paradise and Bower Birds

By Tom Iredale. Pp. xii+239+33 plates. (Melbourne: Georgian House Pty., Ltd.; London: Phoenix House, Ltd., 1950.) 105s. net.

On p. 2 of this book there occurs the following pronouncement: "The acme of uselessness in ornamentation appears to have been reached in the Birds of Paradise, as here coloration and feather structure appear in the male, making it a very beautiful creature, while the female has remained very ordinary". It is a minor tragedy that the book, superbly illustrated by Mrs. Iredale (Lilian Medland) and finely produced by its Melbourne publishers, is in its text a hotchpotch of such statements, old-style taxonomy and long and uncritical quotations from the frequently inaccurate accounts of collectors and bird photographers.

The birds of paradise are unrivalled in their epigamic adornments and astonishing in the use they make of them. The bower birds are generally not only of outstanding physical beauty, but also perform complex displays at their bowers and display-grounds to which they bring coloured or shining flowers, berries, leaves, shells and bones. Each species makes its choice according to the hereditary conservatism of its kind. Three species paint the walls of their bowers with various substances. One Australian bower bird actually fashions a tool to help it apply the paint which, in this instance, is a mixture of saliva and charcoal obtained from logs burnt by bush-fires. Another clears a patch of dark jungle floor and covers it with a striking pattern of leaves sawn from neighbouring plants with a remarkable 'toothed' beak that is adapted to the job. Yet in this book no attempt has been made to relate habit and function. Mr. Iredale has steadfastly ignored all the implications of the work of Howard, J. S. Huxley, F. H. A. Marshall, Lorenz and other pioneers who have revolutionized our understanding of the function and physiology of display during the last three decades. Mr. Iredale has likewise largely ignored the opinions of Stresemann, Stonor, Mayr and others who have done so much work on the anatomy and phylogeny of the birds of paradise. He dismisses a little contemptuously the possibility that some of the rare birds, collected and described during the trading days, are the result of natural hybridization. The present reviewer has never been directly concerned with this problem; but he cannot help feeling that it is the careful studies of Meise and Stresemann, rather than the present generalizations, that carry the more weight with the disinterested worker in a neighbouring field.

On the credit side, in addition to the coloured illustrations, typography and binding, there are interesting historical data concerning the legendary attributes of the birds of paradise. Thus, John Huyghen van Linschoten, after a voyage to the East Indies: "In these Ilands onlie is found the bird, which the Portingales call passaros de Sol, that is Fowle of the Sunne, the Italians call it Manu codiatas, and the Latinists, Paradiseas, and by us called Paradice-birdes, for ye beauty of their feathers which passe al other birds; these birds are never seene alive, but being dead they fall on the Ilands: they flie, as is said alwaies into the Sunne, and keepe themselves continually in the ayre, without lighting on the earth, for they have neither feet nor wings, but onlie head and body, and the most part tayle . . .". This legend arose, of course, from the birds' unearthly beauty and because trade-skins (which were bartered from tribe to tribe long before recorded Pacific history) often lacked legs and wings.

Other accounts stated that besides lacking wings and legs, paradise birds also lacked stomachs. But a latter-day sceptic had the following to offer: "It was believed by the credulous and ignorant, the most numerous class of men, that it lived alone upon the air and dew; that it had no intrails, nor feet; but remained perpetually floating upon the air while sleeping, as well as while awake; while hatching and laying as well as while procreating its young. . . . Instead of a stomach and intestines, which, to so extraordinary a feeder, would have been useless, the cavity of its abdomen was said to be filled with fat."

There is also included brief but welcome information concerning the great nineteenth-century travellers A. R. Wallace, D'Albertis, Beccari and Macgregor. But, incredibly, the book has no references and there is no index.

Whatever one's friendship and affection for the author—extending over twenty years—one cannot find in the text much else to praise. It is "as dry as the remainder biscuit after a voyage". Mr. Iredale has indeed strange places crammed with observation—and he has vented it in mangled form.

A. J. Marshall

Electromagnetic Theory

By Oliver Heaviside. Complete and unabridged edition of Vol. 1, Vol. 2, and Vol. 3, with a Critical and Historical Introduction by Ernst Weber. Pp. xxx+386. (New York: Dover Publications, Inc.; London: E. and F. N. Spon, Ltd., 1950.) 63s.

ADMIRERS of Oliver Heaviside's work will be highly appreciative of the appearance of an unabridged edition in a single volume of his three volumes on "Electromagnetic Theory". In spite of the excellent English in which it is written, Heaviside's work is in general by no means easy to read, and only by patient search and serious study can real benefit be derived from much of it. A major difficulty in the earlier editions was the absence of a detailed index to supplement the tables of contents, and there can be no doubt that this lack accounts for the fact that a number of his important contributions were overlooked for many years. It is unfortunate that this omission has not been repaired in the new edition.

The book is a most attractive reproduction of the original text and is preceded by a historical survey by Ernst Weber, director of the Microwave Research Institute of the Polytechnic Institute of Brooklyn. This introduction comprises a short biography of Heaviside and appreciations of his contributions to vector analysis, electromagnetic field theory, transmission line theory, operational mathematics, loaded communication lines and electromagnetic units, each followed by a list of books and other texts dealing with developments of the respective topics. This survey is well written but is too short to do full justice to the subsequent text, and readers will find it helpful to refer to the much extended appreciation of Heaviside's work contained in the recently published Heaviside Centenary issue of the *Journal of the Institution of Electrical Engineers*, and be able thereby to correct a number of excusable errors in Dr. Weber's biographical statement. The thorough review of Heaviside's work given in this centenary issue makes it unnecessary to comment further on the subject-matter of the book.

WILLIS JACKSON

Measurements of Mind and Matter

By Dr. G. W. Scott Blair. Pp. 116. (London: Dennis Dobson, Ltd., 1950.) 9s. 6d. net.

THE rheologist's concern is with things like the 'body' of a dough or the 'firmness' of a clay, qualities which defy reduction to simpler physical concepts and which are assessed more consistently by human judgment than by conventional measuring-technique. Materials of this kind can be classified in terms of 'quasi-properties', intermediate between, say, viscosity and elasticity, which appear dimensionally awkward. These represent the response of a material to a changing situation as a whole rather than to a simple change of one or two factors, and Dr. G. W. Scott Blair likens this kind of classification to the methods of Gestalt psychology. He discusses the meaning of measurement in general from the philosophical point of view, and shows the dimensional difficulties that can arise in practice.

The real argument of the book is that in the relatively unexplored field of 'psychophysics', which constitutes the frontier between physics and psychology, a different approach from that of pure physics may be justified; this in itself needs no elaboration, for anything amenable to a purely physical treatment is surely well within the frontier. Nevertheless, a number of controversial points are raised, and th author's own reflexions on them are given in detached and critical manner. The book is addresse to the non-specialist and the general reader, th latter of whom may find it rather a tough proposition and its object is rather to give a wider currency t the fact that certain problems exist than to lay dow solutions to them.

G. R. NOAKES

Warne's Metric Conversion Tables

Designed by Otto Klein. Computed by Scientifi Computing Service, Ltd. Pp. 104. (London an New York: Frederick Warne and Co., Ltd., 1950. 15s. net.

THESE conversion tables have been compiled t meet the demand for a quick and efficien system of converting Imperial and American measure into the metric system, and vice versa. The British and American measures are in the main identical; but confusion is sometimes caused with the Imperial and American gallons, and with the American short and the British long tons. This book certainly covers fairly thoroughly the relations between these, as well as the conversion into metric units. Measures of weight, length, speed, surface, volume and capacity are included, as well as reduction tables, conversion of one temperature scale to another and pressure tables; altogether there are eighty tables.

As regards the use of this book, it will, of course, have a limited appeal in schools and universities, since the conversions are given to a higher degree of accuracy than is ordinarily required (though it might be of some use in schools if it did nothing more than resuscitate the long-forgotten art of 'learning tables'). But its chief use is in the wider field of commerce, and it should be of great value to those engaged in business transactions between countries which have adopted the Imperial measures and those using the metric system.

Natural History

Birds and Mammals. By David Seth-Smith. (Reason Why Series.) Pp. 198. (London: Herbert Jenkins, Ltd., 1949.) 7s. 6d. net.

DURING his long experience as curator of mammals and birds in the London Zoo and as that popular broadcaster 'The Zoo Man', Mr. David Seth-Smith has had unrivalled opportunities for determining what questions relating to mammals and birds most frequently attract public interest. In this book he has selected and answered 324 of them. The result is a very readable volume, crammed with information, illustrated by sixteen mostly good, full-page line drawings (partly by the author and partly by L. R. Brightwell) and provided with a good index

The book can be safely placed in the hands of anybody interested in natural history, for the young will find much to stimulate and the old perhaps many things they did not know before. It would have gained had there been a little more critical proof-reading; for example, antlers are nourished by arteries, and not by veins (p. 31); lemmings go right across Eurasia between Scandinavia and North America (p. 51); the cheetah does not owe its speed to semi-retractile claws—actually, the claws are completely retractile although they are not hidden by special lobes of skin when they are retracted (p. 59); and, of the rook, "the food is very varied . . . and probably only becomes harmful to agriculture when too numerous" (p. 159) is not what the author intended to say.

M. A. C. HINTON

ELECTRON-MICROSCOPIC OBSERVATIONS ON THE XYLEM ELEMENTS OF A FOSSIL PLANT

By A. WESLEY and B. KUYPER*

Botany Department, University of Leeds

DURING the course of preparing sections of petrified plant material by the peel-section method of Walton[1], it was suggested by Dr. R. D. Preston that interesting results might be obtained if such plant remains could be examined in the electron microscope. The object of the present contribution is to record the observations so far made by a technique which we believe to be new to palæobotany. Even these preliminary observations have revealed important details which could not easily have been investigated by any other method. The preparation of fossil material for observation in the electron microscope proved to be unexpectedly difficult, but the following method was finally found to be suitable.

A number of peel sections were made from smoothed surfaces of coal-balls to investigate the state of preservation; but in most cases it was found that, for the present purpose, preservation was incomplete or too poor. However, one specimen contained exceptionally well-preserved material, and it was from this block that the preparations and photographs have been made. The specimen is part of a coal-ball, which was presented to the senior author by the late Prof. W. T. Gordon in 1945. Unfortunately the locality from which it was obtained is unknown; but it is undoubtedly of Lower Coal-Measure age. Running longitudinally through the block is a Stigmarian axis and at right angles to this and to one side is part of a decorticated stem of *Lepidodendron vasculare* (Binney) (= *Lepidodendron selaginoides* Sternberg). Only the woody cylinder of the latter is preserved, measuring about 1·5 cm. long and 1·2 cm. in diameter, with the central primary xylem 0·5 cm. in diameter. A surface was ground in a plane tangential to the *Lepidodendron* stele, and preparations were made from the surface of the secondary xylem so exposed.

The new technique involves the preparation of a section of the plant material by the peel-method and then remounting the section on another film for examination in the electron microscope. Only very thin sections of plant material are of any use, and these were obtained by first dissolving out the calcium carbonate from the smoothed surface of the coal-ball by etching with 2 per cent hydrochloric acid for three minutes. This strength of acid and time of etching were found to be most suitable for this particular material, since the coal-ball contains a high percentage of calcium carbonate. A solution of cellulose nitrate in amyl acetate, of the consistency of pure glycerine, was used for obtaining the 'peels'. Each dried film, containing the imbedded plant cell-walls, was then soaked in dilute hydrochloric acid to remove any particles of rock that might have been pulled off when the film was stripped from the block; after washing well in water, the 'peels' were dried under slight pressure to prevent curling.

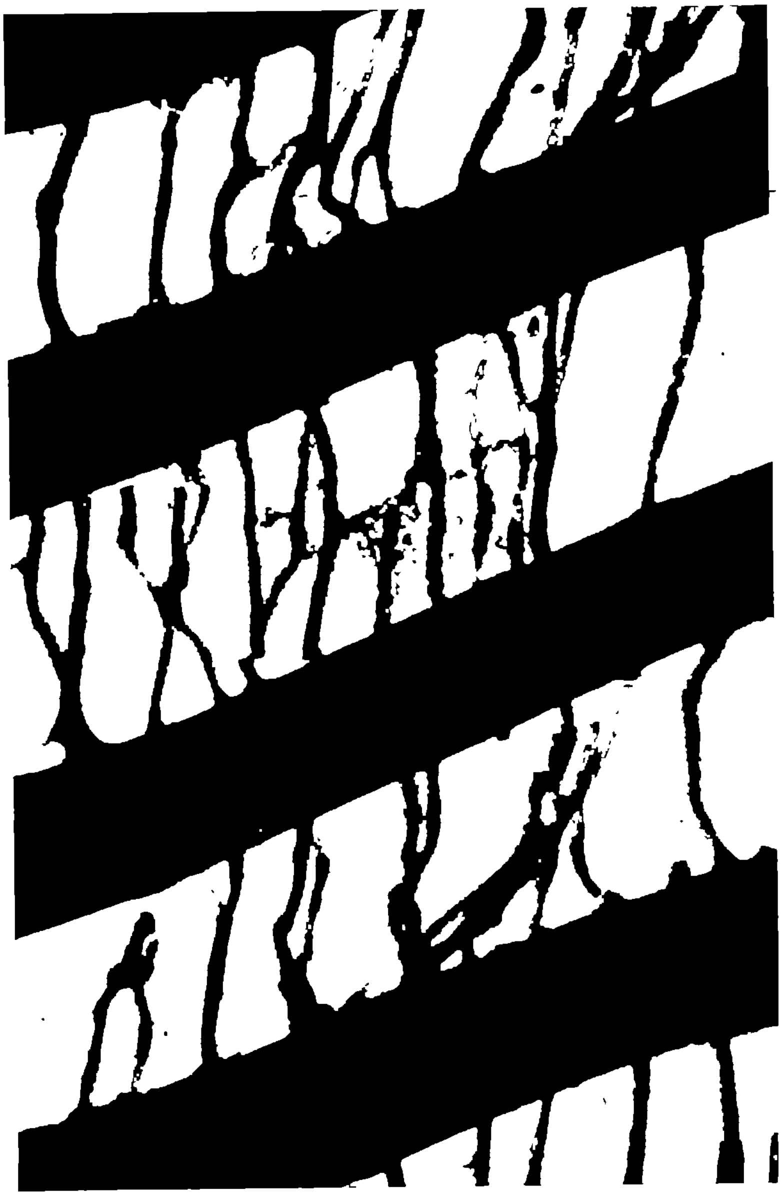

Fig. 1. Portion of a tracheid of *Lepidodendron vasculare* (Binney) showing four transverse scalariform bars and connecting vertical threads (× c 5,450)

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* On leave from Messrs. Philips Electrical Co., Eindhoven, Holland

The surface of the cellulose film which had been in contact with the rock surface was then covered with a thin layer of 'Formvar' dissolved in dioxan (0·25–0·5 per cent), which was allowed to dry. Selected portions of the double-layered film containing the plant material were cut out and placed on the electron microscope grids with the 'Formvar' surface downwards. The cellulose nitrate was dissolved away with amyl acetate, leaving the plant material standing up in relief and attached to the 'Formvar' film. The preparations were then ready for observation in the electron microscope. The use of cellulose nitrate dissolved in amyl acetate is necessitated since other types of cellulose film partly dissolve when the solution of 'Formvar' in dioxan is applied.

Previous observations under the light microscope have revealed in the tracheids of the xylem of Lepidodendroid plants pronounced scalariform sculpturing of the secondary walls with the transverse bars stretching completely across the wall face. Occasionally the bars may fork; but in general this is not common, and in all cases they merge into a continuous layer at the corners of the tracheids. The bars are slightly narrower at the middle and are spaced at distances rather greater than their breadth. Extending in a vertical direction across the openings between the bars are a number of fine threads which occasionally branch or anastomose with one another by transverse connexions.

This peculiar feature was first described and figured by Williamson[1] in "a scalariform vessel from a Lepidodendroid plant from the coal-measures, probably a *Lomatophloros*" (apparently a misprint for *Lomatophloios*), and he records "a number of delicate vertical lines of lignine, usually simple, less frequently branched, connecting together the contiguous transverse bars of the vessel". Since then, other workers have recorded similar threads in the primary and secondary xylem elements of numerous species of Lepidodendroid plants; but in no case have they ever been observed in any other group of plants either living or extinct.

The following list, which is complete so far as can be ascertained from the records, indicates the range of Lepidodendroid species which exhibit the presence of this unusual structure: *Lepidodendron vasculare* (Binney)[3-6], *L. squamosum* (Göpp.)[3], *L. brevifolium* Will.[7], *L. cf. brevifolium* Will.[8,9], *L. brownii* Unger sp.[10], *L. cf. fuliginosum* Will.[11], *L. johnsonii* Arnold[12], *L. scleroticum* Pannell[13], *Lepidophloios wünschianus* Carr.[8,14], *L. cf. wünschianus* Carr.[11], *L. harcourtii* (Witham)[15], *L. cf. harcourtii* (Witham)[7], *Bothrodendron mundum* Williamson sp.[16,17], *Sigillaria boblayi* Brongn.[18], *Stigmaria ficoides* Brongn.[3,6], *Stigmaria* sp.[19], *Lepidostrobus bertrandi* Zalessky[18], *L. brownii* Unger sp.[20].

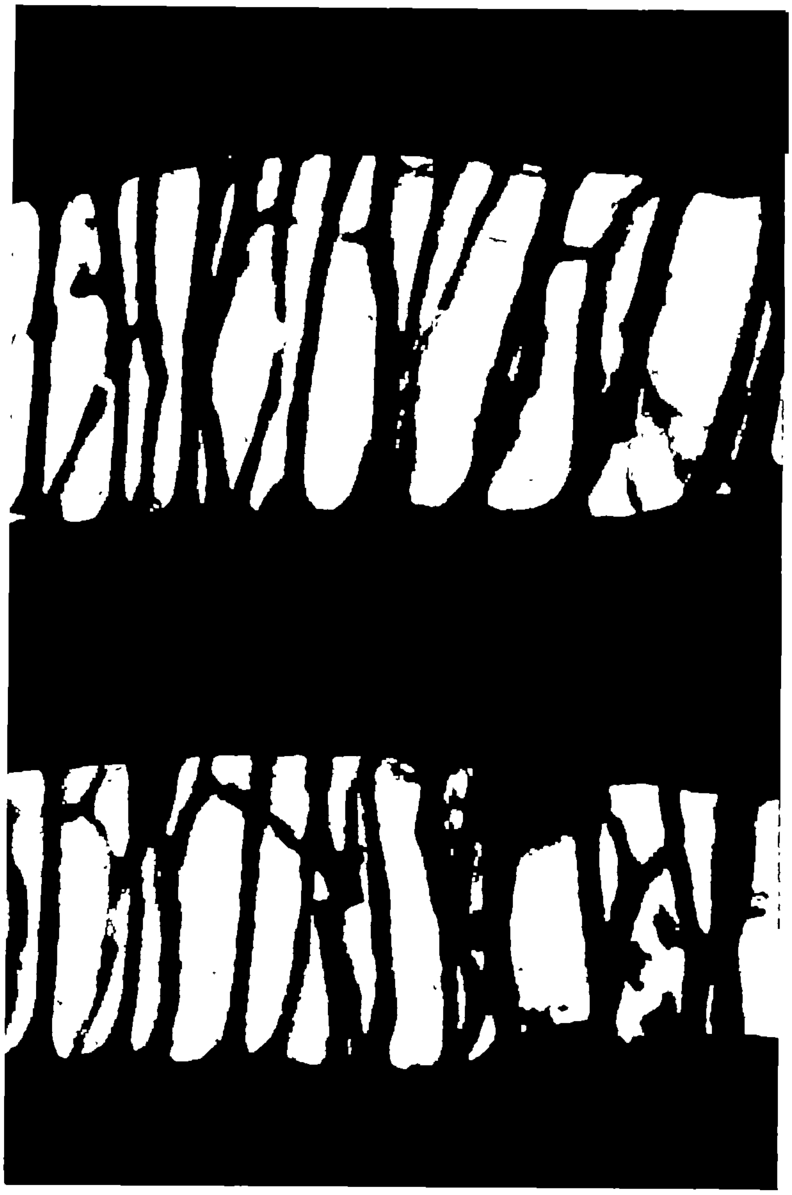

Fig. 2. Similar view of another tracheid (× c. 10,000)

The significance of the series of threads extending across the pit-areas has been discussed by various writers, and divergent conclusions have been reached. It is hoped, in the present contribution, to confirm the generally held opinion that the threads are secondary in nature—the view first put forward by Williamson in 1869 [1].

Seward and Hill[7] suggested that these threads had been formed by the contraction and tearing of the thin membrane which originally connected the scalariform bars. Writing in 1910, Seward[6] added the opinion that the threads probably represent remains of the original wall, which was in process of absorption, but he did not rule out the possibility of post-mortem changes leading to contraction and splitting. On the other hand, Solms-Laubach[3], who also considered the threads to be part of the primary wall, advanced the view that the threads correspond

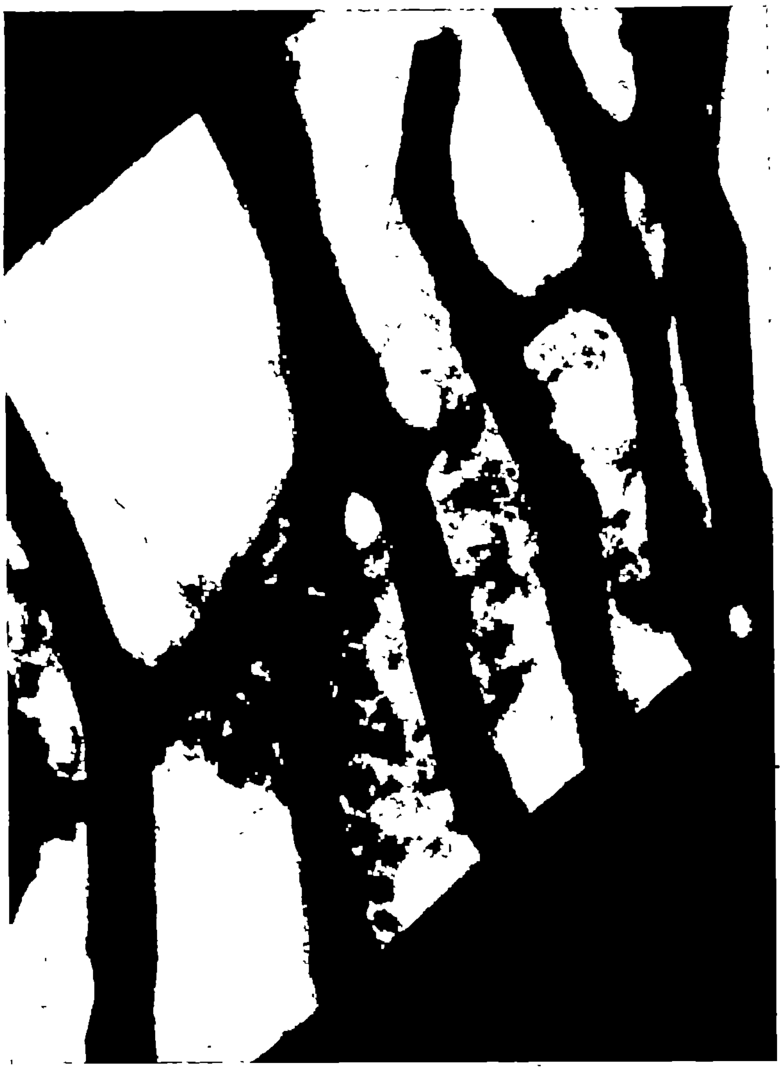

Fig. 3. Part of the tracheid shown in Fig. 1 more highly magnified. To one side a patch of extraneous matter has become entrapped between the vertical threads (× c. 21,800)

to the "*grenzhautchen*" of the tracheid wall, the middle lamella of which had disappeared. Other writers, including Hovelacque[4], Zalessky[10], Duerden[6], Arnold[12] and Pannell[13], have followed Williamson in regarding them as part of the secondary thickenings which lay against the primary wall and bridged the pit-cavity on the inside of the tracheid wall; but Calder[10], at least for *Lepidodendron brownii* Unger sp., considers them as tertiary thickenings laid down in a thin layer around the bars of the scalariform thickenings, with the fine threads connecting the layers.

Figs. 1–3 illustrate the typical appearance of these fine threads in the electron microscope. So far as can be determined from the preparations that have been examined in the electron microscope, there has been no indication of the presence of the original wall stretching between the threads, or of the middle lamella substance between the xylem elements. The absence of such primary wall structures and the isolation in the coal-ball of the xylem cylinder from any cortical tissues leads to the conclusion that the plant must have died prior to preservation, and that all such delicate structures had decayed and disappeared before petrifaction set in. Only the more resistant plant parts, impregnated with lignin, have actually been preserved. This point alone would suggest that the threads are not part of the primary wall, and reference to the figures will dispel the idea that they represent a stage either in a post-mortem change or in absorption of the original wall, since they are too regular and constant in their breadth. Furthermore, Duerden[6] has figured sections of maturing secondary tracheids where the threads are being formed against the inside of the primary wall.

The possibility of their being tertiary in nature still remains, and on consideration it may seem that the threads might not be, in fact, attached to the transverse bars, but to some other layer enclosing the bars. We have, however, never observed such a layer surrounding the bars as was envisaged by Calder, and our preparations have shown that, where the threads have been slightly damaged or completely removed, they leave distinct pegs firmly attached to the bars (Fig. 1).

It seems certain, therefore, that the transverse bars and vertical system of threads are part of one and the same wall structure, and the evidence obtained from our new observations, together with those of certain previous workers, indicates that the series of threads form part of the secondary wall deposits.

In some places (Figs. 1–3), running in a different but parallel plane, two systems of threads are evident which belong to the two neighbouring walls of adjacent tracheids. Examination of the electron micrographs reveals an additional point of interest. The two systems of threads which cross the pit-areas between the transverse bars of adjacent tracheids

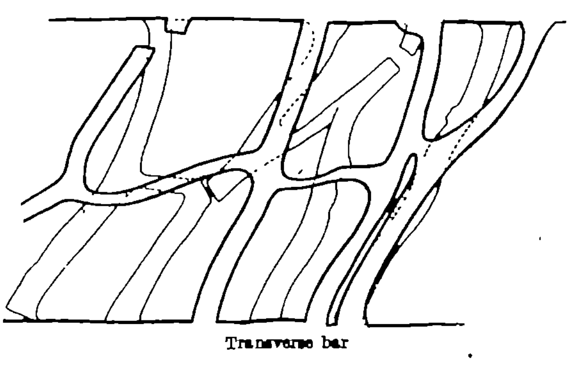

Fig. 4. Diagrammatic representation showing arrangement of two sets of threads on adjacent wall faces The nearer transverse bars and series of vertical threads are outlined more heavily than the corresponding structures of the adjacent tracheid

bear no relation to one another, either in their pattern of branching or at their points of attachment to the transverse bars. The smaller pit-areas which are thus formed between the individual threads do not entirely correspond with a similar region on the wall of an adjacent tracheid and are virtually blind in some parts (Fig. 3). Fig. 4, which has been redrawn from Figs. 1 and 3, shows this point particularly well.

The possibility that any two adjacent series of threads may have become slightly distorted or moved out of alignment with one another during fossilization or preparation of the cellulose nitrate 'peels' is precluded by the very little lateral movement which occurs when fractures break some of the threads. In addition, a number of tracings was made, but in no case was it possible to 'fit' the pattern of any set of threads with the corresponding series of an adjacent tracheid wall.

We are indebted to Dr. R. D. Preston for permission to use the electron microscope provided by the Department of Scientific and Industrial Research, and gratefully acknowledge his advice and help during the course of this investigation.

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PHYSICS OF ELECTRICAL DISCHARGE

DURING recent years the mechanism of the electrical breakdown of gases has been a subject of renewed interest. This is due to a variety of causes—in particular, the increasing use of compressed gases as a dielectric with high voltages (as in power cables), and experience with high-voltage machines for research in nuclear and medical physics. Recent work, especially in the United States, on the behaviour of compressed air has demonstrated the surprising fact that the breakdown strength does not increase as the gas pressure increases; this indicates a definite failure of Paschen's law. Increased interest in the mechanism of the electrical breakdown itself has also been stimulated by the desire to obtain a full explanation of the lightning flash.

The initiation and the mechanism of the electrical breakdown of gases was the general theme of a symposium on "Some Aspects of Discharge Physics" which formed the spring provincial meeting of the Physical Society, held at the University College of Swansea during March 29–31. The hundred and fifty scientific workers present, though mainly physicists, included a number of electrical engineers and mathematicians; and a large number of universities, government research establishments, industrial research associations, electrical and other industrial firms were represented at the meeting. The president of the Physical Society, Prof. L. F. Bates, in welcoming the members, pointed out that this was the first visit of the Society to Wales. On the afternoon of March 29 visits were made to the Abbey works of the Steel Company of Wales, and to the Gower Peninsula. On the morning of March 31 a tour of the Department of Physics of the University College of Swansea was made, and of the Sketty Hall Laboratories of the British Iron and Steel Research Association. Altogether, the success of the meeting showed the great interest now felt in discharge physics.

The symposium started with an address by Dr. A. H. von Engel (Oxford) on recent advances in the subject of fundamental collision processes. Examples of ionization by electrons and photons with energies less than the ionization energy were given; mercury vapour can be ionized by low-energy quanta producing two excited atoms which collide to form a molecular positive ion and a free electron. Again, auto ionization is an important cumulative process, for example, in metal vapours: first, two electrons are excited in the same atom, and one of them may then be released if the total potential energy of the atom exceeds the ionization potential. Further, two normal identical atoms may become ionized by collision if their relative velocity exceeds a critical value which corresponds to twice the ionization energy; this has been shown experimentally, and it agrees with classical laws of transfer of energy in collisions. Recent work on ion mobilities was then discussed: the disagreement between theoretical and experimental values of the mobility of positive ions of rare gases moving in their own gas has been found to be due to the formation of molecular ions (for example, He_2^+), which, unlike atomic ions, do not transfer their charges in collisions to neutral atoms. After discussing dissociative recombination, Dr. von Engel concluded by stressing that discharge physics is now entering a most interesting phase.

The next paper, given by Prof. Llewellyn Jones, was on the electrical breakdown of gases. From experimental investigations during the past twenty years, it had widely been concluded that the growth of pre-breakdown currents at high pressures followed a simple exponential law (involving no secondary ionization), and that to account for sparking it was therefore necessary to assume the sudden introduction of an entirely new ionization mechanism (streamer) not related to the growth of initial pre-breakdown currents[1]. This assumption was critically analysed by Prof. Jones, who showed that the experimental data were insufficient to justify such an assumption. The difficult experimental conditions which must be satisfied in order to investigate the problem over the significant range of spark parameters were discussed, and a high-voltage ionization chamber which has been designed and built to satisfy these conditions was described. With this apparatus, measurements have been made at Swansea of pre-breakdown ionization currents for values of the spark parameter ap, which included those corresponding to a 1-cm. gap in the atmosphere[2]. The results show that, while the growth of the currents is simply exponential over the greater part of the sparking distance, in the important region near breakdown itself the currents do, in fact, increase at the faster rate represented by an equation of the Townsend type involving primary and secondary ionization coefficients α and ω. This indicates that the mechanism of the spark itself is the same as that which leads to the growth of the photo-current even in its early stages ($i \sim 10^{-15}$ amp.). Possible secondary ionization processes were discussed in the paper—such as the ionization of gas atoms by photons, or by collision through the agency of positive ions involving electron transfer and the production of fast neutral atoms[2]; and also the cathode processes of secondary emission by positive ions or by photons. It was stressed that the essential feature of the breakdown mechanism is the development of the avalanche from behind by a secondary generating cause moving towards the cathode, a process which is most efficient when it acts at the cathode itself. Evidence was also given for the existence of secondary emission from the cathode by the impact of positive ions even with spark voltages up to 30 kV. W. Hopwood (Liverpool) then followed with a paper on the positive streamer mechanism. He pointed out that, in view of the experimental results of Llewellyn Jones and Parker[3] and recent work in the United States[4] on the formative time-lag of sparking in the important region near breakdown, some modification of the original streamer type theory is now required.

There was active discussion of these papers. C. G. Morgan (Swansea) dealt with the failure of Paschen's law at high voltage[5], and indicated that the intervention of cold-cathode field-emission is sufficient to explain this failure and also some experimental results of his own. R. Fortescue (Queen Mary College, London) raised questions on the interpretation of photographs of anode and mid-gap streamers, on instability at breakdown and on the physical explanation of the influence of the cathode on breakdown at very high pressures. E. H. Cohen described recent high-voltage work done at Queen Mary College employing gas pressures of 1,000 lb./sq. in. S. Haydon (Swansea) gave theoretical considerations of photo-ionization in the gas; preliminary calculations with Dr. P. M. Davidson suggest that such processes do not predominate in the spark mechanism in air at high pressure; but for detailed calculations further numerical data on absorption cross-sections are required. J. Dutton (Swansea) discussed the interpretation of the results of recent work on formative time-lags[4], and showed that these are fully consistent with modern work on the growth of pre-breakdown currents, described above, and with the explanations proposed, concluding that a streamer mechanism is both insufficient and unnecessary to explain these results.

The session on March 30 opened with a paper by C. G. Morgan (Swansea) on the cold emission of electrons and discharge initiation. Cold emission from various electrode surfaces in air at atmospheric pressure under fields of the order of 10^4 volts/cm. has been found to depend strongly upon the nature of the electrode surfaces: thin oxide films or microscopic insulating particles give rise to enhanced electron emission[6]. Experiments have shown that the emission follows a field law. The role of post-breakdown residual positive ions in initiating succeeding sparks has also been examined, and it is concluded that a surface charge of positive ions on an insulating film at the cathode can give rise to enhanced field emission. This effect can lead to failure of Paschen's law. R. D. Craig (Metropolitan-Vickers Electrical Co., Ltd.) described experiments on the production of electrode vapour and its effects on the afterglow: 10 μsec. high-current pulse discharges were employed with electrodes of magnesium, copper, iron, carbon and tungsten. The observed large transport velocity of electrode material can only be explained if it leaves the electrode in the form of droplets or liquid jets.

In the discussion which followed, J. C. S. Shaw (Cambridge) pointed out that Mr. Morgan's views are consistent with present knowledge of backfires in rectifiers[7]. W. D. Chesterman (Admiralty Research Laboratory) described some of his experiments on the production of light flashes by the discharge of a condenser through a sealed quartz tube. G. G. Isaacs (G.E.C. Research Laboratory, Wembley) outlined work on high-pressure mercury vapour discharges, and showed that the cathode may give rise to effects extending far beyond what is usually regarded as the cathode region at these high pressures.

In the afternoon of March 30 there were four papers on high-frequency discharges. Dr. G. D. Morgan (University College of North Wales, Bangor) discussed breakdown and described experiments at Swansea made in hydrogen at low pressures p and at frequencies f between 5·0 and 70 Mc./s. to test the validity of a general similarity theorem: $V_s = \varphi(ap, f/p)$. The theorem holds accurately for breakdown, but less accurately for maintained high-frequency currents—this he attributed to discharge instability. G. Francis (Oxford) has found that the growth of electrodeless discharge at low pressure proceeds in three stages: the first stage is a multiplication of electrons by secondary emission from the glass walls of the vessel; the second is the production of a distributed positive space-charge of gas ions with a maximum at the centre of the vessel; finally, an equilibrium state is established when the production of ions and electrons in the gas equals the losses to the walls. A new technique has been used, and oscillograms showed how the growth of the discharge depends on the pressure and on the gas. W. L. Harries (Oxford) described the mechanism of the low-frequency electrodeless discharge in chlorine, and the influence of irradiation. He has found that the current consists of pulses, the number increasing with the voltage: each pulse corresponds to a series of electron avalanches developing between small areas of the inner glass surfaces. G. C. Williams (Swansea) described his work on the similarity theorem and corona relationship for both static and high-frequency discharges in air, hydrogen and monatomic gases; he also discussed the mechanism of the static corona discharge.

The symposium concluded with a paper by Dr. Elwyn Davies (Swansea) on the breakdown mechanism in static discharges at low pressures. He has examined the dependence of the shape of the cathode emission (ω/α) curves on the deposition of electro-positive or electro-negative atoms on cathodes of nickel, aluminium, silver, copper and molybdenum. Deposition of electro-positive atoms on the cathode produces sharp photoelectric peaks in the curves in the region $X/p \simeq 150$ V./cm. × mm. pressure of mercury; but at higher values of X/p the quantity (ω/α) is not greatly affected. Dr. Davies analysed these results in terms of the varying effective work function of the surface due to the deposition of atoms. He concluded that in hydrogen the high photoelectric emission from cathodes of low effective work function is due to low-energy photons generated in the pre breakdown currents, but that for clean metals the secondary emission is due almost entirely to the impact of positive ions; photoelectric emission due to any high-energy photons generated in the ionization currents is negligible in comparison. Thus the breakdown process is almost completely determined by the nature of the cathode surface. The succeeding discussion included contributions from Prof. J. M. Meek (Liverpool) and J. R. Acton (Ericsson Telephones, Ltd.).

F. LLEWELLYN JONES

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REPORT OF THE COMMITTEE ON WEIGHTS AND MEASURES LEGISLATION

SOME important recommendations, of widespread interest, emerge from the deliberations of the committee appointed by the President of the Board of Trade to review the existing weights and measures legislation and administration in Great Britain. The report* presents the results of the first full inquiry into this subject since that of the Standards Commission of 1867–70. Not unnaturally, in view of the large amount of legislation which has since been effected, the recent committee, under the chairmanship of Sir Edward Hodgson, advocates a consolidation of the law in regard to weights and measures; but the chief scientific interest lies in Part 1 of the report, dealing with the units and standards of measurement. Foremost among the items of Part 1 is the recommendation that the Imperial system of units should eventually be abolished in favour of the metric system. This recommendation is unanimous and, as the committee says, contentious in the extreme. It visualizes a lengthy period to prepare the general public for the change and to provide schemes for the change-over, trade by trade, during a transition period extending over twenty years or more. But, above all, the recommendation is conditional on an approach being made to the Commonwealth and the United States, so that all may move together, or not at all.

When the Commission of 1867–70 examined this question, it recommended that the use of the metric system concurrently with the Imperial should be permitted for the purpose of trade. As a result of this recommendation, provision was made for the use of approved metric standards of weight and measure. In 1870 the metric system was compulsory in fifteen countries, but when the Hodgson Committee approached the matter, the number of such countries in the world had increased to fifty-five, the outstanding exceptions being the Commonwealth and the United States, which together conduct half, if not more, of the world's trade, using chiefly the yard–pound system. In the face of conflicting external factors and the mixed evidence submitted, the Committee found no easy solution. The real problem before it was whether to maintain two legal systems or to take steps to establish world-wide uniformity by changing completely to the metric system. The Committee, while bearing in mind the well-known objections to the change and in particular the difficulty of altering the units of measurement in the engineering and other industries, has resisted the arguments in favour of retaining the present concurrent use of both systems and has laid more stress on the part to be played by Great Britain in the international affairs of the future, in trade and commerce, defence, etc. The future needs of the country are not easily assessed, but at no time have smooth international dealings been so important as at present.

Much has been said on the subject by pro- and anti-metricists, as for example at the discussion at the British Association meeting in Brighton in 1948. It is hoped that any differences of opinion as to the Committee's recommendation will rise above the usual retorts as to the relative shortcomings of this or that set of units and reach a level where the significant factors are disentangled from the irrelevant. Looking back over a hundred and fifty years since the initiation of the metric system, we cannot close our eyes to its advance; and there is no indication that the trend towards its universal adoption has been reversed. It remains to be seen whether the Committee's long-term view on this subject will eventually receive sufficient support to overcome the inherent objections to the change.

The Committee, in making this recommendation, also envisaged the decimalization of the coinage, but this matter was considered to be outside its terms of reference. As a shorter-term proposal of the wider project, the Committee recommends that the apothecaries, troy and pennyweight systems of measurement should be abolished after five years and replaced by the metric system. This, though it might be regarded as a 'thin end of the wedge' for the long-term project, has the obvious advantage of removing from the Imperial system much unnecessary complexity of units; moreover, metric weights are normally used in scientific work.

Whether the long-term proposal to change to the metric system is accepted or not, strong support should be forthcoming for the recommendation that the independence of the Imperial and metric units of length and mass should be terminated, and that the yard and pound should be defined in law as definite fractions of the international metre and kilogram respectively. This proposal was put forward in 1946 by the British Empire Scientific Conference and has two main objects. The first is to remove embarrassments arising from the existing situation and particularly those caused by variations from time to time in the relationship of the material standards of the yard and the metre to one another, and also those of the pound and kilogram. The effect of the slight progressive shortening of the Imperial Standard Yard is sufficient to be felt in high precision measurements with engineering standards and in the surveying field. The second object is to eliminate the small differences which exist between the Commonwealth and the American yards and pounds. The differences have arisen because these units have been defined in Britain by reference to independent standards, whereas in the United States, ever since 1866, they have been defined by fixed ratios to the metre and kilogram respectively. The Committee recommends the general adoption of the principle of fixing the yard/metre and pound/kilogram ratios, and proposes to apply it in a most rational manner to bring the Commonwealth and American yards and pounds into equality. The definitive values recommended are as follows: 1 yard = 0·9144 metre (corresponding to 1 inch = 2·54 centimetres exactly); 1 pound = 0·453 592 37 kilogram or 0·453 592 3 kilogram.

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* Board of Trade. Report of the Committee on Weights and Measures Legislation. (Cmd. 8219.) Pp. iv+147. (London: H.M. Stationery Office, 1951.) 3s. 6d. net.

With the view of their adoption in the Commonwealth and the United States, the Committee suggests that the Government of the United States be informed of these proposals. This is a worthy project which should be strongly pursued between the countries concerned. Scientific workers generally, and metrologists in particular, will support the proposal.

In connexion with the legal definitions of units and standards of measurement used in Great Britain, it has been found that these are not always satisfactorily prescribed in an Act of Parliament. An element of flexibility is essential to enable British practice to keep abreast of the latest technical developments and international agreements, and for various purposes the Committee recommends suitable machinery for effecting changes whenever the need arises. This machinery is based on the principle of delegated powers of legislation to be exercised by the Minister within the broad purposes of an Act. In order to provide satisfactorily for definitions in law of certain units, for example, those of time, capacity, temperature, heat and electricity, together with the prescription of standards for such units, and associated matters, it is proposed that a permanent commission be appointed by the President of the Board of Trade to advise on such subjects. The Committee has in mind a strong and wide advisory basis for this work and suggests that the commission should consist of the Astronomer Royal, the director of the National Physical Laboratory, the president of the Royal Society, two members nominated by the Lord President of the Council, one by the Lord Chancellor, and the chairman and not more than three other members by the President of the Board of Trade. It is recommended that the President of the Board of Trade be empowered to give effect by subordinate legislation to the recommendations of the commission and required to lay before Parliament at appropriate intervals a report on its work.

Concerning the more general conclusions to which the inquiry has led, the Hodgson Committee is satisfied that the existing principles of weights and measures law are soundly based and stand in no need of fundamental revision. They have provided a reasonable protection to all engaged in trade, and the machinery of administration appears to have worked well over the years. In the remaining parts of the report, recommendations of varying scope and importance are made in regard to weighing and measuring equipment and the protection of the public against the giving of short weight or measure; but, in the main, these proposals represent additions to, or simplifications of, the present framework, rather than completely novel features. It is recommended that the administration of weights and measures law should continue to be in the hands of local authorities, but should be entrusted in future only to those larger authorities the work of which would require the employment of at least three inspectors. On this basis there would be eventually about a hundred and forty weights and measures administrative units in place of the 258 at present, and more economical use of staff could justifiably be expected from such a change. As in the past, the Board of Trade through its Standards Department should bear the ultimate responsibility for ensuring efficiency. The main duties of the Department are defined, with a recommendation that its name be changed so as to avoid confusion with the British Standards Institution, which, as is well known, deals with standards from another aspect.

It is hoped that, whenever there is general agreement that the Committee's recommendations are wise and can be implemented without much upheaval, they will be put into effect with reasonable promptitude. In particular, the redefinition of the yard and pound in terms of the metre and the kilogram is a reform long overdue, which should not be delayed on account of other recommendations which may appear controversial or involve major difficulties.

F. A. GOULD

OBITUARIES

Prof. Alexander McKenzie, F.R.S.

WITH the death of Prof. Alexander McKenzie, emeritus professor of chemistry in the University of St. Andrews (University College, Dundee), on June 11, at the age of eighty-one, another link has been severed with the great classical age of organic chemistry.

McKenzie was the son of a village schoolmaster in Angus and received his early education at the High School, Dundee. He entered the United College, St. Andrews, in 1885 and laid a sure foundation for his liberal outlook of later life by reading for the M.A. degree before embarking upon his studies in chemistry. The thrill of research soon captivated him, and after working under Thomas Purdie for a while he gave up, at considerable personal sacrifice, his lectureship at the United College to work with Marckwald in Berlin. His Ph.D. thesis there was a masterpiece which has become a classic. Shortly afterwards he graduated D.Sc. of St. Andrews and embarked on his teaching career, first in London and then in Birmingham, where he became special lecturer in organic chemistry. In 1905 he was appointed head of the Chemistry Department in Birkbeck College, London, a post which he held with such distinction that he was the obvious choice for the chair in his native Dundee when this fell vacant at the end of 1913.

During 1914–38 McKenzie was professor of chemistry in University College, Dundee. His researches expanded and developed throughout the field of stereochemistry, and his reputation became worldwide. At home the merit of his work was recognized by his election in 1916 as a Fellow of the Royal Society, and in Germany by the rare distinction of his admission as an Honorary Fellow of the Kaiserlich Deutsche Akademie der Naturforscher, Halle. On his retirement he received the LL.D. of St. Andrews.

McKenzie's research work was mainly concerned with stereochemical problems, in particular as applied to the derivatives of mandelic, tartaric, malic, maleic and fumaric acids. The isolation of the optically active forms of benzoin and his work on catalytic racemization are examples of his early pioneering. A clear appreciation of the factors leading to loss of optical activity enabled him to devise and carry out the first asymmetric synthesis of mandelic acid; and this was followed by further successful syntheses of the same kind. McKenzie will also be remembered for his work on the Walden inversion, which also led to the investigation by polarimetric methods of the deamination reactions of α-amino-alcohols and the accompanying migration of organic radicals. These topics provided material for a long series of important researches. All his work was characterized by a subtle elegance which led one of his colleagues to comment that "in attacking the refined secrets of the organic molecule he discarded the ponderous weapons of men of grosser mould for the light rapier of the 'chymicall Artist' ".

McKenzie also possessed an acute faculty for the appraisal of work besides his own, as witnessed by his early applications of the Grignard reaction. Furthermore, he had the philosophical and cultural outlook characteristic of the scientific men of his generation, an outlook which is so often lacking to-day.

He was an inspiring teacher, and during his twenty-five years in Dundee he trained a steady stream of research students. He took a lively and enduring interest in the personalities and progress of his pupils, an interest which he maintained throughout his years of retirement. His enthusiasm for the progress of organic chemistry never flagged, and he insisted on reading every new thesis on organic chemical topics originating from the Department.

He is survived by Mrs. McKenzie and their son.

D. H. Everett

We regret to announce the following deaths:

Sir Walter Johnson, C.M.G., director of medical and sanitary services in Nigeria during 1929–36, known for his work on trypanosomiasis and yellow fever, aged sixty-five.

Commissioner David Lamb, C.M.G., LL.D., director of the Salvation Army Emigration Department during 1903–30 and known for his social studies, who frequently attended meetings of the British Association, on July 7, aged eighty-four.

Mr. William Lowson, formerly senior lecturer in analytical chemistry in the University of Leeds, with which he had been associated since 1897, on May 20.

Prof. H. Nagaoka, professor of physics in the University of Tokyo during 1896–1926, on December 10, 1950, aged eighty-five.

Dr. John Rickman, sometime president of the British Psychological Society and for many years editor of the Society's *Journal*, aged sixty.

NEWS and VIEWS

Institute of Navigation: Thurlow Award

Dr. E. G. Bowen, chief of the Division of Radiophysics of the Commonwealth Scientific and Industrial Research Organization, Sydney, has been given the Thurlow Award for 1950 of the Institute of Navigation, of the United States, for his outstanding contribution to scientific navigation during the past year. The Award is a memorial to Colonel Thompson L. Thurlow, formerly chief of the Navigation and Instrument Section of the Equipment Laboratories of the United States Air Force at Wright Field, Dayton, Ohio, who was killed in 1944. Dr. Bowen and his co-workers have developed several new radio navigational aids which are of special importance in aviation. Their distance-measuring equipment (D.M.E.) has been adopted for civil airline use in Australia. For the first time it provides the pilot of an aircraft with an instrument showing his distance from an airport he is approaching. Another system they have developed, multiple-track radar range (M.T.R.), enables aircraft to fly on a series of tracks radiating from an airport. It has aroused considerable interest in aviation circles overseas. Their latest device is a microwave navigational system which provides a radio counterpart to the simple visual method of navigation using beacon lights. It enables the pilot to 'see' and use radio beacons in thick weather in as nearly as possible the same way that ground markers or light signals can be used as navigational aids under conditions of perfect visibility. It offers great promise as a navigational system for use by aircraft where it is uneconomical to provide the elaborate facilities used on main air routes, and for use by ships in confined waters.

Dr. W. J. V. Osterhout

Dr. W. J. V. Osterhout, the well-known American botanist, will celebrate his eightieth birthday on August 2. Dr. Osterhout has, since the beginning of the century, established himself as one of the world's authorities in plant physiology, especially cell physiology, working mainly in the University of California and Harvard University until 1925, when he transferred to the Rockefeller Institute, New York. From there he retired when he reached his seventieth year; a note of appreciation was published in *Nature* at that time (147, Jan. 25, 1941). Dr. Osterhout has trained or inspired workers in the subjects of his choosing in all parts of the world. We should like to join all those in congratulating him on this occasion and to express the hope that he will long continue to exert his powerful influence and encouragement.

Royal Society Research Fellowships

Dr. C. E. Lumsden, of the University of Aberdeen, has been appointed second Henry Head Research Fellow of the Royal Society from October 1, to work at the Maida Vale Hospital for Nervous Diseases and the National Hospital for Nervous Diseases on disseminated sclerosis. The Council of the Royal Society has appointed Dr. D. R. Wilkie to be the first Locke Research Fellow, from October 1, to work at University College, London, on energy relations in muscular contraction. Frank Spiller Locke, formerly reader in physiology at King's College, London, who died in 1949, left part of his estate to the Royal Society for the endowment of Locke research fellowships in experimental physiology and pharmacology. The Council has also appointed for the first time two Stothert Research Fellows, each for two years in the first instance, from October 1. Mr. J. R. Vane will work at the Nuffield Institute for Medical Research, Oxford, on the mechanism by which histamine produces gastric secretion, and Mr. J. M. Walshe will work at University College Hospital, London, on amino-acid metabolism in liver disease. The Stothert Research Fellowships are established by the bequest to the Royal Society of the residuary estate of Dr. John Henry Stothert, lecturer in pharmacology at University College

Hospital, who was drowned at the age of twenty-seven in a canoeing accident in Austria in 1937; the bequest came to the Society in 1948 after the death of Lady Stothert.

Agricultural Machinery at the Science Museum

The collections of agricultural implements and machinery at the Science Museum, started in 1857, contain a fine historical series from which a selection has been made for public exhibition. They were taken to the country for safety in 1939 and it is only now possible to show them again to the public. The present display occupies the first floor of a building block of which the frame, with temporary wall panels, was constructed before the War as a part of the original East Block, but not completed and furnished until now. In this, the first section of the newly finished museum building to be opened, daylight has been excluded and by use of controlled fluorescent lighting it has been possible to incorporate several novel methods of display. These, while avoiding the transience of the display methods now common in trade exhibitions and the like, have nevertheless been devised with the view of the maximum visual appeal. Recent developments have been shown by means of a series of nearly a hundred models, all to a scale of one inch to a foot, contributed by some twenty firms in the industry. These are displayed against scenic backgrounds with plaster bases and illustrate the work of the up-to-date mechanized farm throughout the seasons of the year. As a centre-piece there is a full-sized sectioned and working combine harvester. Other full-size exhibits include early ploughs, a horse wheel, Bell's reaper of 1826 and the Ivel farm tractor of 1902, the first medium-powered farm tractor driven by an internal combustion engine. In the space at present available it has only been possible to deal with arable farming. The display has been planned in close consultation with the Ministry of Works, which has been responsible for the design and provision of the building, lighting, display cases, etc.

Gas Council Research Centre at Birmingham

The Gas Council has set up a second research centre at the Nechells Gasworks, Birmingham, the work of which will be mainly concerned with the complete gasification of coal. This centre will be administered by the West Midlands Gas Board on behalf of the Gas Council, and its director will be Dr. F. J. Dent, at present assistant director of the Gas Research Board. Dr. Dent has been closely concerned with the experiments upon complete gasification which have been conducted at the Poole Research Station. Great importance is attached to this particular field, and the Gas Council has decided that this work can be accelerated at Birmingham where there are far greater facilities than at Poole, although this does not mean that the work at Poole will cease.

Expedition to Chubb Crater in Northern Canada

The National Geographic Society and the Royal Ontario Museum, Toronto, are sending a joint expedition to far northern Canada to explore the recently discovered Chubb crater. Dr. Victor Ben Meen, a well-known Canadian geologist and director of the Museum, will lead the expedition. The crater site is in northern Quebec between Hudson Bay and Ungava Bay, and the expedition, which is travelling by air, expects to land on a near-by ice-free lake and make camp as near the boulder-strewn crater as is possible. The crater is more than two miles wide and hundreds of feet deep, surrounded by a rim averaging 400 ft. high. Dr. Meen saw the crater last year when he surveyed the area in the company of Frederick W. Chubb, a prospector who discovered it, and after whom it is named. Its appearance suggested a tilted cup with one side considerably higher than the other. It is thought that the crater may have been caused by the fall of a meteorite. The expedition is taking modern scientific equipment and will attempt to ascertain the origin of the crater.

Courses and Examinations for Instrument Maintenance Mechanics

The City and Guilds of London Institute has recently announced the adoption of a new scheme of courses and examinations in instrument maintenance (Subject No. 79). The scheme, which has been drawn up by an advisory committee representing a wide range of interested bodies, is intended for mechanics and technicians concerned in the maintenance, repair and installation of the instruments used for process and production control in industrial plants and in the Armed Services. Particular attention has been given to the requirements of the chemical, iron and steel, and petroleum industries, to fuel economy, and the needs of the Services; but the structure of the scheme is such that it will have wide application. The courses consist of five years of part-time study at a technical college, with an intermediate examination at the end of the third year, and a final examination at the end of the fifth year. There is provision for students holding an appropriate Ordinary National Certificate to enter the course at the beginning of the fourth year. It is hoped that by the provision of these courses the serious shortage of skilled instrument mechanics which is at present handicapping British industry will be effectively reduced. Further details of the scheme, including a pamphlet containing the regulations and syllabuses for the City and Guilds examinations (available shortly, price 6d.) can be obtained from the Department of Technology, City and Guilds of London Institute, 31 Brechin Place, London, S.W.7.

A Pioneer in Modern Farm Practice

A recent number of the magazine *Scotland* (No. 52, June 1951) includes an article extolling the important contributions made by scientific men from Scotland, and in particular from Glasgow, to the development of the industrial revolution and of the atomic age. While these are, for the most part, well known, the author, Prof. Hugh Nicol, of the West of Scotland Agricultural College, also places on record the interesting fact that at the commencement of the nineteenth century a Glasgow citizen, William Harley, author of "The Harleian Dairy System" (1829), ran an internationally famous dairy farm in Glasgow. In the dairy, which held two hundred cows, of which a careful register was kept, there was a steam engine which operated machines for turnip-slicing, chaff-cutting and churning. This machine was in operation in 1814 and possibly as early as 1812, in the same year, as Prof. Nicol puts it, that the famous steamship the *Comet* first sailed on the Clyde; it is claimed to be the earliest known instance of the use of steam for agricultural purposes.

Representation of Snow in Museum Displays

The standards of modern display make great demands on the museum curator, who is constantly called upon to reproduce natural environments of various types. Perhaps a snow scene is one of the most difficult to construct, and its realism is often marred, not least by streaks of dust. In the December 1950 issue of the *Museums Journal*, W. T. Stirling, of the Royal Scottish Museum, Edinburgh, describes, with operational details, a method by which 'snow' is made from paraffin wax. Molten wax is sprayed with considerable force on to the surface of cold water contained in a large sink, and from a distance which confines the wax particles to the water surface. The accumulating solidified particles are periodically removed and placed in a fine-meshed sieve to drain. Finally they are heaped on to the exhibit. This method obviates any surplus wax on the specimens or the case, and has the advantage that the 'snow' may be arranged in any way, and may be re-arranged if soiled by dirt. The characteristic sparkle may be obtained by liberally sprinkling with thinly blown and finely fractured glass.

Heriot-Watt College, Edinburgh: Award of Fellowships

THE governors of the Heriot-Watt College, Edinburgh, have instituted a new award, namely, fellowship of the College, designed primarily to encourage original work in those branches of study at present recognized for the associateship of the College, namely, mechanical and electrical engineering, applied chemistry, mining engineering, brewing and fermentation industries. The fellowship is open to (*a*) an associate of the College of not less than five years standing, who presents a thesis embodying the results of original research carried out since leaving the College; (*b*) associates or others holding equivalent qualifications, who complete a period of advanced study in the College and present a thesis. The governors of the College also have powers to confer the honorary fellowship on persons distinguished in science or engineering connected with the College. It is hoped that the institution of this award will in due course give an impetus to the extension of the research activities and higher technological training in the College, and so enable it to play an ever-increasing part in developing industrial productivity.

On July 10, the Lord Provost of the City of Edinburgh, the Right Hon. James Miller, conferred the honorary fellowship of the College on the following old students, former members of staff and governors of the College: John M. Caldwell, general manager, Scottish Oils, Ltd.; Prof. Raymond G. H. Clements, emeritus professor of highway engineering, Imperial College, University of London; Major-General David R. Duguid; Dr. Charles Forrester, deputy chief-fuel engineer, Ministry of Fuel and Power; Prof. James Greig, William Siemen's professor of electrical engineering, King's College, University of London; Wm. Hamilton Gray, senior partner with the firm of McKerrell Brown & Gray; Prof. Alex. R. Horne, emeritus professor of mechanical engineering, Heriot-Watt College; Dr. Edward Hughes, vice-principal, Brighton Technical College; J. Morison Inches, managing director of J. & J. Morison, Ltd.; Peter Kerr, technical secretary of the Institute of Petroleum; Henry R. King, production director, Scottish Division, National Coal Board; James M. Mackintosh, formerly organizer of further education under Edinburgh Corporation Committee; Dr. Wm. Maxwell, until 1949 managing director of Messrs. R. & R. Clark, Ltd.; Dr. Christina C. Miller, lecturer in chemistry, University of Edinburgh; Dr. David Penman, formerly principal, Indian School of Mines; Dr. John S. Penman, vice-principal, Barnsley Technical College; Dr. Willison B. Peutherer, manager, Grangemouth Refinery, Scottish Oils, Ltd.; Dr. James Sandilands, assistant professor, Heriot-Watt College; Roderick M. Shearer, formerly head of the Mathematics Department, Heriot-Watt College; Dr. James Cameron Smail, emeritus principal, Heriot-Watt College; Dr. Alex. M. Smith, head of the Department of Chemistry, College of Agriculture, Edinburgh; Dr. John B. Tait, senior principal scientific officer, Marine Laboratory, Scottish Home Department, Aberdeen; Dr. J. Albert Thomson, chairman and managing director, Brown Bros., Ltd., London; Wm. Watson, formerly head of the Physics Department, Heriot-Watt College; Robert Wilson, director, Pillans & Wilson, Ltd.

National Radio Exhibition

THE term 'Radiolympia' has in the past become well known to all those who are interested in the exhibition organised and held in London under the auspices of the Radio Industry Council. This year, circumstances have necessitated a change of name to that of National Radio Show, and it will be held at Earls Court during August 29–September 8. In connexion with this exhibition, a very interesting and well-produced booklet has recently been issued by the above Council. It is entitled "British Radio and Television for the World—London 1951"; and is intended to interest the overseas reader who will be visiting Great Britain in connexion with one or other of the several exhibitions being held in the early autumn of this Festival of Britain year. The contents of the booklet deal with the current state and trends of technical development in the fields of television, radio and sound reproduction, communications and navigational aids, electronics, including equipment for industrial, medical and scientific purposes, and with valves, cathode ray tubes, components and accessories. All these subjects are illustrated by many interesting photographs, including views of the Birmingham television installation and an associated relay station, the sound-reproducing arrangements in the new House of Commons and, literally, a thimbleful of sub-miniature valves. Copies of the booklet are obtainable on application to the Secretary, Radio Industry Council, 59 Russell Square, London, W.C.1.

Royal Meteorological Society: Officers

THE following have been elected officers of the Royal Meteorological Society for the year 1951–52: *President*, Sir Charles Normand; *Vice-Presidents*, Wing-Commdr. Poulter, Dr. R. C. Sutcliffe, Sir Robert Watson-Watt, W. M. Witchell; *Vice-President for Canada*, A. Thomson; *Vice-President for Scotland*, Sir Ernest Wedderburn; *Secretaries*, Prof. P. A. Sheppard, R. G. Veryard; *Treasurer*, Prof. G. C. McVittie; *Editor*, Prof. P. A. Sheppard. The new session will begin on October 1.

University of London: Appointments

THE following appointments have been made in the University of London: Dr. K. A. Hirsch, to the University readership in mathematics tenable at Queen Mary College; Mr. J. K. T. L. Nash, to the University readership in civil engineering tenable at King's College; Dr. Stanley Rowlands, to the University readership in physics tenable at St. Mary's Hospital Medical School.

The title of professor emeritus in the University has been conferred on the following in respect of the chairs they have held at the colleges mentioned: Prof. M. E. Delafield (chemistry as applied to hygiene, London School of Hygiene and Tropical Medicine); Prof. H. F. Hallett (philosophy, King's College); Prof. M. F. Lucas Keene (anatomy, Royal Free Hospital School of Medicine); Prof. J. R. Partington (chemistry, Queen Mary College); Prof. A. V. Hill (physiology and head of the Biophysics Research Unit, University College); Prof. D. M. S. Watson (Jodrell chair of zoology and comparative anatomy, University College); Prof. H. E. Watson (Ramsay chair of chemical engineering, University College).

The following doctorates have been conferred: *D.Sc.:* Mr. W. B. Mann (Imperial College of Science and Technology); *D.Sc.(Econ.):* Mr. R. H. Coase (London School of Economics and Political Science).

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: J. Cofie (senior agricultural officer, Gold Coast), senior assistant secretary, Gold Coast; N. Lamont (agricultural officer, Fiji), economic botanist, Fiji; G. M. Roddan (director of agriculture, Nyasaland), director of agriculture, Kenya; J. O. Torto (assistant director of agriculture (cocoa industry, temporary), Gold Coast), senior assistant secretary, Gold Coast; W. T. S. Brown (conservator of forests, Gold Coast), deputy chief conservator of forests, Gold Coast; D. A. Cannon (senior pathologist, Nigeria), assistant director of laboratory services, Nigeria; A. Kertesz (medical officer, Nigeria), pathologist, Nigeria; Dr. J. Anderson (senior veterinary research officer, Kenya), assistant director of veterinary research, Kenya; G. D. N. Bartlett (agricultural assistant, Nyasaland), principal agricultural assistant, Nyasaland; R. Elliott (entomologist, Sierra Leone), entomologist, Nigeria; C. D. Hutchings (senior agricultural officer, Jamaica), deputy director of agriculture (Extension Services), Jamaica; F. F. Smithyman (agricultural assistant, Nyasaland), principal agricultural assistant, Nyasaland; Dr. R. A. Kenney, senior scientific officer (physiologist), Heat Research Unit, Nigeria; D. A. Brown, veterinary officer, Kenya; P. D. Berwick, meteorologist, East Africa High Commission; H. T. Hayes, fisheries officer, East Africa High Commission; A. B. Law, meteorological officer, Northern Rhodesia; R. T. Smith, sociological research officer, British Guiana; J. E. Stevens, senior meteorological officer, Northern Rhodesia; T. Trimble, meteorological assistant, East Africa High Commission; W. R. Bransby-Williams, field officer, Colonial Insecticides Research Unit, East Africa.

The Night Sky in August

NEW moon occurs on Aug. 2d. 22h. 39m., U.T., and full moon on Aug. 17d. 02h. 59m. The following conjunctions with the moon take place: Aug. 1d. 04h., Mars 3° S.; Aug. 5d. 07h., Mercury 2° S.; Aug. 5d. 21h., Venus 4° S.; Aug. 7d. 02h., Saturn 4° N.; Aug. 20d. 21h., Jupiter 5° S.; Aug. 30d. 0h., Mars 2° S. Mercury is an evening star, setting about an hour before the sun on Aug. 1, but it draws closer to the sun and is in inferior conjunction on Aug. 31, and is not favourably placed for observation during most of the month. Venus sets about an hour after the sun on Aug. 1, but as the planet is approaching the sun it is not well placed for observation throughout the greater part of the month. Mars rises about 2h. 30m. during August and can be seen for some time before sunrise in the constellation Gemini. Jupiter rises at 22h., 21h. and 20h. on Aug. 1, 15 and 31, respectively, and is visible a little south of δ and ε Piscium throughout the month, stellar magnitude −2·3. Saturn, an evening star, sets about 1¾ hours after sunset on Aug. 1 but draws closer to the sun and is not easily seen at the end of the month, when it sets less than an hour after sunset. Occultations of stars brighter than magnitude 6 are as follows: Aug. 4d. 11h. 18m., α Leonis (*D*); Aug. 4d. 12h. 32·6m., α Leonis (*R*); Aug. 23d. 01h. 29·3m., μ Arie. (*R*). (*D*) and (*R*) refer to disappearance and reappearance, respectively, and the times refer to observations made at Greenwich. The Perseid meteors attain a maximum about Aug. 10–12, but moonlight will make observations of the shower somewhat difficult.

Announcements

THE honorary degree of LL.D. of the University of Aberdeen has been conferred on Sir William Ogg, director of Rothamsted Experimental Station, Harpenden, Herts.

HONORARY degrees of the University of Reading have been conferred on the following: *D.Litt.*, Sir John Beazley, professor of classical archæology in the University of Oxford, and Sir Frank Stenton, formerly vice-chancellor of the University of Reading; *D.Sc.*, Sir John Russell, formerly director of Rothamsted Experimental Station, and Sir Henry Tizard, chairman of the Advisory Council on Scientific Policy.

THE honorary degree of D.Sc. of the University of Wales has been conferred on Sir David Brunt, professor of meteorology in the Imperial College of Science and Technology, London.

THE following appointments have been made in the University of Leeds: Dr. R. P. Hullin, lecturer in biochemistry; Mr. W. S. Reith, research chemist and honorary lecturer in the Department of Botany.

POWER Jets (Research and Development), Ltd., have appointed Mr. G. C. R. Mathieson to be senior lecturer at the School of Gas Turbine Technology, Farnborough, Hampshire. Mr. Mathieson was until recently a senior scientific officer in the Aerodynamics Department of the National Gas Turbine Establishment, Pyestock, which he joined in 1946.

SIR ALEXANDER CARR-SAUNDERS has resigned from the chairmanship of the Colonial Social Science Research Council, owing to the pressure of other duties; he will be succeeded by Sir David Parry, professor of English law in the University of London since 1930. Sir Alexander has recently assumed the chairmanship of the Inter-University Council for Higher Education in the Colonies.

THE Annual Exhibition of the Amateur Entomologists' Society will be held on Saturday, September 22 (2 p.m. to 6 p.m.), at Buckingham Gate Central Schools, Wilfred Street, London, S.W.1. There will be exhibits of specimens, equipment, apparatus, photographs, etc., and talks by experts including Major Maxwell Knight. Further particulars can be obtained from the honorary publicity secretary of the Society, L. W. Siggs, 10 Repton Road, Orpington, Kent.

INTERNATIONAL CO-OPERATION IN THE ANALYSES OF THE DEEP-SEA CORES COLLECTED BY THE SWEDISH DEEP-SEA EXPEDITION 1947–48

By C. D. OVEY
British Museum (Natural History)

I RECENTLY had the good fortune to be the guest, for a few days, of Prof. Hans Pettersson, leader of the Swedish Deep-sea Expedition 1947–48, and several of his research workers in Sweden. It is evident that it will not be long now before many important results of the work on the Expedition's deep-sea cores, collected by Dr. B. Kullenberg with his piston core sampler, appear in print in that country. The chemical and biological analyses are being carried out with extreme care by a well-organized group of workers, partly at the Oceanografiska Institutet in Göteborg and partly in Stockholm, and at Grödinge where Mr. Gustav Arrhenius has a number working under his direction on cores from the Eastern Pacific.

The Oceanografiska Institutet is the 'home' of the investigations, whence the material is distributed. Both there, where mostly Central and Western Pacific and Indian Ocean material is being dealt with, and at Grödinge, the cores are carefully stored in cold air-proof rooms at a temperature of 5° C. in the presence of formalin. These precautions prevent shrinkage, cracking and drying, and ensure against bacterial action in the sediments which would cause oxidation of the manganese. Chemical tests are being carried out on the content of phosphorus, nitrogen, titanium, iron, nickel, vanadium, carbon and calcium carbonate. Tests of grain size are also being undertaken by Mr. Arrhenius. As with the single Atlantic core now being examined in the British Museum (Natural History) by my colleague, Dr. J. D. H. Wiseman, and I, it has been found by Mr. Arrhenius that the carbon dioxide content in Pacific cores is a reciprocal of the adsorbed water content. It is also agreed that a high percentage of carbon dioxide, which is derived from carbonate, is a reflexion of the productivity of the foraminifera which provided the material through the accumulated remains of their calcitic shells. Mr. Arrhenius has now given me a few samples from his Eastern Pacific cores, to discover whether warm-water foraminifera are abundant when the carbonate content is high in cores from that area, as has been shown to be true by the British Museum work on the Atlantic core already mentioned. It is hoped by co-operation of this sort to be able to link up the chemical work in Sweden, and its geological and hydrological implications, with the inferences of temperature changes of the surface layers of the ocean at present being made in Great Britain. It must be remembered that the results of the examination of the Pacific cores, shortly to be published, will cover a wide range of different hydrographic conditions through the comparison of a number of core-sections. The Pacific area samples, as shown by Dr. F. Koczy's work at Göteborg on the interpretation of echo-profiles and of the hydrographic properties near the floor in that area, indicate considerable vertical mixing due to the irregularity of the floor. From a study of the cores themselves, this is evidently as true of the past as it is of the present. The single Atlantic core being examined in Great Britain, however, suggests that deposition took place on the whole continuously and undisturbed, although there is some evidence of disturbance at a few depths due to bottom-living organisms. (I had the opportunity of examining part of the core at Göteborg and of seeing the log.) It therefore seems that the Atlantic core (No. 241 at 01° 10′ N., 19° 50′ W.), where the sedimentation was relatively undisturbed and the sea floor flat over a wide area, is ideal for the work on the interpretation of climatic change. The Pacific cores cannot be approached at this angle; but there is very good reason for supposing that, by application of the work done in Britain and the proof of the validity of planktonic foraminifera as temperature-indicators, temperature fluctuations will be traceable in the Pacific area.

One of the first of the Expedition's long cores was examined by Dr. F. B. Phleger, the first to apply foraminifera as temperature-indicators to this series. This core came from the Caribbean Sea, but it seems doubtful whether the local rate of sedimentation retained the constancy necessary for a close chronological problem. Nevertheless, Dr. Phleger has shown by his diagram that there were conspicuous and considerable variations in temperature in that area during the recent past.

As Prof. F. E. Zeuner ("Dating the Past", 2nd edit. 1950, p. 401) and Dr. J. D. H. Wiseman, in a recent address to the Society of Visiting Scientists, have implied, conclusions from single cores are tentative; but much will be learned as soon as Mr. Arrhenius publishes his work on the series of cores in the Eastern Pacific. Prof. Hans Pettersson was, however, very careful in his choice of core 241, which, although an isolated example, was obtained from a flat area of quiet undisturbed deposition. Further adjacent cores would naturally be of great value in establishing a standard for climatic variation in the equatorial Atlantic, but I wish to emphasize that it is my considered opinion and that of my colleague, Dr. Wiseman, that this particular core is singularly suitable for this purpose.

In Stockholm, Dr. R. W. Kolbe has been working with the diatoms of the Eastern Pacific cores and has provided Mr. Arrhenius with a fascinating story on the size distribution of *Coscinodiscus nodulifer* A. Schmidt. Dr. F. Brotzen is making a study of the benthonic foraminifera from cores in the same area. I was in complete agreement with him in the identity of the planktonic species which I am using as temperature-indicators. Interesting studies of radiolaria from Western Pacific cores by Mr. W. Riedel will be of great importance when linked with other work. His results, showing the presence of Tertiary forms, will be in print shortly.

Prof. Pettersson himself is conducting radioactive determinations on cores from the Central and Western Pacific Ocean, but this is a long and tedious operation. Carbon-14 tests, being made on the Eastern Pacific cores, will be of first-class importance; but unfortunately tests for this operation are done at the expense of considerable material, as it is necessary to use a large quantity for each count.

The above impressions are merely a very brief summary of the work now being carried out in Sweden on the material collected by the Swedish Deep-Sea Expedition, and in no way has space allowed for a complete survey. Let it be said that Prof. Pettersson has succeeded in building up a great network of scientific research on his cores both in Sweden, in north-west Europe, in Great Britain and in the United States. Every core, whether isolated or one of a group or sequence, is of value from some aspect of the deep-sea floor, which is so little known. It is not possible at this early stage to assess the worth of the work, whether geophysical, geochemical, biological or palæoclimatological. It is, however, evident even at this early stage that, whatever the aspect of approach, the whole will gradually be dovetailed into a preliminary story which will be a guide to future workers and explorers in this field in the same manner that the great *Challenger* Expedition of the last century became the foundation of oceanographical work to the present generation of marine investigators. We must therefore look forward with hope to co-ordinating this work further in August at the meeting of the Association d'Océanographie Physique in Brussels. It is essential to encourage co-operation in all the varied lines of study of the cores, because, however great the difficulties in obtaining sufficient financial assistance for this all-important work, collaboration, and not rivalry, is of prime importance; without it, what little money that is at present available would largely be wasted.

AN EXTRA-ADRENAL ACTION OF ADRENOTROPIC HORMONE

By Prof. HANS SELYE

Institute of Experimental Medicine and Surgery, University of Montreal

JUST fifteen years ago, I described in this journal the 'general-adaptation-syndrome' as the somatic expression of "the response to damage as such". It was surprising that all organs of the body show degenerative changes, with widespread pyknosis and catabolism, under the influence of various damaging agents; only the adrenal cortex exhibits signs of increased hormone secretion and cellular proliferation. This was ascribed to the increased production of 'adrenotropic hormone', now generally known as ACTH[1]. These observations lead us to the concept that non-specific damage, or 'stress', has its own physiology and pathology (quite apart from specific actions of the agent used to produce stress) and that the pituitary-adrenal system plays a cardinal part in this non-specific adaptive or defensive reaction[2,3].

Subsequent investigations showed that the acute thymus involution, which occurs during the first 'alarm-reaction' stage of the general-adaptation-syndrome, is prevented by suprarenalectomy, while active adrenocortical extracts can produce thymus involution, even in the adrenalectomized animal. Hence, I concluded that "the secretion of the adrenal gland must therefore be considered essential for the ability of the thymus to undergo sudden involution"[4]. Since after hypophysectomy stress causes neither adrenocortical stimulation nor thymus involution, it was thought that the thymolysis is elicited by stress through the discharge of adrenotropic hormone and the consequent increase in the production of corticoids[5].

The numerous pertinent reports, published during the intervening years, appeared to support this concept; indeed, it is now generally held that not only the thymolytic, but also all known actions of adrenotropic hormone are mediated through the hormones of the adrenal cortex, because adrenotropic hormone produces no obvious changes in adrenalectomized animals, or in patients with complete adrenal destruction[6].

Recent experiments revealed that many of the actions of somatotrophic hormone are likewise abolished by adrenalectomy and can be restored, even in adrenalectomized animals, by suitable treatment with corticoids (Selye, in the press). This raised the question whether some of the supposedly trans-adrenal actions of adrenotropic hormone might not also be direct, though dependent upon the simultaneous presence of corticoids in the body fluids. The results to be reported here show that such a peripheral synergism between adrenotropic hormone and corticoids does, in fact, exist. Concurrent treatment with adrenotropic hormone and cortisone caused pronounced thymolysis in the adrenalectomized rat, although each of these hormones given separately failed to do so at the same dose level.

Experimental procedure. Three experiments have been performed on a total of 120 female piebald rats. In each of these we used four groups of ten rats treated respectively as follows: (I) hypertensinogen: (II) adrenotropic hormone; (III) adrenotropic hormone and cortisone; (IV) hypertensinogen and cortisone. Hypertensinogen was administered merely in order to determine the possible effect of a non-hormonal foreign protein. It was given at a daily dose-level of 6 mgm., administered in the form of six subcutaneous injections of 1·0 mgm. in 0·1 ml. of saline, subcutaneously every four hours. Adrenotropic hormone (ACTH, Connaught Laboratories, Toronto, Lot No. 2–2, 3–1) was given at the same dose-level and in the same manner as the hypertensinogen. It will be recalled that in order to obtain maximal adrenocorticotrophic effects from adrenotropic hormone, it is essential to give it at short intervals; it is for this reason that injections were given every four hours during the day and night. Cortisone was administered in the form of one subcutaneous injection of 0·5 mgm. a day, in the form of a microcrystalline suspension (as distributed by Merck and Co., Ltd., Montreal) which contains 5 mgm. of cortisone acetate per ml.

All the experimental animals in the three series were bilaterally adrenalectomized and ovariectomized forty-eight hours before the initiation of the injections. Immediately after this, they were given 1 per cent sodium chloride instead of tap water as a drinking fluid. The removal of the gonads and adrenals was necessary in order to eliminate both the known endogenous sources of steroid hormones.

The three experimental series differed only in that injections were given in the first experiment during four days, in the second during six days, and in the third during nine days. At the end of each experiment the animals were killed by exsanguination and their thymus glands removed for weighing and histological study.

TABLE 1. EFFECT OF FOUR DAYS TREATMENT

Treatment		Hypertensinogen	ACTH	ACTH + cortisone	Hypertensinogen + cortisone
Body-weight (gm.)	Initial	121	121	121	121
	Final	117	109	114	120
Weight of thymus	in mgm.	366	319	203	282
	in mgm./100 gm. body-weight	308±18·5	294±16·1	179±15·9	237±18·1

TABLE 2. EFFECT OF SIX DAYS TREATMENT

Treatment		Hypertensinogen	ACTH	ACTH + cortisone	Hypertensinogen + cortisone
Body-weight (gm.)	Initial	108	108	108	107
	Final	109	104	104	109
Weight of thymus	in mgm.	299	291	161	249
	in mgm./100 gm. body-weight	275±23·5	280±21·8	156±13·7	228±17·4

TABLE 3. EFFECT OF NINE DAYS TREATMENT

Treatment		Hypertensinogen	ACTH	ACTH + cortisone	Hypertensinogen + cortisone
Body-weight (gm.)	Initial	110	110	110	109
	Final	129	108	118	131
Weight of thymus	in mgm.	423	303	168	283
	in mgm./100 gm. body-weight	324±18 1	280±15·6	141±16·4	217±12·6

Results. The details of the experimental arrangement, the initial and final body-weights, as well as the thymus weight expressed in mgm. and in mgm. per 100 gm. of body-weight (the latter with its standard error) are given in the accompanying tables.

It will be noted that none of the injected materials caused a significant loss of body-weight during our short-term experiments. Neither adrenotropic hormone nor an equivalent amount of non-hormonal protein (in the form of hypertensinogen) produced any consistent and significant involution of the thymus in these adrenalectomized rats. Cortisone, when given in conjunction with hypertensinogen, induced only a moderate degree of thymolysis. However, in all three series, marked involution of the thymus was noted in the animals given adrenotropic hormone and cortisone. Statistical analysis of the apparent differences between groups III and IV showed that in all three series the augmentation of cortisone thymolysis by adrenotropic hormone was significant. The value of P, in comparing the thymus weights in mgm. per 100 gm. between groups III and IV, was $< 0·05$ in group I, and $< 0·01$ in groups II and III.

Histological studies essentially confirmed the observations made by mere weighing of the thymus in that maximal thymolytic phenomena were noted in groups III of all three series.

Discussion. These data indicate that adrenotropic hormone can synergize the thymolytic effect of a corticoid hormone, such as cortisone, even in the absence of the adrenal cortex. It follows that the thymolytic effect of stressor agents is not necessarily due to increased production of corticoids through discharge of adrenotropic hormone, but that it may in part also result from a peripheral synergism between the hormone and the corticoids.

These findings call to mind certain observations made in this Institute by Dr. Herlant[6], who showed that the thymolytic effect of threshold doses of adrenocortical extract is increased by an alarm-reaction, even in adrenalectomized rats. The present observations suggest that this increase may have been due, at least in part, to an endogenous discharge of adrenotropic hormone by the pituitary of the animal exposed to stress.

It remains to be seen whether a disproportion between circulating adrenotropic hormone and corticoids can produce results qualitatively different from those normally elicited by either of these hormones, and whether conjoint treatment with the hormone and cortisone would be of special benefit in the treatment of those lymphatic, inflammatory and allergic diseases which respond favourably to glucocorticoids.

These investigations were supported by a grant from the National Cancer Institute of Canada. I am also indebted to Miss Marguerite Parent for technical assistance.

[May 8.

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ANTITUBERCULOUS EFFECT OF CERTAIN SURFACE-ACTIVE POLYOXYETHYLENE ETHERS IN MICE

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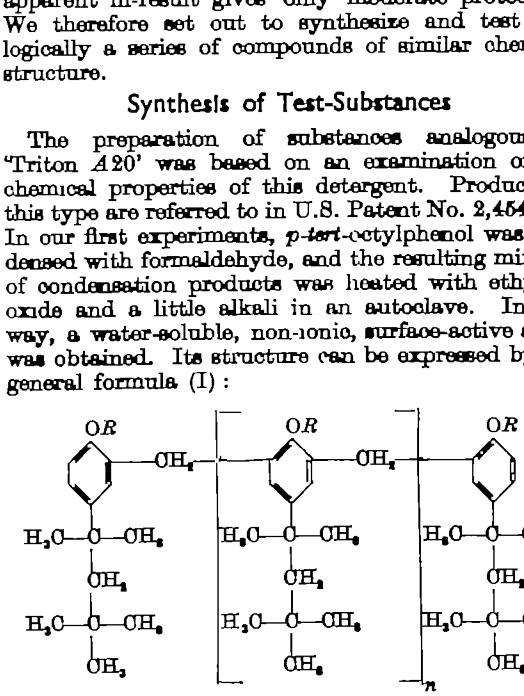
As part of a study, by two of us (P. D'A. H. and R. J. W. R.), of factors influencing the susceptibility of mice to experimental tuberculosis, methods of altering the body lipids were sought. For this purpose a new technique[1–4], by which the blood cholesterol and phospholipids could be maintained at high levels for several weeks by the repeated intravenous injection of the non-ionic surface-active agent 'Triton *A*20', was tried. This agent is described by its manufacturers (Rohm and Haas Co., Philadelphia; we are indebted to their associates, Charles Lennig and Co., Ltd., London, for supplies of the substance) as a 25 per cent aqueous solution of an arylalkyl polyether of phenol ('Triton *WR*1339'); and all doses of 'Triton *A*20' given below refer to this anhydrous material. In the first experiment, made more than a year ago, 'Triton *A*20' produced a striking suppressive effect on the course of a moderately acute tuberculous infection in mice. Further experiments amply confirmed this unexpected observation. 'Triton *A*20' has, however, undesirable toxic effects in mice. Injection of the optimal intravenous chemotherapeutic doses (15–25 mgm.) is followed immediately by convulsions, though these are transitory and seem to leave no after-effects; while a single injection of 25 mgm. intraperitoneally or 10 mgm. subcutaneously produces a gelatinous ascites or œdema, respectively, and the highest daily dose (2·5 mgm.) tolerated by these routes without apparent ill-result gives only moderate protection. We therefore set out to synthesize and test biologically a series of compounds of similar chemical structure.

Synthesis of Test-Substances

The preparation of substances analogous to 'Triton *A*20' was based on an examination of the chemical properties of this detergent. Products of this type are referred to in U.S. Patent No. 2,454,541. In our first experiments, *p*-*tert*-octylphenol was condensed with formaldehyde, and the resulting mixture of condensation products was heated with ethylene oxide and a little alkali in an autoclave. In this way, a water-soluble, non-ionic, surface-active agent was obtained. Its structure can be expressed by the general formula (I):



I

$R = -CH_2CH_2O(CH_2CH_2O)_{15-16}CH_2CH_2OH$ except where indicated otherwise.
$n = 0, 1, 2, 3$ and higher integers.

This product (*D*2) was found to be as active chemotherapeutically as 'Triton *A*20' (see below), and it was therefore decided to prepare products homogeneous with respect to *n*. Condensation of *p*-*tert*-octylphenol with ethylene oxide gave a toxic product (*D*3). 2 : 2′-Dihydroxy-5 : 5′-di-*tert*-octyldiphenylmethane (I; $n = 0$; $R = H$) was made from excess *p*-*tert*-octylphenol and formaldehyde by adapting a conventional method. Condensation of this crystalline substance with ethylene oxide afforded the product *D*4 (I; $n = 0$). *p*-*tert*-Octylphenol with formaldehyde and sodium hydroxide gave 2 : 6-*bis*hydroxymethyl-4-*tert*-octylphenol[4] and, contrary to an earlier statement[5], no difficulty was experienced in condensing this substance with excess *p*-*tert*-octylphenol to give 2 : 6-di(2′-hydroxy-5′-*tert*-octylbenzyl)-4-*tert*-octylphenol (I; $n = 1$; $R = H$) which, though non-crystalline, could be purified by distillation at a pressure of 10^{-2} to 10^{-3} mm. mercury. This compound was condensed with ethylene oxide to give *D*9*a* (I; $n = 1$).

Condensation of the substituted diphenyl methane (I; $n = 0$; $R = H$) with formaldehyde in glacial acetic acid saturated with hydrogen chloride (cf. refs. 5, 6), and subsequent molecular distillation of the reaction mixture after elimination of excess parent compound, gave a product consisting essentially of the tetracyclic compound (I; $n = 2$; $R = H$) which reacted with ethylene oxide to give *D*10*a* (I; $n = 2$). The residue in the molecular still was also condensed with ethylene oxide, giving *D*10*b* (I; $n = 4, 6, 8$, etc., together with unexpelled tetracyclic compound). For comparative biological tests, *D*10 (I; $n = 2, 4, 6$, etc.) was prepared from a resin obtained exactly as above except that molecular distillation was omitted.

In another experiment and as a possible alternative to molecular distillation, an attempt was made to purify the crude tetracyclic compound by successive countercurrent distribution between ligroin (boiling range 88°–101°) and 94 per cent aqueous ethanol at 0° C. Only a partial purification resulted, but the best fraction was condensed with ethylene oxide; the product (*D*11) showed activity similar to that of *D*10*a*.

The product isolated by a double molecular distillation of another batch of the crude tetracyclic compound was also shown by countercurrent distribution to be not quite homogeneous.

Finally, 2 : 6-*bis*hydroxymethyl-4-*tert*-octylphenol was condensed with excess of the substituted diphenyl methane (I; $n = 0$; $R = H$). A product, collected at 300°–310° in the molecular still, was presumably mainly the pentacyclic compound (I; $n = 3$; $R = H$). This gave *D*12 (I; $n = 3$) on condensation with ethylene oxide.

The results given below show that no activity can be observed in the products when *n* is less than 2. The presence of the di- and tri-cyclic compounds in mixtures such as *D*2 appears to have no advantage. On removing these substances as completely as possible by distillation from the resin corresponding to *D*2 and condensing the residue with ethylene oxide, the product (*D*2*a*; I; $n = 2, 3, 4$, etc.) was found to be as active as *D*2.

Bacteriostatic Tests

Paradoxically, in the light of the chemotherapeutic results to follow, 'Triton *A*20' was suggested[7] as a useful addition to fluid media for the culture of tubercle bacilli, since it promoted dispersed growth of virulent organisms (strain *H*37*Rv*); optimal concentrations were 0·1–0·01 per cent. and there was neither inhibition nor enhancement of growth in this range. We have confirmed the dispersive properties, but observed an increasingly bacteriostatic effect on strain *H*37*Rv* at concentrations greater than 0·1 per cent. Other workers[8] have reported an enhancing effect of 'Triton *A*20' on the growth of tubercle bacilli at lower, and an inhibitory action at higher, concentrations; the inhibitory range extended as the *p*H was increased. *D*3 did not permit growth of *H*37*Rv* at 0·01 per cent; our other products, whether active or inactive against infection with this strain in mice (see below), were less inhibitory to its growth *in vitro* than 'Triton *A*20', but were similarly dispersive. No bactericidal action on *H*37*Rv* by 'Triton *A*20' 0·1 per cent and 1·0 per cent at *p*H 6·8–6·6 was evident after 20 hours exposure.

Chemotherapeutic Tests

The chemotherapeutic assessment is illustrated by a typical experiment. Twenty-two female mice of the albino Parkes strain, weighing 18–20 gm., and fed on a stock mash diet, were infected intravenously with 0·06 mgm. dry weight (about 10^7 viable organisms) of *Mycobacterium tuberculosis*, strain *H*37*Rv*, grown in 'Tween 80'-albumin medium. Starting the next day, ten of the mice received intravenous injections of 25 mgm. of *D*2 in 0·2 ml. saline twice weekly for two weeks, the injections being given slowly; the other twelve mice served as an untreated control. The control mice lost weight, and nine of the twelve died with gross pulmonary tuberculosis between 18 and 26 days after infection (median survival time 23 days); one died of intercurrent infection on the fifth day; and the two remaining animals, which were sick, were killed on the thirty-fourth day and their lungs showed well-marked tuberculous lesions. In contrast, apart from one death from intercurrent infection also on the fifth day, none of the ten treated mice died; they gained weight and appeared healthy when they were killed on the thirty-fourth day, that is, twenty-three days after the last injection; and they had air-containing lungs showing in eight of them scattered tuberculous lesions, pin-point in size, and varying in number, and in the ninth animal somewhat more advanced changes.

Using the same test, the following preparations, at the doses stated, had a similar order of anti-tuberculous activity to *D*2: 'Triton *A*20' (15–25 mgm.), *D*2*a* (25 mgm.), *D*10 (25 mgm.), *D*10*a* (15 mgm.), *D*10*b* (25 mgm.), *D*11 (15 mgm.) and *D*12 (25 mgm.). On the other hand, given at the following maximum tolerated doses, *D*4 (5 mgm.) and *D*9*a* (7·5 mgm.) were inactive. When the twice-weekly intravenous dose of 'Triton *A*20' was reduced to 10, 5 and 1 mgm., none of the three series of animals showed deaths from tuberculosis during the experiment, but the pulmonary lesions on killing were increasingly severe. The results obtained were as effective when the course of treatment with 'Triton *A*20' (25 mgm.) was started five days as one day after infection, and even a single dose at five days profoundly reduced the mortality and the lung lesions. Moreover, although individual animals failed to receive one or more doses after the first, in the usual course of four, owing to difficulties in repeatedly injecting the tail vein, this seemed to make little or no difference to the therapeutic results. When the usual course of 'Triton *A*20' (15 mgm.) was started ten days after infection, no protection was evident. Streptomycin, 2,000 units daily subcutaneously, gave results similar to 'Triton *A*20', 15 mgm. and 5 mgm. twice weekly intravenously, both drugs being started on the day after infection and administered for two weeks. When, however, the type of experiment was varied by killing about eight (instead of three) weeks after cessation of treatment, most of the streptomycin-treated mice had died of chronic pulmonary tuberculosis, whereas the animals treated with 'Triton *A*20' (15 mgm.) were still alive though their lungs showed that the infection had progressed. An experiment in which 2·5 mgm. of 'Triton *A*20' was given daily subcutaneously for two weeks, from the day after infection, resulted in similar protection against death to that given by 15 mgm. twice weekly intravenously, but the pulmonary lesions on killing (34 days) were more advanced in the majority of the animals.

Pharmacology and Toxic Effects

We have confirmed the observation[1-3,9] that intravenous injection of 'Triton *A*20' is followed by a rise in blood cholesterol, associated, when the rise is considerable, with milky serum. Estimations made two days after the end of a two weeks course of twice-weekly injections of 25 mgm. in mice showed a four- or five-fold increase in blood cholesterol, with milky serum, the levels returning to normal in about a week; with doses of 10 mgm. and 5 mgm. there was a two-fold and no increase, respectively. Blood cholesterol estimations were not made after giving our own products, but milky serum was observed at 24–48 hr. after a single intravenous injection of 15–25 mgm. of all that could be given at these doses, except *D*12. Similar hyperlipæmia was produced by the higher doses given by the intraperitoneal and subcutaneous routes. The adrenal glands from mice given a course of 'Triton *A*20' intravenously (15–25 mgm.) were pale pink, instead of the characteristic yellow. Histochemical tests showed the cortex to have been stripped of fat and cholesterol, these being apparently restored to normal in one or two weeks after cessation of treatment, the cholesterol more slowly than the fat. Sections of liver showed some decrease of fat, but the fat depots in general appeared unaffected. A similar temporary pallor of the adrenals was noted after one or more intravenous injections of most of our products, and subcutaneous and intraperitoneal administration with the larger doses also produced this phenomenon.

All the surface-active agents mentioned here have an ultra-violet absorption peak at 278 mμ, and this characteristic was used to estimate 'Triton *A*20' and *D*2 in the blood, after precipitation of the blood proteins by a 4 : 1 ethanol–ether mixture. The blood concentrations reached after single intravenous injections of 25 mgm. of 'Triton *A*20' were high, and their fall remarkably slow. The concentrations per ml. were 7 mgm. at 24 hr., 3 mgm. at two days, 2 mgm. at three days, and 0·8 mgm. even at four days. A course of *D*2 25 mgm. daily subcutaneously for ten days gave, four days later, 4 mgm. per ml. On the other hand, no 'Triton *A*20' was detectable in the blood after 100 mgm. had been given daily orally for a month.

*D*3 was the most toxic of the series to mice, its intravenous LD_{50} being 3 mgm. and death being immediate. For *D*4 and *D*9*a* the LD_{50} was 12·5 mgm. by this route. All but one of the other products were tolerated intravenously at doses varying from 15 mgm. to 75 mgm. without convulsions, in contrast to 'Triton *A*20', and without other serious symptoms; *D*12, however, was associated with transitory spasticity. Since *D*2 contained both *D*4 and *D*9*a* in proportions such as would have been expected to confer an appreciable toxicity, it would seem that admixture with the higher polymers had masked this. Further evidence of this phenomenon is provided by the comparative hæmolytic tests. None of our products tested intraperitoneally or subcutaneously at single 20–25 mgm. doses (*D*2, *D*2*a*, *D*10 and *D*12) gave rise to ascites or subcutaneous œdema, nor did *D*2*a*, *D*10 or *D*12 do so after seven to ten daily subcutaneous injections of these amounts. A more detailed examination was made on animals killed nine days after they had completed a course of 25 mgm. of *D*2 intravenously twice weekly for three weeks. They seemed healthy and had gained weight. At autopsy the principal organs were normal in appearance and size (except for the adrenals already described), and adipose tissue was normally distributed. Microscopically also, these organs showed no abnormalities; in particular, the liver cells showed no obvious degenerative changes, in contrast to the livers of animals treated with 'Triton *A*20', which often had small areas of focal necrosis. The livers appeared normal also in mice that had received courses of *D*2*a*, *D*10, *D*10*a* and *D*10*b* intravenously, but damage was seen in a small proportion after *D*11 and *D*12. We have not observed the presence in excessive quantities of 'foam cells' in the reticulo-endothelial systems of our animals, as described by Payne and Duff[10].

Serial No.	Chemical structure	Inhibitory concentration* (gm./100 ml.)	Chemotherapeutic activity	Intravenous toxicity		Hæmolytic ratio ('Triton $A20$' = 1)
				LD_{50} in mgm.† (single injection)	Liver damage (course of injections of 15–25 mgm.)	
$D2$	I; n = 0, 1, 2, 3, etc.	1·0	+	>75·0	0	0·02
$D2a$	I; n = 2, 3, 4, etc.	1·0	+	>62·5	0	0·02
$D3$	p-Octylphenol polyoxyethylene ether	0·01	Too toxic for test	3·0		1,600
$D4$	I; n = 0	1·0	0	12·5		500
$D9a$	I; n = 1	>1·0	0	12·5	± (7·5 mgm.)	1·0
$D10$	I; n = 2, 4, 6, etc.	>1·0	+	>50·0	0	0·25
$D10a$	I; n = 2 (substantially)	>1·0	+	>50·0	0	0·25
$D10b$	I; n = 4, 6, etc (and unexpelled I; n = 2)	>0·5	+	>25·0	0	0·25
$D11$	I; n = 2 (substantially)	>1·0	+	>25·0	±	
$D12$	I; n = 3 (substantially)		+	>50·0	±	
'Triton $A20$'		0·7	+	>25·0	±	1·0

* No growth at two weeks in synthetic medium containing 2·5 mgm. albumin and 0·0008 mgm. (moist weight) tubercle bacilli per ml.
† Mice weighed 18–20 gm. each.

'Triton $A20$' had a low hæmolytic activity *in vitro*, this finding being in agreement with other workers[11]. Tests with our products in comparison with this agent showed that $D3$ was 1,600, and $D4$ 500, times as hæmolytic, while $D9a$ had the same activity. The other products showed somewhat lower hæmolytic activities than 'Triton $A20$', particularly $D2$ and $D2a$, which gave values of one-fiftieth or less. Mouse serum was never seen to be pigmented even after the largest doses of 'Triton $A20$', or of any of the products that showed equal or lower hæmolytic activity *in vitro*. Capillary permeability tests with intravenous pontamine blue revealed a contrast between $D4$, which markedly increased leakage of the dye through the vessels into the tissues, and 'Triton $A20$', $D2$ and $D2a$, which showed no such effect.

Discussion

Within the limits of the present study, the products tend to be less toxic, and more active against tuberculous infection, as molecular size increases. Antituberculous activity in compounds of formula I may perhaps be limited to a definite range of values of n: it is worth noting that an increase of one unit in n raises the molecular weight by about 1,000.

Marked bacteriostatic activity *in vitro* was found only with the simplest compound ($D3$), which was too toxic to be tested chemotherapeutically. All our other products, both active and inactive *in vivo*, showed an approximately equal bacteriostatic power of a low order. It remains doubtful, therefore, whether direct bacteriostatic action is responsible for the antituberculous effect in mice, in spite of the high concentrations attainable in their blood. The relevance of the remarkable hyperlipæmia, and loss of lipids from the adrenal glands, to chemotherapeutic effectiveness is also doubtful, since 'Triton $A20$' was definitely antituberculous at doses too small to produce these phenomena, while they were not apparent even after the higher, and effective, doses of $D12$.

The detoxifying action of the higher polymers on the toxic lower members of the series, as well as their persistence in the blood, suggests the possibility of using these compounds in association with other, even toxic, drugs having high tuberculostatic activity *in vitro*.

Experiments are in progress with a method of reverse phase partition chromatography with the object of isolating the pure compounds containing four and more phenolic nuclei in the molecule. The substituents in the phenolic nuclei will also be varied. On the biological side, the reactions of the tissue white cells to these surface-active substances, and any possible antituberculous effect in animal species other than mice, will be investigated.

Some of this work is forming the subject of a patent application.

We are indebted to Dr. A. J. P. Martin for his advice in connexion with the partition chromatography.

Summary

The development of experimental tuberculosis in mice is markedly inhibited by injection of certain non-ionic, water-soluble, surface-active preparations of low toxicity, having the general formula I ($n > 1$), obtained by reaction of ethylene oxide with condensation products of formaldehyde with p-*tert*-octylphenol. Some of the more important results relating to these products are summarized in the accompanying table.

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RADIOCHEMICAL TECHNIQUES IN ANALYSIS

IN conventional radioactive tracer methodology a labelled substance is added to a system so that its physical or chemical fate in the system can be followed by its radioactivity. In this way radiochemical techniques have been more used as a research tool than as an aid to routine chemical analysis. There are several ways, however, in which radiochemical techniques may be effectively used in analytical chemistry, some of which were exemplified at the recent meeting organized by the Physical Methods Group of the Society of Public Analysts and Other Analytical Chemists. The meeting, under the chairmanship of B. S. Cooper, was held in the rooms of the Institute of Physics in London on

May 22. This 'radiochemistry meeting', which was the second to be held under that title, was well attended and very successful, and promises to become a useful annual event.

Four papers were presented at the meeting. The first, by F. P. W. Winteringham, A. Harrison and R. G. Bridges (Pest Infestation Laboratory), was read by the first author and described the application of radiochemical techniques to quantitative paper-chromatographic analysis. Radiochemical techniques have been so applied in three ways: (1) the mixture for analysis already contained labelled components as in tracer experiments, or it was exposed to a labelled reagent before chromatographic separation so that one or more of the components were converted into radioactive derivatives; (2) the finished paper chromatogram was exposed to a labelled reagent which combined selectively with one or more of the separated components, the excess of reagent then being removed, leaving a radioactive isotope either associated or combined with the components; (3) the finished paper chromatogram was irradiated in the Harwell Pile so that any components containing an element of suitable activation cross-section was made conspicuously radioactive. In all cases the labelled chromatograms were scanned radiometrically so that the labelled components could be located or estimated. A simple device was described in which uni-dimensional paper chromatograms or strips cut from a two-dimensional chromatogram were fed automatically at a controlled rate through a slot so that consecutive sections of the paper were exposed for a given time interval to a screened end-window Geiger–Muller tube under conditions of uniform geometry. By using a suitable integrating circuit connected to a pen-recording milliammeter or self-balancing potentiometer, the mean rate of count was plotted against the distance along the strip, giving the required radio-chromatogram. The effects of β-particle self-absorption by the paper, and its variation, have been calculated to be small and unlikely to impair quantitative work even with soft β-emitters like carbon-14 or sulphur-35. Several radiochromatograms, obtained by the methods discussed, were presented.

The second paper, by E. Lester Smith and D. Allison (Glaxo Laboratories), dealt with the paper chromatographic analysis of penicillin mixtures labelled with radioactive sulphur-35. Dr. Lester Smith described how crystalline penicillins containing up to 600 microcuries of sulphur-35 per mgm. were prepared biosynthetically in a medium containing sodium sulphate labelled with sulphur-35. A point of interest was that the mould *P. chrysogenum*, *Q*176, tolerated up to one curie of sulphur-35 per litre of medium. The penicillin mixture was resolved on a buffered paper chromatogram by the method of Goodall and Levi. The separated components were located or estimated by three methods and the results compared. In the first method (Goodall and Levi) the developed chromatogram was placed against an agar plate inoculated with *B. subtilis* so that on incubation the separated penicillins were located and estimated by the zones of bacterial inhibition. In the second method the strips were placed against X-ray film in the dark so that the components labelled with sulphur-35 could be located autoradiographically. Finally, the paper chromatogram was cut up into equal sections which were mounted below a thin end-window Geiger–Müller tube and the β-activity of the sulphur-35 assayed radiometrically. The results by all three methods agreed well, and the experiments demonstrated clearly the value of a radioactive tracer technique in checking existing chemical and biological methods of assay. An interesting outcome of these experiments was that a significant fraction of the penicillins appeared to be destroyed after application to the paper strip, this being suggested by a zone of radioactivity at the origin not associated with antibiotic activity.

A. A. Smales read the third paper, contributed by himself and B. D. Pate (Harwell), and described a method for the ultra-micro determination of arsenic by neutron activation. Pile irradiation of a sample containing arsenic gives rise to radioactive arsenic-76 by means of the reaction $^{75}\mathrm{As}(n,\gamma)^{76}\mathrm{As}$. Arsenic-76 decays by β-emission of maximum energy 3·0 MeV. with a half-life of 27 hr. Radiation due to this isotope in a chemically separated fraction is characterized by its energy and decay period. The sensitivity and accuracy of the method were tested by a carrier technique in which a known excess of inactive arsenic was added to the irradiated sample and a known proportion isolated by conventional analytical techniques, the activity of arsenic-76 in the separated fraction then representing a known proportion of the arsenic originally present in the sample. Close agreement was obtained between chemical and activation analysis at high concentrations, and the results obtained by the activation method alone were consistent on samples diluted well beyond the limits of chemical detection. The data provide an excellent example of the sensitivity and accuracy of the methods of activation analysis. The determination of as little as 10^{-4} μgm. of arsenic in biological samples appears to be quite practicable. Their great sensitivity, notwithstanding the methods, are not without pitfalls for the unwary. This was illustrated in the application of the method to the assay of germanium dioxide for arsenic. On neutron activation, germanium itself gives rise to more than one radioactive isotope of arsenic—for example, by the sequence, $^{74}\mathrm{Ge}(n,\gamma)^{75}\mathrm{Ge} \xrightarrow{\beta} {}^{75}\mathrm{As}(n,\gamma)^{76}\mathrm{As}$, so that 'spurious' arsenic appears as a result of the irradiation. Arsenic-77, which also arises from germanium, may be distinguished radiometrically. Mr. Smales suggested that a similar difficulty might arise during the irradiation of samples rich in bromine or selenium, for example, by the reaction $^{79}\mathrm{Br}(n,\alpha)^{76}\mathrm{As}$.

The last paper was presented by R. D. Keynes (Cambridge), who described the application of the methods of activation analysis to the determination of sodium and potassium in biological samples. Samples for analysis were irradiated in the Harwell Pile together with samples of spectroscopically pure sodium carbonate and potassium bicarbonate which were used as reference standards. It was found that, during the irradiation of desiccated nerve fibres isolated from cuttle-fish, sodium-24, potassium-42, phosphorus-32 and sulphur-35 were the principal radionuclides formed, the last no doubt partly arising from the reaction $^{35}\mathrm{Cl}(n,p)^{35}\mathrm{S}$. Sodium-24 and potassium-42 arise by neutron activation of the natural isotopes, so that the corresponding radioactivities are a direct measure of the sodium and potassium originally present. By a simple screening technique the sodium-24 and potassium-42 were distinguished by their energetic γ- and β-emission respectively, and chemical carrier separation was unnecessary. A small correction had to be made for the phosphorus-32, which could be determined after the short-lived sodium and potassium isotopes had decayed to insignificance. A modification in estimating the potassium only was to add a known excess of potassium carbonate carrier to the irradiated sample and, precipitating a known fraction of the total potassium as the dipicrylaminate, this salt was then radiometrically assayed separately. These methods have been used successfully on a routine basis for the determination of weights of the order of 0·5 μgm. of sodium and 5 μgm. of potassium in biological samples. The results indicate that as little as 0·05 μgm. of sodium can be estimated to within a few per cent, so that the potentialities of the method in chemical analysis are obvious.

It would not be appropriate to record here more than a few points raised in the ensuing discussion. R. C. Chirnside asked if the decomposition of the penicillins noted during the paper chromatography of the labelled material minimizes the value of the Goodall and Levi method; Dr. Lester Smith replied that, unless the relative decomposition of the individual penicillins was unequal, the value of the original method would not be affected because it was used to show the proportional composition of the penicillin mixture rather than the individual weights. J. Haslam asked if the method of radioactivation analysis can be applied to the determination of iodine in sea water, to which Mr. Smales replied that the relatively short half-life of the iodine-128 produced by neutron activation of natural iodine makes the determination very difficult, since any separation and counting would have to be completed within a matter of two or three hours of removing the sample from the pile; however, Mr. Smales mentioned that the determination of a range of trace elements in water by radioactivation analysis is, in fact, being investigated. A. C. Mason wondered if the methods could be used for the determination of boron in plant material—a difficult problem in chemical analysis—and Mr. Smales replied that boron unfortunately gives rise to no suitable isotope on neutron irradiation. Other items discussed ranged from the particular advantages to be expected as a result of combining radioactive tracer techniques with paper chromatography to the use of radioactivation analysis for the detection of arsenic in poisoned victims.

F. P. W. Winteringham

UNIVERSITY OF GLASGOW

FIFTH CENTENARY CELEBRATIONS

On the evening of June 29, the last of a series of 'At Homes' in the Bute Hall at the University brought the celebrations of the fifth centenary of the University of Glasgow to a close. They began almost a fortnight before with the arrival on June 17 and 18 of nearly two hundred delegates representing universities and other learned bodies in all parts of the world, and of many other distinguished scholars invited to receive honorary degrees.

On the afternoon of Monday, June 18, the guests were welcomed informally at faculty receptions in the College Rooms and Queen Margaret Union, and renewed or established friendships which were strengthened by the academic and social functions of the ensuing days. That evening many guests attended the first McEwen Memorial Concert in the Hunter Hall.

On Tuesday, June 19, a very full programme began with the presentation of addresses in the Bute Hall, when delegates, representatives and graduands from at home and abroad were welcomed by the Chancellor, Lord Boyd-Orr. Before a full assemblage of the Senatus, academic staff and honorary doctors of the University, the guests bringing messages of greeting were called in turn and handed their greetings to the Chancellor. More than two hundred such messages were presented, all graciously worded and many of them beautifully illustrated. They have been on display to the public, together with many other addresses received by post, in the Upper Library throughout the period of the celebrations, and have attracted many visitors.

One of the most colourful and impressive ceremonies took place on the Tuesday afternoon when, in robed processions, delegates, graduands and the Chancellor, Court and Senate of the University went in bright sunshine from the Royal Infirmary to the Commemoration Service in Glasgow Cathedral, the first home of the University congregations five hundred years ago. The whole of the Cathedral quire was filled with the academic gathering, while wives and friends occupied the nave, an assemblage in all of some 1,200. The sermon was preached by the Minister of Glasgow, and others officiating were the Principal, the Professor of Divinity, the Clerk of the Senate, the Moderator of the General Assembly of the Church of Scotland and the University Chaplain. The music was played by the Professor of Music.

On Tuesday evening some eight hundred guests were entertained to dinner in two gatherings, one at the Central Hotel presided over by the Chancellor, and the other at the adjacent Grosvenor Restaurant where the chairman was the Rector. It was a happy circumstance that the Prime Minister, who was to receive the next day the honorary degree of Doctor of Laws, and Mrs. Attlee arrived in time to be present. Among the speakers were the Lord Justice General, the President of the University of California, the Lord Bishop of Durham, Sir Oliver Franks, the Principal of McGill University, Prof. F. L. Ganshof, of the University of Ghent, Prof. J. M. Holst, of the University of Oslo, and Prof. M. Le Breton, of the University of Paris.

The mornings of June 20 and 21 were reserved for the two major academic functions, the honorary graduation ceremony and the commemoration oration by Lord Macmillan of Aberfeldy respectively. For these functions some 2,700 persons assembled on each occasion in St. Andrew's Hall, almost half of them in academic robes. The colourful splendour on each occasion was perhaps unprecedented in the history of the University or of the city.

At the graduation ceremony twelve honorary degrees of Doctor of Divinity and fifty-four of Doctor of Laws were conferred. Among those receiving the degree of LL.D. were the following: Prof. E. D. Adrian, professor of physiology in the University of Cambridge; Prof. A. C. Aitken, professor of mathematics in the University of Edinburgh; The Right Hon. C. R. Attlee, Prime Minister; Sir John Beazley, professor of archæology in the University of Oxford; Prof. Niels Bohr, professor of theoretical physics in the University of Copenhagen; Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell; Sir John Craig, steelmaker in Glasgow; Dr. H. W. Dodds, president of Princeton University; Dr. R. Dohrn, director of the Zoological Station at Naples; Dr. P. J. Du Toit, president of the South African Council for Scientific and Industrial Research; Prof. T. G. Halle, professor of palæobotany in the University of Stockholm; Prof. B. A. Houssay, formerly professor of physiology in the University of Buenos Aires; Prof. F. H. Knight, professor of social sciences in the University of Chicago; Prof. H. R. Kruyt, formerly professor of physical chemistry in the University of Utrecht; Prof. E. O. Lawrence, professor of physics in the University of California; N. A. MacR. MacKenzie, president of the University of British Columbia; Sir Arcot Mudaliar, vice-chancellor of the University of Madras; Prof. J. Ortega y Gasset, formerly professor of philosophy in the University of Madrid; Lord Reith of Stonehaven; Prof. D. S. Russell, professor of pathology in the University of London; Prof. L. S. Ruzicka, professor of organic chemistry in the Swiss Federal Institute of Technology; Prof. René Sand, professor of social medicine in the University of Brussels; Prof. G. G. Simpson, professor of vertebrate palæontology in Columbia University; Prof. Norman Kemp Smith, formerly professor of logic and metaphysics in the University of Edinburgh; Prof. J. G. Solch, professor of geography in the University of Vienna; Sir Richard Southwell, formerly rector of the Imperial College of Science and Technology, University of London; Prof. S. Timoshenko, professor of mechanics in Stanford University; Prof. O. Veblen, formerly professor of mathematics in the Institute for Advanced Study at Princeton; Prof. C. E. Weatherburn, professor of mathematics in the University of Western Australia; and Prof. G. H. Whipple, professor of pathology in the University of Rochester. The speakers on behalf of the new graduates were the Bishop of Strängnäs, Lord Reith, the president of Princeton University and the president of the University of British Columbia. The new and past doctors and their wives were afterwards entertained to luncheon in the Bute Hall by the Chancellor, Court and Senate, when replies to the toast of "The New Graduates" were made by Prof. C. H. Dodd, of Cambridge, and Prof. L. S. Ruzicka, of the Swiss Federal Institute of Technology.

The Wednesday programme was completed by two happy social functions at which Town and Gown mingled, an afternoon reception at the Trades House by the Deacon-Convener of the Trades of Glasgow and the Collector of the Trades House, and a reception in the evening at the City Chambers by the Lord Provost and Magistrates.

At the opening of the Oration Ceremony on June 12, the Chancellor expressed the regret of all that Their Majesties the King and Queen were unable to grace the gathering with their presence, and the Principal read an address from the University to the King and a gracious message from His Majesty. Lord Macmillan then delivered the Commemoration Oration, an eloquent tribute to the past achievements of the University and expression of the ideals which should guide its future. The conclusion of this ceremony, the last of the academic functions of the celebrations, was most fittingly the maiden speech of the Prime Minister as a doctor of the University of Glasgow. More than two thousand guests attended a reception at the University on the Thursday afternoon. In the evening, while their wives were the guests of Lady Hetherington at an 'at home' in the College Rooms, the delegates and new graduates were entertained to dinner by the Senate in the Grosvenor Restaurant. Robes and formalities were laid aside. The Principal presided and the speakers at the dinner included the Vice-Chancellors of the Universities of Cambridge and London, Dr. H. R. Kruyt of the Universities of Utrecht and Amsterdam, and Dr. B. Blanshard of Yale University.

On June 22, a precedent was followed that had been created fifty years before (almost to the day) on the occasion of the ninth jubilee, when the University took its guests for a cruise on the Firth of Clyde. As in 1901, it was a day of midsummer sunshine and the Firth a panorama of mellow beauty. The *Queen Mary II* sailed in the morning with eight hundred guests from Bridge Wharf in the centre of the city past the shipyards and Dumbarton Rock and cruised in the Kyles of Bute, Loch Striven and Loch Riddon, returning round the Cumbraes to Wemyss Bay, whence the journey to Glasgow in the evening was made by train. On the morning of June 23, some 150 guests who still remained were taken by coach to Loch Lomond.

The following week was reserved for gatherings of Glasgow's own graduates, and more than three thousand members of the General Council and their wives were entertained in the Bute Hall on June 26, 27, 28 and 29. J. B. NEILSON

AMERICAN PHYSICAL SOCIETY

ANNUAL MEETING

THE 1951 annual meeting of the American Physical Society was held at Columbia University, New York City, during February 1–3. The annual meeting of the American Association of Physics Teachers took place simultaneously at Barnard College. At the joint session of the two bodies on February 2, the retiring presidential address of the Physical Society was delivered by Prof. I. I. Rabi, who took as his subject "Molecular Beam Researches in Nuclear and Electronic Physics"; the Oersted Medal of the Association was presented to Prof. J. W. Hornbeck (who died on February 27); and the tenth Richtmyer Memorial Lecture was delivered by Prof. J. C. Slater, who spoke on "The Electron Theory of Metals". The after-dinner speaker at the banquet in the evening was Prof. J. R. Oppenheimer, who spoke principally about meson theory.

At the business meeting of the Physical Society the following officers were elected: *President*, C. C. Lauritsen; *Vice-President*, J. H. Van Vleck; *Secretary*, K. K. Darrow; *Treasurer*, G. B. Pegram; *Managing Editor*, S. A. Goudsmit. The headquarters of the *Physical Review* have now been removed from the University of Minnesota, which housed them for the past quarter of a century, to the Brookhaven National Laboratory.

Twenty-eight invited papers, in addition to two hundred and ninety-one (a new record) ten-minute papers, were contributed to the meeting of the Physical Society. The invited papers included: a group of papers describing the Brookhaven National Laboratory and the research work carried on there; various papers on nuclear physics, including one by C. C. Lauritsen on the work on nuclear energy-levels at the California Institute of Technology; four papers mainly concerned with mesons; in the division of electron physics, J. A. Hornbeck on a review of positive-ion mobilities in the noble gases; in the division of fluid dynamics, E. Teller on magneto-hydrodynamics and G. Birkhoff on some modern problems in classical hydrodynamics; J. Bardeen on supraconductivity and lattice vibrations, and two contributions by English visitors, S. Chapman on some phenomena of the upper atmosphere and M. H. L. Pryce on nuclear hyperfine structure of paramagnetic resonance. A complete list of the papers, together with abstracts, is given in the minutes of the meeting, which are printed in the April 15 issue of the *Physical Review* (82, 291; 1951).

It was reported that the membership was 9,740, and that the income of the Society had exceeded expenditure by a substantial amount, but that there was little hope that the Society would be equally fortunate during 1951. A change in the by-laws was approved which empowered the Council to fix the erms on which members of the Society shall receive either *Physics Abstracts* or *Engineering Abstracts*. The subscription prices at which these journals are sold to the Society by the Institution of Electrical Engineers, London, have recently been raised, and he purpose of the amended by-law is to enable the Council to recover the extra cost. A committee was appointed to make recommendations about the future relations of the Society and *Science Abstracts*.

The minutes include a copy of the letter sent by Dr. D. W. Bronk, president of the National Research Council, on December 11, 1950, to R. L. Clark, the director of the Manpower Office of the National Security Resources Board, in which specific recommendations with regard to the question of scientific man-power in the United States of America, the setting up of a National Scientific Personnel Board and the establishment of a register of professionally qualified scientific workers are outlined. The Council of the Physical Society formally approved of these recommendations.

MOVEMENT OF SWIFTS IN SUMMER

THE year 1950 was a good one for studying the movements of swifts (*Apus apus*), and during the year the movements of forty thousand birds were recorded: a report on the observations has been made by H. G. Hurrell and recently described in *British Birds* (**44**, No. 5; May 1951).

Movements were found to take place not only during arrival and departure but also in the middle of the breeding season as well. The date when movement occurs is the main reason for classifying it as immigration, emigration or a movement occurring between the two. There is no certain way of distinguishing movements in the field, although there is a tendency for larger numbers of birds to group together when they are leaving Great Britain.

Swifts appear to penetrate the country from the south and work northwards. Arrivals over many years average a day or two earlier in the south than in the south-east. The east coast as a rule is reached rather late and usually in such small numbers that there is little to indicate any spring passage of swifts from the British Isles to other countries.

It is difficult to say when the arrival period ends because movements which have a migratory appearance may take place at any time while swifts are in Britain. Large movements occur in June and early July. These are thought to be undertaken because unfavourable weather forces the swift to seek regions with more adequate food supplies; the food of the swift is adversely affected by the passage of a cyclone or depression.

In 1947 Koskimies suggested that the birds tried to avoid an advancing depression by flying against the wind round the south-east side of it, and that these weather movements are undertaken by first-year non-breeding swifts and, to a varying extent, by the breeding birds. If mid-season movements were always bad-weather movements, a comparison of the data with meteorological records should show some kind of broad correlation. At times this could be found; but there are cases when there is no obvious connexion between major movements and low temperatures or low pressures. The 1950 mid-breeding season records took place at a time when weather conditions were comparatively stable and an anticyclone was maintaining fine warm weather over most of the British Isles. Nor is there clear evidence that the birds taking part in these weather movements are first-year non-breeding swifts. As yet the evidence is insufficient to say whether large mid-season movements are composed mainly of British swifts or of swifts which have just arrived from overseas.

It is impossible to say when emigration begins, since it commences during July when mid-season movements may still be taking place. Many breeding and most non-breeding swifts leave during July. During this month in 1950 swifts were frequently on the move, while August showed an almost complete absence of any swifts flying northwards; the main directions were south or south-west. Early in August the British Isles are practically drained of breeding swifts. Yet quite large numbers were recorded throughout the month at favoured spots, especially on the east coast. During the last ten days of August, there was a widespread and, for the time of the year, remarkably strong wave. Such large numbers on these late dates are surprising, and it is suspected that these are largely swifts from other countries in more northerly latitudes visiting Britain on their return passage.

In another article in the same issue of *British Birds* ("The Use of Mobile Observers in the Study of Patterns of Migration"), Arnold Darlington criticizes much of the work on the migration of swifts which has been done in recent years because observations have been made at fixed vantage points, a method which has inherent in it several possible errors.

These errors are reduced if watchers deploy over an area and attempt to locate the main concentrations of swifts and to follow up any flight-lines radiating from them. The use of mobile squads of observers operating on bicycles has proved particularly useful, skilled riders being able to ride at a speed greater than the ground-speed of a migrant swift. In May 1950 the use of fifty-seven cyclists experienced in this mobile method of observation and operating in nineteen units enabled an intensive study to be made of the distribution of migrating swifts passing through south Cambridgeshire. From their results it would appear that, first, in anticyclonic, stable conditions, with light wind and mild temperatures, the movement of swifts tends to follow individual tracks and, although flight-lanes may be followed to some extent, they are not immediately apparent and may require careful seeking. The swifts tend, however, to be attracted by certain places, and here the flight-lanes may become concentrated and obvious, often persisting in their essential form for days on end. Second, in more unsettled conditions, with strong wind, low temperatures and cloud, the swifts may take to watercourses in great numbers, flying low and tending to 'pile up' in some places.

T. H. HAWKINS

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Ancient Greek Plated Coins

The techniques of the production of the officially issued plated coins of ancient Greece have been discussed at length by Campbell[1]. In the samples examined, it was inferred that the plating had normally been effected by a fusion process analogous to that by which Sheffield plate was later made. Examples are, however, reported in which a silver solder may have been employed, though the evidence is not sufficiently clear, in Campbell's view, to provide definite proof.

During the examination of a number of similar plated coins, one, however, a didrachm of Neapolis, B.M.C., p. 100/59, the date of which is approximately 300 B.C., was found in which it was certain that solder had been used. Between the core which, incidentally, consisted of copper 95·7 per cent, lead 0·7 per cent, zinc 0·4 per cent and silver 1·9 per cent, and the silver case, there existed a definite, and, on the surfaces, regular layer of a silver–copper alloy. At the edges of the specimen, however, as is shown in Fig. 1, two layers of this solder are to be seen. In Fig. 2 is shown the structure of this duplex layer at higher magnification. It consists, essentially, of a silver–copper alloy, which, from the structure, would appear to be approximately 60 per cent silver–40 per cent copper. It will also be noted from Fig. 2 that the eutectic structure which would be expected if it were due merely to interdiffusion of silver and copper at high temperature is almost non-existent, as a result presumably of previous spheroidization.

From these observations, coupled with the examination of the whole section of the coin, it is apparent that the plating operation was effected by first making a shallow silver cup to fit the copper core, lining this with a thin sheet of the silver solder, and, after the insertion of the core, covering the whole with another inverted cup, similarly lined with solder. When the whole was afterwards reheated above the temperature of the silver–copper eutectic, the solder would melt and run between the two cups, fusing core and plate together. A gentle hammering of the rim would complete the preparation of the blank, which, as the twinned structure of both core and plate shows, was then struck hot. This plating process i shown diagrammatically in Fig. 4. Fig. 1 woulc then represent a section such as that on *XX*. Suc a method of production is in excellent agreemen with that suggested by Prof. E. Darmstaedter[2].

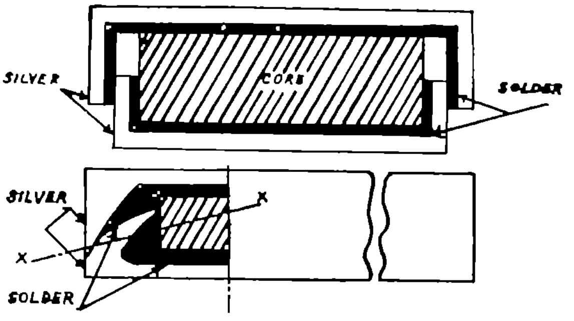

Fig. 4

For comparison, in Fig. 3 is shown the typica silver–copper eutectic obtained by direct fusion, ir all ways similar to the corresponding structure observed by Campbell. This proof of a definit soldering operation at this early date seemed o: sufficient interest to justify publication.

We are pleased to acknowledge financial assistanc from Messrs. Imperial Chemical Industries, Ltd., ir support of this and other work on the methods o production of ancient coins.

F. C. Thompson
A. K. Chatterjee

Department of Metallurgy,
University, Manchester 13. March 21.

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[1] Campbell, W., *Numismatic Notes and Monographs*, No. 57, Amer Numismatic Soc. (1933).

[2] Darmstaedter, E., *Mitt. der Bayer. Num. Gesellschaft*, 48 (1929) trans. Spink's *Numismatic Circular*, **39**, 54 (Feb. 1931).

X-Ray Crystallographic Measurements on some Compounds showing Intramolecular Overcrowding

It has been recognized for some time that there exist classes of aromatic structures in which the (intramolecular) distance of closest approach between non-bonded atoms, calculated on the basis of conventional bond-lengths and bond-angles, is smaller than the sum of the van der Waals' radii of these atoms. Bell and Waring[1] have suggested the term

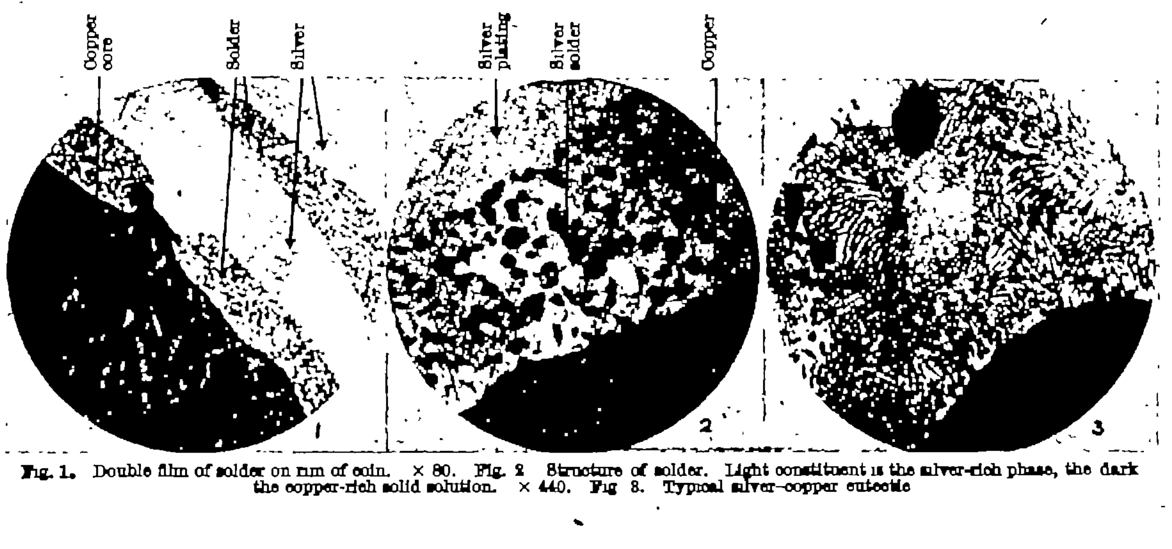


Fig. 1. Double film of solder on rim of coin. × 80. Fig. 2 Structure of solder. Light constituent is the silver-rich phase, the dark the copper-rich solid solution. × 440. Fig 3. Typical silver–copper eutectic

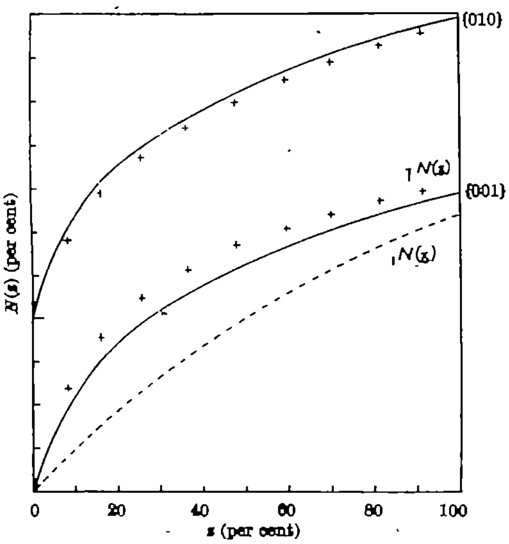
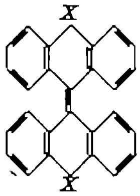


Fig. 1. Graphical comparison of functions $_1N(z)$ and $_{\bar{1}}N(z)$. Experimental points for the dixanthylene {001} and {010} zones. Successive curves displaced vertically by 40 per cent

intramolecular overcrowding' for this type of steric effect.

We may assume that the strain due to such abnormal approach distances is relieved by distortion of the molecule: indeed, substituted 3 : 4-benzphenanthrenes[2] and 3 : 4 : 5 : 6-dibenzphenanthrenes[1] have been fully or partially resolved into optical somers, and are not, therefore, planar molecules. Such departure from the regular structure of the aromatic ring system can be investigated by X-ray crystallographic methods; we have therefore surveyed a series of compounds, of which the most promising are listed in Table 1. We are now investigating tetrabenznaphthalene[3] and 3 : 4-benzphenanthrene[4] by two-dimensional Fourier methods; discussion of their 'abnormalities' must await completion of the structure analysis.



There exists a second class of overcrowded molecules of the accompanying general formula, such as dianthrone (X = CO) and dixanthylene (X = O), in which the steric effect depends on the presence of the central double bond (the corresponding dihydro compounds, such as 10 : 10′-dianthronyl, are free from overcrowding). These compounds are also of interest because of their thermochromic properties (for example, ref. 5), which have recently been investigated[6,7] spectroscopically; as a result of these studies, dianthrone has been assigned a configuration in which "the ground state is a singlet with the double bond in a state of considerable torsion"[6].

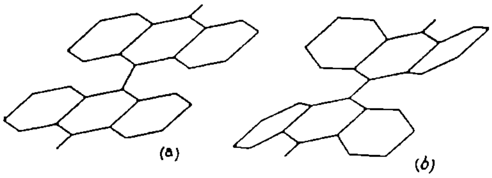


Fig. 2

Our preliminary results for dianthrone and dixanthylene are given in Table 2. Cell dimensions and space group of dianthrone unequivocally imply that the molecule has a centre of symmetry. In dixanthylene it is not possible to determine the space group unambiguously from the systematic absences alone; however, the Wilson test[8,9] applied to the intensity distribution in the $h0l$ and $hk0$ zones has shown both zones to be centric (see Fig. 1). We therefore assign to dixanthylene the space group $C2/c$. Packing considerations make it unlikely that the molecule has a twofold axis of symmetry. We conclude that dixanthylene, like dianthrone, is centrosymmetric.

We can envisage the following three extreme possibilities for their molecular shape: (i) fully planar; (ii) biplanar (Fig. 2a); (iii) bent (Fig. 2b). In both the biplanar and the bent forms the overcrowding is relieved. In order to decide between these possibilities, we are now investigating the crystal structure of dianthrone by two-dimensional Fourier methods.

If the molecular configuration of dianthrone in the crystalline state is retained in solution, the X-ray evidence conclusively rules out any configuration in which the two anthrone ring systems are twisted

Table 1

Compound	a	b	c	β	n	ρ exp.	ρ theor.	Space group
3 : 4-Benzphenanthrene	14 69	14 19	5 75	—	4	1·26	1·26	$P2_1 2_1 2_1$
Tetrabenznaphthalene	20 45	7 74	12·18	119° 38′	4	1·29	1·28	$P2_1/a$
3 : 4 . 5 . 6-Dibenzphenanthrene	17·46	14·24	5·83	94°	4	1·26	1 27	$P2_1/a$
1 · 4 : 5 : 8-Tetraphenyl naphthalene	17·1	22·0	5·93	—	4	1 25	1 26	$P2_1 2_1 2_1$

Table 2

Compound	Formula	a	b	c	β	n	ρ exp.	ρ theor	Space group	Molecular symmetry
Dianthrone	$X \equiv C - O$	10·20	8·45	12 67	119° 48′	2	1 35	1 35	$P2_1/c$	$\bar{1}$
Dixanthylene	$X \equiv O$	14 87	12·90	9 41	95°	4	1 33	1·31	$C2/c$	$\bar{1}$ or 2

Table 3

Configuration	Free rotation about central bond	Possible stereo-isomeric forms
Planar (i)	No	*Cis* and *trans* isomers
Biplane (ii) or Bent (iii)	No	*Cis* and *trans* isomers *Cis* should be resolvable into two optical isomers
	Yes	Two optical isomers

relative to one another about the central bond, as suggested by Grubb and Kistiakowsky; furthermore, as can be seen from Table 3, resolution of disubstituted dianthrones into optical isomers will not necessarily be sufficient to decide the exact molecular shape of this type of compound.

We wish to thank Drs. L. Haskelberg and J. Szmuszkowicz for samples of 1 : 4 : 5 : 8-tetraphenyl naphthalene and 3 : 4 : 5 : 6-dibenzphenanthrene respectively, both of which were prepared by new syntheses. Full details of this work will appear elsewhere.

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Fourier Synthesis by Optical Interference

The expression of the electron density in a crystal as a Fourier series is the mathematical equivalent of the process of image formation by light waves in an optical instrument. Thus, if the X-ray diffraction data can be converted into appropriate light waves, it should be possible to produce an image of a crystal optically instead of by the more arduous process of calculation. Making use of this idea, Bragg[1] produced an image of the projection of the crystal diopside, CaMg(SiO$_3$)$_2$, on the (010) plane.

This crystal, however, provides only a special case, in that no phase differences exist between the scattered waves. Buerger[2] has solved the problem of introducing phase differences by the use of mica plates, tilted to produce the required retardation. Marcasite, FeS$_2$, the crystal to which he has applied the method, is centrosymmetrical, and so the phase differences in the scattered beams are either 0 or π; thus mica plates need be placed only in certain of the interfering beams, and only a fixed tilt is required.

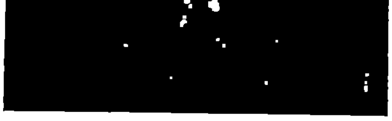

Fig. 1. Optical synthesis of durene

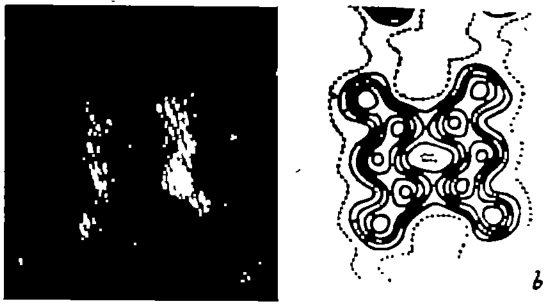

Fig. 2(a). One molecule from Fig. 1 enlarged
Fig. 2(b). Electron density map for comparison with Fig. 2(a)

We have made use of another method whic although it can be used only for centrosymmetric crystals, appears to us to be simpler and more easil adaptable to experimentation. An opaque plate i drilled with equal holes at the points of the reciproca lattice section of the crystal; in each hole is place a small tube fitted with a disk punched from a optically uniform sheet of mica, and the whole i viewed through crossed nicols. Each mica plat transmits an intensity of light depending upon it orientation, and thus each may be turned to transmi an intensity proportional to the intensity of th corresponding X-ray reflexion. It may easily b shown that the amplitude of the transmitted ligh is proportional to $\sin 2\varphi$, where φ is the angular dis placement of a disk from one of its extinctio positions; thus, on passing through $\varphi = 0$ th amplitude changes sign, and in this way phas changes of π can be simulated.

We have applied the method to the data given b Robertson[3] for durene, and the result, together wit the calculated electron-density map for comparison is shown in Figs. 1 and 2. Although the representatio is not perfect, the molecule is quite recognizable, an the method would certainly serve to distinguis between possible and impossible combinations o signs.

A more complete account of the method, togethe with plans for obtaining a clearer image, and fo making use of it in crystal-structure determination will be published elsewhere.

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Cold Emission of Electrons in Spark Gaps

Studies[1,2] of sparks in short gaps have show that under suitable conditions breakdown can occu within times, after the application of the gap voltage which are considerably smaller than those expecte if the initial ionization in the gap were due only t natural processes such as natural radioactivity, cosmi rays, or the break-up of gaseous ions. It is clear therefore, that there must be another source o initiatory electrons. There is, however, considerabl doubt concerning the nature of these sources, an the mechanism of electron liberation from them.

Pre-breakdown electron production in a spark gap is related to the time-lag of sparking, and considerable information on electron production can be obtained from analysis of time-lag data; under certain conditions, the inverse of the statistical lag is a measure of the rate of electron emission from the cathode under the given gap conditions. In this way, the rates of electron emission from cold nickel and tungsten electrodes, in short parallel-plate gaps in the atmosphere, under the influence of spark overvoltages up to 200 per cent, have been investigated in this laboratory, using a technique which permitted the effect of a single initial electron to be recorded. The spark current was suitably limited so that effects such as electrode erosion were negligible. The investigation showed that the surface condition and previous treatment of the cathode exerted great influence on the rate of pre-breakdown electron emission. A most significant result was that enhanced cold emission occurred when the average electric field F ($= V/d$) in the gap was of the order of 10^5 volts/cm., and it is not easy to see how electron emission of the magnitudes observed could be field emission from a metal, as it is well known that such emission requires fields of 10^7 volts/cm. or more.

In order to investigate this problem, the rate of electron emission i from the cathode was measured for various values of gap voltage V, and a relationship between i and V was found. For a cathode of nickel, oxidized by previous sparking in air, considerable electron emission of the order of 10^4 electrons per second was found for values of the macroscopic electric field in the gap of the order of 10^5 volts/cm. The relationship between i and V experimentally established was:

$$\ln(r) = -A/V + B, \qquad (1)$$

where $r = id^2/V^2$.

The following interpretation of this equation indicates that the mechanism of emission of these initiatory electrons was a field process.

The Fowler–Nordheim[3] field emission equation can be written:

$$\ln(i/F^2) = -(6{\cdot}8 \times 10^7 \varphi^{3/2})/F + \ln(CS),$$

where S is the area of the emitting surface, and $C = 38{\cdot}8 \times 10^{12} (\mu)^{1/2}/(\mu + \varphi)\, \varphi^{1/2}$, in which φ is the work function of the surface, and μ is the parameter of metallic electron distribution in the Fermi–Dirac statistics.

This equation can be written:

$$\ln(r) = -(6{\cdot}8 \times 10^7 \varphi^{3/2} d)/V + \ln(CS). \qquad (2)$$

Thus, equations (1) and (2) are the same when $A = 6{\cdot}8 \times 10^7 \varphi^{3/2} d$, giving the same slope in the $\ln(r)$, $1/V$ curves; and $B = \ln(CS)$, giving the same intercept on the $\ln(r)$ axis.

Thus, the experimental equation (1) leads to estimates of φ, the work function of the source from which the electrons were extracted, and also of S the area of the emitting surface. Values thus obtained are $\varphi \doteq 0{\cdot}1$ volt, and $S \sim 10^{-14}$ cm.^{2}.

If the value of $\varphi \sim 4{\cdot}5$ volts for common metals is used in equation (1), then to obtain the measured emission of 10^4 electrons per second, F must be of the order of 10^7 volts/cm.

In this work, F, given by V/d, is of the order of 10^5 volts/cm. Consequently, we have alternative conclusions to draw; either F in these experiments at the surface of the electrodes is some hundreds of times greater than the macroscopic applied field, and the electrons are released from the pure metal, or φ, the effective work function of the surface layer, is much less than 4·5 volts, and the electrons are released from that surface.

Schottky[4] has estimated a maximum value of about 10 for the intensification of the local field at microscopic points on the electrode surface, and substitution of this value in equation (1) gives $\varphi = 0{\cdot}48$ volt.

On this view, then, the electrons could not have come from a pure metal, still less from a metal with an electronegative monomolecular oxide surface film with a still higher effective work function. The most reasonable suggestion is that the electrons come from the surface oxide layer itself, and these estimated values of φ and of the emitting area of approximately molecular cross-section suggest oxygen ions as the source. These results, therefore, support the view that the cathode oxide layer, always present on electrode surfaces in air, is the source of electrons, extracted by field emission, which can initiate impulse sparks.

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Ultra-Violet Absorption Spectra of Gallium and Indium Monofluorides

RECENT work on equilibria involving aluminium monohalides[1] suggested that gaseous gallium and indium monofluorides might be formed by reaction of the metals with aluminium trifluoride. This has proved to be so, and we have been able to photograph the absorption spectrum of gallium fluoride at about 1,000° C., and that of indium fluoride at about 1,400° C.

Vibrational analyses of the three band systems for each molecule expected by analogy with the other halides[2] have been completed. The constants derived are given in the accompanying table.

State			ν_e	ω_e	$x_e\omega_e$	$y_e\omega_e$
GaF	C	$^1\Pi$	47364·$_6$	541·$_9$	8·$_8$	−0·6
	B	$^3\Pi_1$	33427·$_7$	666·$_4$	4·$_3$	—
	A	$^3\Pi_0$	33098	659·$_4$	4·$_0$	—
	X	$^1\Sigma+$	0	623·$_1$	3·$_4$	—
InF	C	$^1\Pi$	42808·$_8$	463·$_6$	7·4$_9$	−0·4$_6$
	B	$^3\Pi_1$	31257·$_7$	572·$_6$	3·4$_8$	—
	A	$^3\Pi_0$	30442	571·$_2$	3·4$_5$	—
	X	$^1\Sigma+$	0	534·$_7$	2·5$_6$	—

The assignment of states A and B as $^3\Pi_0$ and $^3\Pi_1$ respectively is supported by the fact that the bands of the systems A—X are single-headed, whereas those in B—X possess two heads. The $^1\Pi$ states converge rapidly to give dissociation limits at about 6·3 eV. for gallium fluoride and 5·7 eV. for indium fluoride. A more detailed account of these systems will be published later.

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Theoretical Determination of Electron Density in Organic Molecules

In a recent paper, Abrahams, Robertson and White[1] have determined the electron density in naphthalene by means of X-ray analysis. They found that the electron density is greatest at the carbon atom in the meso-position, smallest at the β-position, and intermediate at the α-position. Between each pair of carbon atoms there is an electron density, evidently due to the binding pairs, which assumes its largest value between the α- and β-positions, and the smallest value between the two meso-positions.

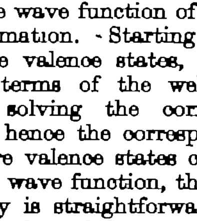
It may be of interest to note that precisely these results can be derived, at least qualitatively, from the theory of the chemical bond. I have used the method first applied by Heitler and Rumer[2] for determining the wave function of naphthalene in the zeroth approximation. Starting from a set of independent pure valence states, the energy can be calculated in terms of the well-known exchange integrals (by solving the corresponding secular equation), and hence the corresponding linear combination of pure valence states can be obtained.

Knowing the wave function, the calculation of the electron density is straightforward and follows the same pattern as that of the energy. If u_a, u_b are the wave functions of the valence electron in the atoms a and b, then the electron density depends on two types of integral:

$$\int |u_a(1)|^2 d\tau, \qquad \int u_a^*(1)\, u_b^*(2)\, u_a(2)\, u_b(1)\, d\tau. \quad (1)$$

Each occurs with certain algebraic coefficients arising from the solution of the secular problem. The first integral in (1) gives rise to an electron density at a, the second also to an *exchange density* between a and b. Values for these integrals can be estimated from the analogy of the hydrogen molecule, but the qualitative results depend on the valence structure of the molecule alone.

Carrying out this analysis, and taking into account only the interaction between neighbouring atoms, the following results are found. We denote the atoms in naphthalene as in the accompanying formula,



the electron density in a by ρ_a, the density between a and b by ρ_{ab}, etc. Then

$$\rho_k > \rho_a > \rho_b, \quad \rho_{ab} > \rho_{bc} > \rho_{ak} > \rho_{kl}.$$

All exchange densities ρ_{nm} are smaller than the ρ_n. The results are qualitatively in perfect agreement with the above experiments.

Attempts in a similar direction have been made by Daudel and Pullman[3]; but their results are not quite consistent because they depend on the choice of the independent basis of valence diagrams. This is not the case in our method.

Details will be published in the *Helvetica Chimica Acta*. I wish to thank Prof. W. Heitler for his advice and guidance, and the Stiftung fur Stipendien auf dem Gebiete der Chemie for a grant.

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Ferromagnetic Resonance Absorption and a New Transition in NiOFe$_2$O$_3$ at Low Temperature

Microwave absorption phenomena, similar t those reported by Bickford for magnetite[1], have bee observed for nickel ferrite in measurements at wave-length of 3·2 cm. made from room temperatur down to − 195° C. At the lowest temperature two absorption peaks were obtained at 1,490 Oe. an 200 Oe., the latter gradually decreasing with risin temperature and finally disappearing at abou − 120° C. The value of g and the maximum absorption increase with decreasing temperature. A anomaly in the magnetization, similar to that foun by Weiss and Forrer for magnetite[2], was observe in the range − 120° to − 195° C., where the magnetization falls suddenly by an amount which is th smaller, the higher the field. Similarly, the electrica resistivity rises suddenly in the same range. Thes phenomena may be due to a transition betwee − 120° and − 195° C.

Experiments at temperatures below − 195° C. ar being planned.

I wish to express my thanks to Dr. T. Muto of th University of Tokyo for his valuable suggestions, an also to Mrs. Y. Torizuka, J. Simoizaka, Y. Kojim and Miss K. Takahasi for their assistance during th course of the experiments. Detailed results of th present work will be published in *Sci. Rep. RI.T.U.*

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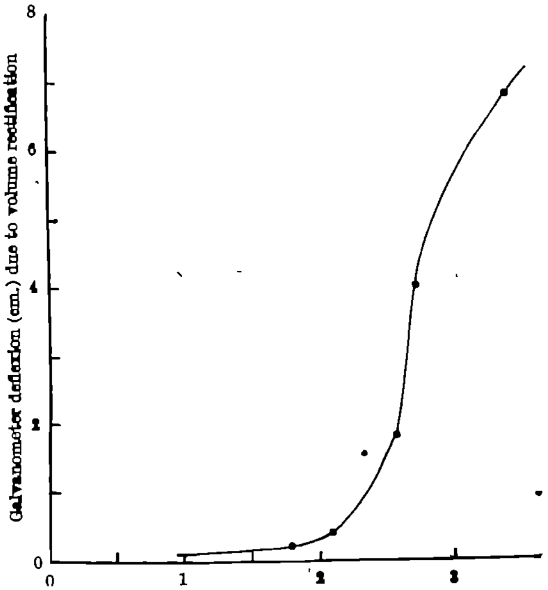
Volume Rectification in Zincite

The experiments of Khastgir and Das Gupta showed that when carborundum, zincite or silico was placed between two mercury electrodes givin large contact areas, there was considerable rectification, while similar experiments with symmetrica crystals like iron pyrites, magnetite, galena, etc showed no rectification when the surface effects wer eliminated. These experimental results suggeste that the rectification observed in polar crystals such as carborundum, zincite or silicon with electrodes o large contact-areas should be associated with th asymmetry in the structure of these crystals. The experiments of Deaglio[2] with two different thicknesses of carborundum having the same contact-areas on the opposite faces, mechanically scraped plane and platinized, showed that rectification per centimetre thickness, as indicated by the static characteristic curves, was the same. This proved that the observed rectification in carborundum was definitely associated with the volume of the crystal and not with the area in contact with the electrodes. The object of the present communication is to report some experimental results with zincite, which has shown similar rectification depending on the volume of the crystal. A theoretical treatment is also given of the origin of volume rectification in polar crystals.

The zincite crystal cut in the form of a cube was mounted between two plane electrodes of large contact area pressed tightly against the opposite faces. Having applied a constant radio-frequency voltage om a tuned circuit to the electrodes, the rectified urrent was measured by a suitably shunted mirror alvanometer for various thicknesses of the same rystal, keeping the resistance of the circuit constant. 'he two opposite faces of the same area were care-illy scraped to reduce the thickness and, after mount-ig the crystal, the total resistance of the crystal ircuit was made the same by inserting additional esistance to make up for each reduced thickness. 'he observed rectified current in the crystal circuit as found to decrease with the decrease of thickness or the same input radio-frequency voltage. The xperimental results for a frequency in the neighbour-ood of 1 Mc./s. are shown in the accompanying raph.



Curve for zincite, 0·945 Mc./s.

In explaining the experimental results, we shall ssume that the specific resistance of a polar crystal or the two opposite directions has different values, ρ_1 and ρ_2. If t be the thickness and A the area of he crystal in contact with either electrode, then the ectified current is:

$$i_r = V\left[\frac{1}{r_1} - \frac{1}{r_1 + (\rho_2 - \rho_1)\,t/A}\right], \qquad (1)$$

where r_1 is resistance of the crystal circuit in one irection, V the applied voltage and ρ_2 is assumed o be greater than ρ_1. Putting $m = (\rho_2 - \rho_1)/r_1.A$, we get:

$$i_r = \frac{V}{r_1} \cdot \frac{mt}{1 + mt}. \qquad (2)$$

Introducing now the 'electro-resistive' effect of Osterberg[3] in crystals like carborundum and zincite which have no centres of symmetry, the resistance of such a polar crystal, under isothermal conditions, long any direction, can be expressed as a function of the applied voltage, as follows:

$$r = a + bV + cV^2, \qquad (3)$$

where a, b, c are electro-resistive constants. The lifference in resistance for currents flowing in the two opposite directions is then given by

$$r_2 - r_1 = (\rho_2 - \rho_1)\,t/A = 2b.V;$$

so that

$$V = m.r_1.t/2b. \qquad (4)$$

Substituting this expression for V in (2), we get

$$i_r = \beta.t^2/(1 + mt), \qquad (5)$$

where

$$\beta = m^2/2b.$$

For carborundum and zincite crystals, either of which has a very high resistance, $m \ll 1$, and we should expect a square-law variation of rectified current with thickness, when the total resistance of the crystal circuit is kept constant. From our experimental results with zincite, it appears that Osterberg's 'electro-resistive' effect, which is the basis of formula (5), is the main cause of volume rectification observed in such a polar crystal.

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Crustal Layers of the Earth

In a discussion on the granitic layer of the earth's crust[1] Dr. P. L. Willmore criticized the P^* data from near earthquakes and is reported to have remarked that, "In South Africa, a similar tendency for waves to arrive early at distances beyond 120 km. is associated with the exposure of high-velocity rock in the region where the onsets are observed". This brief statement with regard to the South African observations may be misleading.

In a seismic study of the crustal layers in the western Transvaal[2], it was found that between 220 and 300 km. there was a large and well-defined phase which was rather more than 1 second early with respect to the P_1 line ($V_1 = 6{\cdot}09$ km./sec.). It was pointed out that the early onsets could be explained in three ways: (1) on the basis of a single-layer crust with a thin surface covering of high-velocity material in the neighbourhood of the field stations; (2) on the basis of a single-layer crust in which the velocity increases with depth; (3) on the basis of an intermediate layer.

If (1) be the correct explanation, then either (*a*) the phase travelled in the faster medium for its *entire* path after leaving the Witwatersrand system, or (*b*) it must have entered the surface layer of higher velocity from the lower-velocity material. In case (*a*), the travel-time graph should have been a straight line with a slope corresponding to the higher velocity. In (*b*), it is well known that it is only with exceptional dispositions of a high-velocity over a low-velocity medium that a phase with relatively large amplitudes would be observed. The geological maps of the area do not suggest that such dispositions of the media exist in the area in question.

Correspondingly early S arrivals were not observed. This fact, far from weakening the case for a change in the composition of the crustal layers at depth, serves to strengthen it. Assuming a single-layer crust with P and S velocities of $V_1 = 6{\cdot}09$ km./sec. and

$v_1 = 3{\cdot}68$ km./sec., the thicknesses of the crustal layer as calculated from the P and S observations are $34{\cdot}2 \pm 0{\cdot}8$ and $38{\cdot}2 \pm 1{\cdot}0$ km. respectively. The inference to be drawn from the smaller thickness found for the P phases is that the ratio of the average velocities of P and S waves in the crust is greater than the ratio V_1/v_1. This is consistent with the fact that early P arrivals were observed between 220 and 300 km., whereas early S arrivals could not be identified with certainty.

Finally, there is a third argument. Given the thicknesses and velocities in the layers, it is possible to calculate the distances at which the P and S phases totally reflected at the Mohorovicic Discontinuity should appear. For the single-layer crust, these distances are 72 and 87 km. for P and S respectively. For the two-layer crust the corresponding figures are 92·9 and 99·5 km. respectively. The observations agree satisfactorily with the predictions for the two-layer crust.

Any one of the above arguments taken by itself might not be regarded as convincing; but when they are considered together it would seem reasonable to conclude from the South African observations that there is a change in the composition of the crustal layers at depth, and that the change is such that the ratio of the P and S velocities increases at depth. It is not possible to decide between a continuous variation of composition and a discontinuous change, that is, the existence of an intermediate layer.

It is of interest to examine the implications of this change in the ratio of the velocities. Birch and Bancroft[3] noted that "Quartz is peculiar in possessing high rigidity with respect to its bulk modulus". It follows that for rocks containing a fair proportion of quartz it would be expected that the ratio of the P and S velocities would be low. This tendency is strikingly illustrated by the data given in the accompanying table.

VELOCITIES OF CERTAIN ROCKS AT 4,000 kg./cm.² AND 30° C.

Rock	Percentage of quartz	V_P (km./sec.)	V_S (km./sec.)	$\frac{V_P}{V_S}$
Sandstone (quartzitic)	80	6·08	4·00	1·52
Granite, Quincy	25	6·08	3·61	1·68
Granite, Rockport	28	6·24	3·59	1·74
Syenite, Ontario	0	6·05	3·36	1·80
Norite, Sudbury	8	6·49	3·65	1·78
Diabase, Vinal Haven	0	6·97	3·88	1·80
Diabase, Maryland	0	6·96	3·83	1·82
Gabbro, Mellen	0	6·96	3·71	1·88
Gabbro, French Creek	0	7·15	3·98	1·80

(The table was compiled from Table 5–8, p. 80, of the "Handbook of Physical Constants", Special Paper 36 of the Geological Society of America, and papers by Birch and his associates.)

Thus the seismic observations in South Africa are consistent with the view that the crustal layers increase in basicity with depth.

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MUCH of the evidence produced by Prof. A. L. Hales is directed against the postulate of uniformity for the materials above the Mohorovicic Discontinuity. The conclusions are indisputable up to that point and the only question is the extent to which differen types of rock are collected into horizontal strat extending over continental distances.

The observations can be explained on the assumption that two materials exist in the crust, propagatin P waves with velocities of about 6·09 and 6·8 km./sec respectively. The reflexions from the Mohorovici Discontinuity show that substantial volumes of th high-velocity material must exist within 100 km. o the origin, whereas the fast refracted wave is observe between 220 and 300 km. At the shorter distances the high-velocity material must be deeply buried but there is no direct seismological evidence concerning the depth of the material which produces th refracted wave. The discrepancy between the estimates for the thickness of a single upper layer confirm the heterogeneity of the crust without yielding any further evidence on the distribution of the materials

Seismologists often postulate horizontal stratification because they feel that such a distribution i inherently plausible, when their data may be equally consistent with other structures. The Transvaa seismograms show only that appropriate materials exist at an appropriate depth in one location, and a undetermined depths elsewhere. In some areas such evidence might be sufficient; but in the Transvaa the more distant recording stations were resting o the diabasic lavas of the Ventersdorp series, the properties of which are very similar to those required for the high-velocity material. Hence, the advocates of a high-velocity layer at depth have to admit three layers in the western Transvaal, but they dismiss the uppermost one as being too thin to transmit waves of measurable amplitude. In fact, the thickness o the lavas is known to exceed 5,000 ft. in some areas[1] but I have not seen any figures relating to the thickness under the seismic stations. The difficulty o getting seismic energy into the surface layer does not appear to be overwhelming. The matter could be decided if observations along other profiles were available or possibly by a more exhaustive examination of existing data. In the meantime, it seems premature to assert that horizontal stratification provides the only possible explanation of the results.

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Reaction of Metmyoglobin with Hydrogen Peroxide

THE formation of a well-defined red complex between hydrogen peroxide and methæmoglobin or metmyoglobin is well established[1–3]. Keilin and Hartree found that the formation requires one molecule of peroxide per hæmatin iron atom. With reducing agents this complex is reduced back to methæmoglobin or metmyoglobin, and in the overall reaction the peroxide is *reduced* to water.

In this respect the complex is very different from that formed between ionic ferric iron and hydrogen peroxide, which Evans, George and Uri[4] showed to have the ion-pair structure

$$[\mathrm{Fe}.^{3+}.\mathrm{O_2H}^-], \text{ that is, } \mathrm{Fe.O_2H}^{2+}.$$

In a kinetic investigation of this system, Barb, Baxendale, George and Hargrave[5] found evidence that this complex plays no independent kinetic part, and that peroxide decomposition is initiated by electron transfer as follows:

$$Fe^{3+} + O_2H^- \rightarrow Fe^{2+} + HO_2, \qquad (1)$$

which results in the partial *oxidation* of the peroxide by the ferric ion. This difference in the fate of the peroxide in the two systems prompted our present investigation using recrystallized horse metmyoglobin, the preliminary results of which are outlined below.

The formation of a metmyoglobin – peroxide complex was observed at all hydrogen ion concentrations between *p*H 5·5 and 12·0. However, the reaction is only straightforward in the *p*H range 8–9, where maximum formation of the complex is obtained and complete regeneration of the metmyoglobin can be effected by adding mild reducing agents. The spectrum of the complex in this region shows a sharp band at 549 mμ with $\varepsilon_{mM} = 9{\cdot}8$ and a broad band appearing as a shoulder at 570–585 mμ with $\varepsilon_{mM} = 8{\cdot}4$. In the Soret region there is a sharp band at 423 mμ with $\varepsilon_{mM} = 107$. With solutions of *p*H < 8 some complex is formed, but an additional reaction involving the hæmatin also occurs and full recovery of the metmyoglobin is not observed. When the reaction is carried out in solutions of increasing alkalinity above *p*H 9·0, progressively less complex is formed and a hæmatin degradation product, colourless both in the visible and Soret regions of the spectrum, is produced.

Table 1. FERROCYANIDE REDUCTION OF THE COMPLEX AT *p*H 8·0

Initial complex × 10⁵ *M*	Ferrocyanide × 10⁵ *M*	Observed complex left × 10⁵ *M*	Complex reduced × 10⁵ *M*	Ratio : $\frac{Fe(CN)_6^{4-}}{\text{complex}}$
2 4	1·0	1·4	1·0	1·00
2·4	1·5	1·0	1·4	1·07
2·4	2·4	0·1	2·3	1·04
4 0	3·0	0·9	3·1	0 97

In addition to ascorbic acid, hydroquinone, and *p*-phenylene diamine, the complex was found to oxidize cysteine, *l*-malachite green, iodide ion (but not bromide ion) and ferrocyanide ion. This last reducing agent proved satisfactory in spectrophotometric titrations for estimating the oxidizing equivalent of the complex. These were done in the optimum *p*H range. Typical results are given in Table 1, which shows that when ferrocyanide is added to the complex, one ferrocyanide ion reacts per molecule of the complex. The complex thus has only one oxidizing equivalent compared with the two oxidizing equivalents of the peroxide itself. On the other hand, when varying amounts of ferrocyanide and metmyoglobin are mixed and peroxide is added, the full oxidizing capacity of the peroxide appears, as shown in Table 2. This suggests very strongly that the formation of the complex occurs as follows:

$$\underset{(2\text{ oxid. equiv.})}{\text{MetMb} + H_2O_2} \rightarrow \underset{(1\text{ oxid. equiv.})}{\text{Complex}} + \underset{(1\text{ oxid. equiv.})}{X} \qquad (2)$$

and that a transient oxidizing entity is produced which can react with added reducing agents if present initially, but which disappears if the complex formation is allowed to proceed independently.

These results indicate that the complex cannot be of the ion-pair type MetMb—OOH, for such a compound would have two oxidizing equivalents.

Table 2. PEROXIDE ADDED TO MIXTURES OF METMYOGLOBIN AND FERROCYANIDE AT *p*H 8·0

(Initial metmyoglobin and peroxide concentrations 1 04 × 10⁻⁴ *M* and 1 01 × 10⁻⁴ *M* respectively)

$Fe(CN)_6^{4-}$ × 10⁵ *M*	Complex formed × 10⁵ *M*	*Oxidizing equivalents of peroxide accounted for, × 10⁵
0	9·1	9·1
12	7·2	19·2
14	5·6	19·6
16	3·8	19·8
		Equivalents present initially, 20·2

* On the basis 1 mol. complex ≡ 1 mol. $FeCN_6^{4-}$ ≡ 1 equiv. H_2O_2.

A tentative mechanism which can account for these results is the formation of an OH radical and 'ferrylmyoglobin' in a reaction of the type:

$$Fe^{+}(H_2O) + H_2O_2 \rightarrow \underset{(\text{complex})}{FeO} + \underset{(X)}{OH} + H_2O + H^{+}, \qquad (3)$$

where Fe⁺ represents the hæmatin iron atom of metmyoglobin. Ferrylmyoglobin would be a compound of quadrivalent iron, analogous to the ferryl ion and the vanadyl ion, and thus have one oxidizing equivalent when reduced to a ferric compound. The observation by Keilin and Hartree[3] that with excess peroxide the complex is converted into oxymyoglobin could be explained by the further reaction of ferrylmyoglobin:

$$\underset{(\text{complex})}{FeO} + H_2O_2 \rightarrow \underset{(\text{oxymyoglobin})}{FeO_2} + H_2O. \qquad (4)$$

This tentative mechanism may also be applicable to some of the complicated reactions of the peroxide complexes of the enzymes peroxidase and catalase. With peroxidase the green complex formed initially from equal amounts of enzyme and peroxide[6] may have the ion-pair structure and break up as in reaction 3, giving the second complex, pale red in colour. This complex with excess peroxide gives a third complex[7], deep red in colour, which according to reaction 4 would have an oxymyoglobin type of structure. Spectroscopic similarities, however, between this third complex (not the second complex) and the metmyoglobin complex may mean that the enzyme system is different.

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Monolayers of Synthetic Protein Analogues

SINCE the natural proteins consist of various amino-acids and their structures are very complex, it is desirable, in order to elucidate their structures and their physical and chemical behaviours, to synthesize simple protein analogues having any particular characteristics of protein molecules[1]. As part of this object, we have synthesized several polypeptides having normal aliphatic side-chains with various numbers of carbon atoms and studied the surface films of these polypeptides spread on water. These polypeptides were easily synthesized from the corresponding normal fatty acids by the N-carboxyamino-acid anhydride method, and have molecular weights of about two hundred thousand. The effects of various solvents and catalysts on the course of

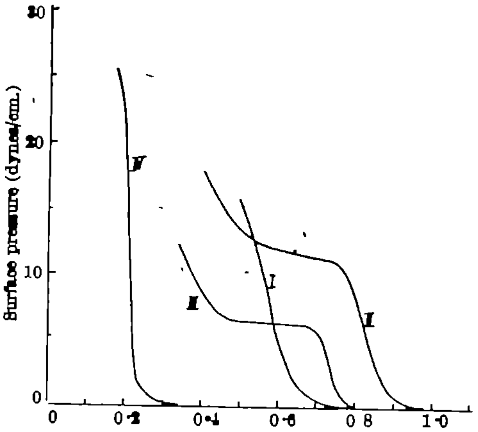

Fig. 1. I, Poly-DL-α-aminocaproic acid ; II, poly-DL-α-aminocaprylic acid ; III, poly-DL-α-aminolauric acid ; IV, poly-γ-methyl L-glutamate

the polymerization of N-carboxyamino-acid anhydrides have already been reported elsewhere[2]. The surface film of poly-γ-methyl L-glutamate spread on water was also studied. The results obtained with surface films spread on water will be briefly described.

The polymers used in our present investigation are poly-DL-α-aminolauric acid, poly-DL-α-aminocaprylic acid, poly-DL-α-aminocaproic acid and poly-γ-methyl-L-glutamate. First, the force–area relations of these polypeptides were examined (Fig. 1). The curve for poly-DL-α-aminocaproic acid resembles very closely those given by ovalbumin and by pepsin film[3]. The limiting area of this curve is about 0·8 m.²/mgm. When the side-chains are longer, as in the cases of poly-DL-α-aminolauric and of poly-DL-α-aminocaprylic acid, a plateau, which is a region of very high compressibility, appeared in the force–area curves. When the area per amino-acid residue was plotted instead of the area per milligram polymer, the force–area relations were changed as indicated in Fig. 2 ; the longer the side-chains, the larger is the limiting area. Among the long and short side-chains found in the films of synthetic polypeptides, the longer ones contribute to the plateau appearing in the graphs. This is remarkably different from the steep inclination of curves resulting from shorter side-chains in films of natural proteins. The mean number of carbon atoms in the side-chains of natural proteins amounts to about three or less. It seems to us that the appearance of the plateau in the force–area curves is related to the length of the side-chains. No plateau was found in the force–area curves for poly-DL-α-aminocaproic acid and for poly-γ-methyl L-glutamate. These polymers have side chains of four carbon atoms.

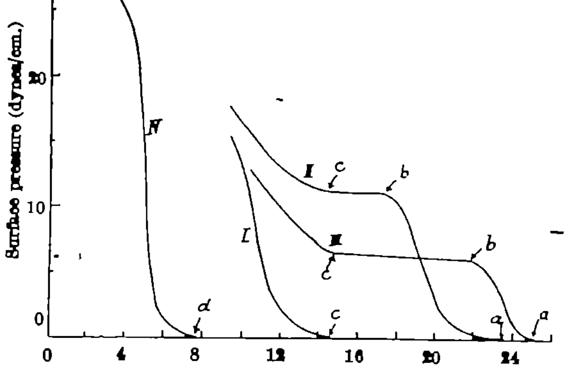

Fig. 2. For key to curves, see Fig. 1

The shape and the limiting area of the force–area curves for poly-DL-α aminocaprylic and poly-DL-α-aminolauric acid changed considerably with time elapsed after spreading the monolayer on the substrate before measurement ; on the other hand, there was scarcely any change with monolayers of polymers with shorter side-chains.

For areas larger than that indicated by point *a* (Fig. 2), the polypeptide molecules were spread with chains flat on the surface. Between *a* and *b*, the surface pressure would be exerted mainly by the action of side-chains. From *b* towards *c*, the surface pressure remained practically constant. It suggests that the molecules of polypeptide are re-orientated in this region and the side-chains compressed away from the surface, so that they are forced upwards or downwards into the water. At point *c*, the area per residue is 14·7 A.². This corresponds to an area of —NH—CH—CO— residue in the closest packing of an arrangement of β keratin configuration. From *c*, the pressure was again increased by further compression. Thus, either the configuration of the backbone of the polypeptide had been changed from the β- to the α-type, or segments of the chain had left the surface. For the film of poly-DL-α-aminocaproic acid as well as that of ovalbumin, the re orientation of the molecules is easier than for the polypeptide films of the longer side chains, because of the shortness of the side-chains. This explains the absence of the plateau in the force–area curves for poly-DL-α-aminocaproic acid and proteins.

The limiting area per residue for the film of γ-methyl L-glutamate polymer is 7·5 A.². This is just half the area per residue of closely-packed chains of β-configuration. It is known that this polymer has a folded structure[4], and the copolymer of γ-methyl L-glutamate with phenylalanine has also the α_{II} configuration[5]. The latter polymer has the α_{II} structure even in a stretched state. This is in good agreement with our experimental results obtained by the surface-layer technique.

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A Colorimetric Method for the Determination of Sugars

VOLUMETRIC procedures have been used for the quantitative determination of sugars after separation by partition chromatography[1,2]. It has been our experience that these methods not only require considerable skill, but also they are lengthy and sensitive to slight variation of the conditions. We have therefore attempted to develop a simple quantitative colorimetric procedure. Preliminary experiments showed that the anthrone[3] and the α-naphthol sulphonate[4] reagents give good results with pure sugar solutions, but the presence of only traces of solvents such as butanol, phenol and propionic acid used in the chromatographic separation of the sugars rendered them useless.

It was then discovered that phenol itself in the presence of sulphuric acid provides a simple rapid method for the quantitative colorimetric determination of ketoses and aldoses and their methyl derivatives on a sub-micro scale. The method, applicable to all carbohydrates with either a free or potential reducing group, is particularly useful for determining sugars which have been separated by partition chromatography using phenol–water as the solvent. The orange-yellow colour, produced by adding sulphuric acid (5 ml.) to the sugar solution (2 ml.) containing phenol, is permanent; its optical density (measured at 490 mμ for hexoses and hexuronic acids and their derivatives and at 475 mμ for pentoses and their derivatives) when referred to a standard curve gives the concentration of the sugar.

This phenol–sulphuric acid reagent, which has enabled us to determine the composition of polysaccharides and their methyl derivatives on as little as 1 mgm. of material, thus offers an additional method for end-group analysis of polysaccharides[6]. The reaction is not limited to phenol, for certain amines such as N(1-naphthyl) ethylene diamine can replace phenol in the above reaction.

In conjunction with the above colorimetric method, it has been found convenient to extract the sugars from the strips of paper cut from the chromatogram by simply immersing them in water. Since the extraction is carried out at room temperature, there is no danger of decomposing the sugars[5]. Substances in filter paper which interfere with the sugar analysis can be largely removed by three or four 'chromatographic' washings with water; washing with dilute sodium hydroxide does not seem to improve the paper.

Further details of this work and its application to the determination of the structure of various polysaccharides will appear elsewhere.

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A New Paper Chromatography Solvent for Amino-Acids

PHENOL and collidine have remained the most widely used pair of solvents for two-dimensional paper chromatography of amino-acids since their introduction by Consden, Gordon and Martin[1]. The use of the latter solvent, however, is attended by certain disadvantages such as double spots and haloes[2], an offensive smell and possible toxic effects[3,4] and, in some countries, difficulty of supply. Alternative solvents have been suggested, for example, butanol – acetic acid[5], acetone – water[3] and pyridine – amyl alcohol[6]. Some defects of the latter system have recently been reported[7].

A new solvent giving an extremely wide distribution of R_F values is mesityl oxide, which has already been mentioned as a possible solvent for the paper partition chromatography of organic acids[8]. The difficulty encountered by Lugg and Overell[8], namely, the condensation of the solvent in the presence of formic acid, has been obviated by the use of re-distilled and fractionated solvent[9]. Because of the tendency to form peroxides on prolonged storage in contact with air, each batch of solvent should be tested for their presence before distillation. The fractionated solvent (b.p. 129–130°) alone does not give any movement of amino-acids; but the acid spots move when formic acid is added to the solvent system. The method of preparation of the most desirable mobile phase is to shake one volume of the solvent with one volume of formic acid (85 per cent) and two volumes of water. R_F values for the amino-acids in such a solvent are listed in the accompanying table, from which it can be seen that the spread of values is considerably higher than with collidine, and indeed almost as high as with phenol. An additional advantage with this solvent is its rapidity of migration, the solvent ascending about 50 cm. in twenty hours on Whatman No. 1 paper.

R_F VALUES OF AMINO-ACIDS

Amino-acid	R_F	Amino-acid	R_F
Alanine	0·35	Methionine	0·61
Arginine*	0·19	*nor*Valine	0·58
Aspartic acid	0·17	Ornithine†	0·08
Cystine	0·06	Phenylalanine	0·72
Glutamic acid	0·20	Proline	0·89
Glycine	0·22	Serine	0·20
Histidine	0·07	Threonine	0·26
*iso*Leucine	0·70	Tryptophane	0·81
Leucine	0·71	Tyrosine	0·63
Lysine	0·23	Valine	0·58

* Applied as monohydrochloride. † Applied as hydrobromide.

The tendency for mesityl oxide gradually to oxidize and polymerize on standing, with the formation of coloured substances, has been especially noticed in the acidified mobile phase, which after several days may develop a slight orange coloration. This difficulty has been avoided by making up small volumes of the mobile phase just prior to use and discarding any residual solvent after about two days. By this means an exceedingly high degree of reproducibility in R_F values has been obtained. Our usual practice is to allow the paper to become equilibrated thoroughly in the vapours of the stationary phase before introducing the mobile phase. The paper may be quickly and satisfactorily air-dried. Heating of the ninhydrin-sprayed sheet then brings up the spots in their characteristic colours. As with carboxylic acids, spots obtained are discrete and should lend themselves well to quantitative studies[9]. All the chromatograms have been run as with other solvents, although it has been stated that prolonged breathing of the fumes should be avoided[10].

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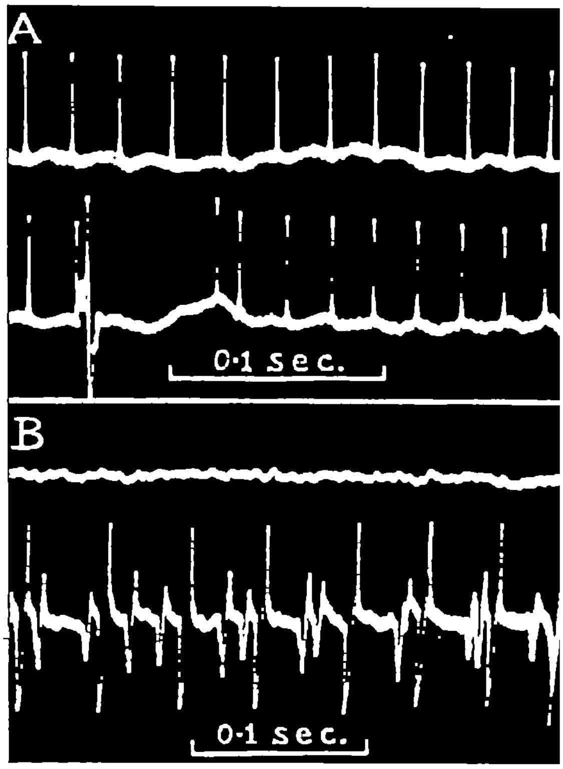
Afferent Limb of the Myotatic Reflex Arc

Within the past decade, the use of electronic methods has laid bare much of the mechanism underlying the myotatic, or stretch, reflex of mammalian striated muscle. Outstanding among these advances are Lloyd's demonstration of the monosynaptic nature of the myotatic reflex pathway, and his disclosure that fibres of large diameter (Group I fibres) constitute the afferent limb of this reflex arc[1]. However, the specific receptor organ responsible for initiating the stretch reflex has so far eluded positive identification, though the balance of evidence suggests muscle spindles rather than Golgi tendon organs[2].

Recently, Szentagothai[3] has brought forward histological evidence indicating that afferent fibres from spindles in the jaw-closing muscles enter the brain stem by way of the *motor* root, while those from Golgi tendon organs pass through the *sensory* root of the trigeminal nerve; furthermore, according to this author, the monosynaptic pathway for the masticatory muscles is completed by way of collaterals from the afferent fibres serving muscle spindles. These observations are difficult to reconcile with the conclusions of Rioch and Lambert[4], who state that the afferent pathway for the jaw-jerk lies in the sensory root of the trigeminal nerve. An attempt to resolve this apparent contradiction has therefore been made in a series of experiments on the trigeminal system in decerebrate cats, and the present communication summarizes the principal results of this investigation.

First, by means of a standard amplifier and oscillograph, an abundance of afferent impulses from stretch receptors in the jaw muscles has been recorded from the peripheral end of the severed motor root of the fifth cranial nerve. Fig. *A* (upper record) shows the discharge of one such ending when the masseter muscle is subjected to moderate stretch. The low mechanical threshold of these stretch endings, and the 'silent period' they exhibit during twitch of the muscle in which they lie (Fig. *A*, lower record), identify them as muscle spindle receptors[5]. This aspect of Szentagothai's findings thus receives oscillographic confirmation.



A. Decerebrate cat. Above: typical stretch receptor discharge elicited by moderate stretch of the masseter muscle and recorded from a fine filament dissected from the peripheral end of the severed motor root of the trigeminal nerve. Below: cessation of discharge from the same receptor during twitch of the masseter muscle. *B*. Decerebrate cat. Electrodes on the exposed lateral surface of the masseter muscle. Above: virtual absence of motor unit activity with the jaw supported in the closed position. Below: typical stretch reflex discharges of several motor units in the same muscle during moderate stretch of the latter after complete severance of the sensory root of the ipsilateral trigeminal nerve

Secondly, after severing the sensory root of the trigeminal nerve in other preparations, the motor root remaining intact, the stretch reflex in the masseter muscle was found to be as active as before (Fig. *B*, lower record). Both the afferent and efferent limbs of this reflex arc must therefore lie in the motor root, which, as Szentagothai has shown[3] carries afferent fibres from muscle spindles only.

The results of these experiments are, therefore, in full agreement with Szentagothai's histological findings, and can be regarded as providing direct physiological proof that muscle spindles and not Golg tendon organs are the stretch-sensitive structures specifically concerned in eliciting the myotatic reflex. No certain explanation can be advanced for the contrary observations of Rioch and Lambert[4]; but it may be noted that, in two of the present experiments, the operation of cutting the sensory root apparently abolished the jaw-jerk. In view of the preservation of this reflex in the remaining experiments, despite complete (and, in some cases, bilateral) severance of the sensory root, it can only be concluded that such atypical results were brought about by unintentional damage, inflicted during the operation, to structures other than the sensory root. Although Szentagothai's studies[3], and the experiments described above, together establish that muscle spindles are indeed the receptor organs responsible for the stretch reflex, it has not yet proved possible to examine separately the reflex effects of impulses arising from the two types of spindle ending[5]. However, in view of the large size of the afferent fibres terminating therein, it is reasonable to conclude that the *primary*, or annulospiral, endings are the actual receptors within the muscle spindles which form the starting point of the myotatic reflex arc.

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Inhibition of the Hypophysis of the Guinea Pig by Ultra-Sound Waves

ULTRASONIC irradiation of the brain has been carried out both for diagnostic and for therapeutic purposes[1]. In the dog, neither electroencephalographic nor histological changes are elicited by ultrasonic irradiation, probably on account of the great absorption of the radiation mainly by the bones of the skull[2]. Since, as earlier observed[3], ultrasonic irradiation of the hypothalamus produced respiratory and circulatory changes, it was decided to examine the effects of irradiation of the pituitary gland. Guinea pigs were used for the experiments, partly because surgical hypophysectomy is almost impossible in this animal and therefore, in case of success, irradiation of the pituitary might prove an interesting and simple method of obtaining hypophysectomized guinea pigs.

Eleven animals, approximately fifteen days old, were grouped in five lots, the first consisting of three twin brothers, the other four comprising two twin brothers each. One of each group was kept as control while the other animals were exposed every other day to irradiation with ultrasonic waves, frequency 800 kc./s., intensity 10–40 watts, time 10 min. and radiant surface 2·5 $cm.^2$. Paraffin oil was employed as intermediary substance. The emitter was placed on the central part of the skull. As the radiation proceeded, the animals exposed to this irradiation showed defective growth compared with their controls, which doubled their weight in the same time.

The irradiated animals carried out movements with great difficulty and sometimes lost their equilibrium. Remarkable changes in the skin were also observed, such as ulcerations and loss of the hair, which looked short, frail and bristle. Radiographic examination (Fig. 1) revealed in the irradiated animals a general decalcification, a decrease of the bone trabeculæ, the vertebræ and all the bones in general being of reduced size. Ossification centres were small and badly ossified.

Examination of the adenohypophysis (Fig. 2) showed a noticeable congestion, with widened capillaries occupying a large proportion of the gland. The cells remaining between these vessels had only a little cytoplasm, frequently vacuolated; the large basophile cells were almost entirely absent; and there were abundant acidophile cells with pycnotic nuclei. This nuclear disposition was remarkably frequent and could also be observed in some chromophobe cells and in many of the pars intermedia. In the thyroid a great number of follicles seemed inactive, of large size with a flat epithelium and a dense colloid substance, both scarcely retracted and vacuolated. The adrenal cortex showed somewhat retracted cells in its fascicular zone with homogeneous cytoplasm almost

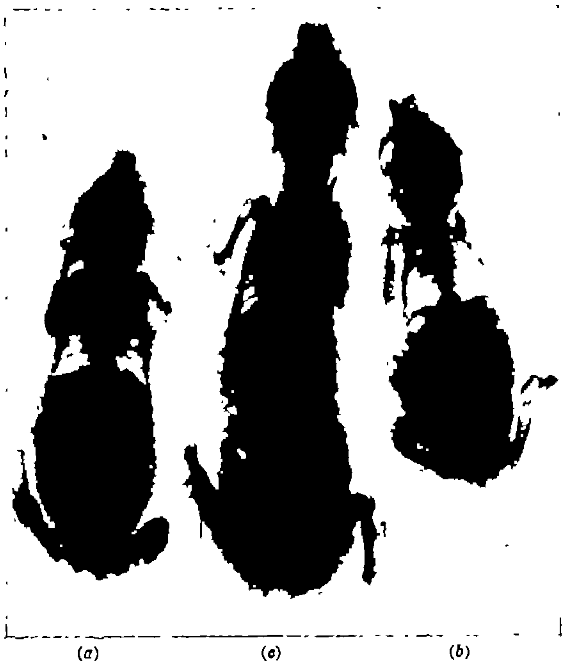

Fig. 1. Radiographs of triplet guinea pigs after two months of ultrasonic treatment of the pituitary gland. Exposures: (*a*) 20 watts; (*b*) 40 watts; (*c*) control. Weights of these animals were: (*a*) 215 gm., (*b*) 200 gm., and (*c*) 350 gm. Lengths of the skeletons were (*a*) 16 cm; (*b*) 14 cm.; (*c*) 21 cm.

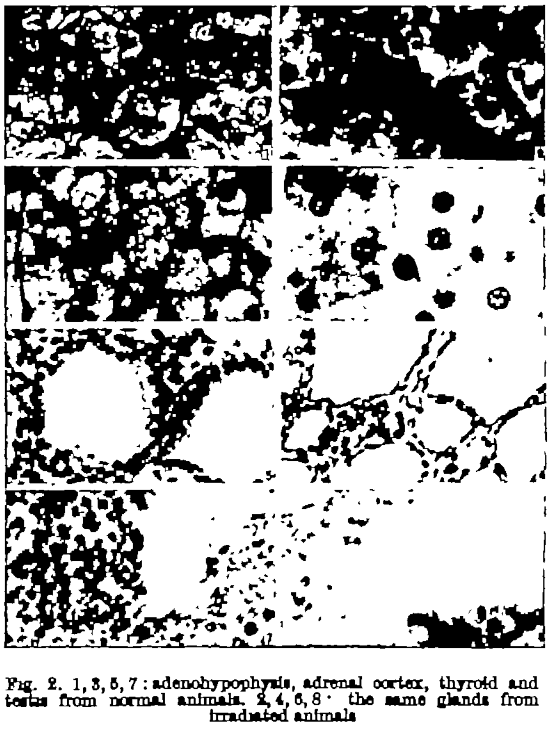

Fig. 2. 1, 3, 5, 7: adenohypophysis, adrenal cortex, thyroid and testis from normal animals. 2, 4, 6, 8: the same glands from irradiated animals

free of lipidic inclusions. The reticular zone of the gland was much congested; nearly every cell showed a pycnotic nucleus, and many were overcharged with pigmentary inclusions. In the testis, a number of seminiferous tubules were atrophied, and the cells of the spermatic series were arranged in only one or two rows. Cells in the condition following the primary spermatocyte had disappeared, with the consequent diminution of the number of mature spermatozoa. Many cells had pycnotic or lytic nuclei. The interstitial tissue was frankly atrophied.

Post-mortem examination of these animals revealed that all the viscera were atrophied, especially the glands, the weight and dimensions of which were much less than those of the controls. The pituitary gland and the fossa pituitaria were relatively small, and the testes were reduced to a third of the normal.

Irradiation of the hypophyseal zone with high doses of X-rays had no appreciable effect on guinea pigs during the growth period. Thus, a guinea pig of 200 gm. exposed to X-rays twice weekly during a fortnight (totalling 1,600 r.), grew to 410 gm. after 45 days. In the same period its unexposed twin brother, the initial weight of which was 230 gm., reached 420 gm. in the same period.

It may be concluded that ultrasonic irradiation constitutes an excellent and bloodless method of affecting the hypophysis of the guinea pig, so as to obtain animals with pituitary insufficiency. It may be possible to apply this method to bigger animals.

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University of Buenos Aires.
March 10.

[1] Dusik, K. T., Dusik, F., and Wyt, L., *Wiener Med. Wschr.*, 88, 425 (1947).

[2] Ballantine, H. T., Bolt, R. H., Hueter, T. F., and Ludwig, G. D., *Science*, 112, 525 (1950).

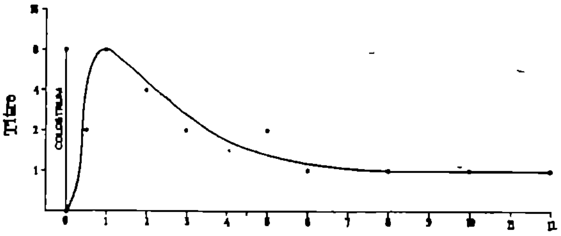
[3] Cicardo, V. H. (unpublished results).

Absorption of Anti-Nematode Antibodies from Ewe's Colostrum by the New-born Lamb

During experimental work on helminth immunity, it was observed that the sera of month-old worm-free lambs gave positive reactions for anti-nematode antibodies. When this observation was made, all the available ewes but one had lambed. A small-scale test was made to determine whether antibodies to parasitic nematodes could be detected in the colostrum of nematode-infected ewes and whether their offspring acquired these antibodies as a result of suckling.

A colostrum sample was taken from a parturient ewe and serum samples were collected from the lamb at birth, that is, prior to suckling, three days later, and then at weekly or fortnightly intervals for three months. The lamb was allowed to run on pasture with its dam; but, though exposed to nematode infestation, eggs could not be detected in its fæces.

All sera and the colostrum were stored at − 20° C. until the end of the experiment. They were then titrated by means of the hæmolytic complement-fixation test. The antigen used was prepared from a mixed culture of *Cooperia curticei* and *Strongyloides papillosus*, following the technique described by Stewart[1].



The results (see graph) showed that the colostrum contained antibodies of relatively high titre. The serum of the new-born lamb did not contain any demonstrable antibodies until after suckling. The antibody titre reached a maximum at one week. During the next five weeks it decreased to a low level, which was maintained for at least three months.

These observations show that anti-nematode antibodies can be transmitted in a manner similar to the more commonly identified antibodies.

Whether the antibodies in the lamb's serum are related in any way to a resistance to nematode infestations has yet to be investigated.

Daisy B. Filmer
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Department of Agriculture,
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[1] Stewart, D. F., *Aust. Vet. J.*, 24, (5), 112 (1948).

Changes in Electrical Conductivity during Bacterial Growth

Parallel measurements of the electrical conductivity and bacterial count in a solution containing glucose and peptone, in which a small amount of inoculum of *Bact. subtilis* has been introduced, show the typical lag, logarithmic and stationary phases and have brought out the striking result that, even before the multiplication of bacteria takes place, there is an appreciable increase in conductivity. This result is to be attributed to the initial activity of bacteria through their multi-enzyme systems in splitting up the peptone in the medium into amino-acids, which are absorbed by the bacteria from the surrounding medium and provide the nutrient material for their growth. Chemical estimation of the amino-acids formed in the medium revealed a close parallelism between their concentration and the electrical conductivity of the suspension at various stages of bacterial growth. This investigation has thus clearly shown that amino-acid formation takes place through bacterial action in the medium before the bacteria begin to multiply.

The observation mentioned above provides evidence for the view that substances are passed from the cells into the medium during the lag phase, a view which is also supported by another observation o ours that the conductivity of a suspension of washed bacteria in 'conductivity water' increases exponentially with time for about six hours, although thi increase is comparatively small, being about $0{\cdot}2 \times 10^{-12}$ mho per bacterium on the average.

K. Krishnamurti
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Nagpur. Feb. 15.

Apyrases of Moulds

THE mycelial mats of *Aspergillus niger* and *Penicillium chrysogenum* possess apyrase activity. The organisms were grown as surface cultures on synthetic media, and at regular intervals the mat was analysed for apyrase activity and for '7-minutes phosphate' in the acid-soluble fraction. During the first phase of metabolism, when sugar was being rapidly consumed, the enzymic activity and the content of labile phosphate were high. When autolysis set in there was a marked drop and sometimes even a complete disappearance of both apyrase activity and labile phosphate. Apyrase probably plays an important part in the metabolism of the mould.

Estimation of enzymic activity in culture solutions was rendered difficult because of the presence of orthophosphate; but at no time was the enzyme concentration high.

Considerable variation existed in the apyrase activity of different strains. The pH – activity relationship was different for *Aspergillus* and *Penicillium*.

Apyrase activity of the mycelium could be extracted by grinding with water in the Waring blendor. The apyrase of *Aspergillus niger* has been concentrated about 450-fold by fractionation with ammonium sulphate. A colourless solution was obtained which was free from glucose oxidase. The enzyme preparations were inhibited by both calcium and magnesium ions at a final concentration of $M/100$. This is in contrast to the marked stimulation of potato apyrase by added calcium ions[1]. Tests with inorganic pyrophosphate showed that the purified enzyme possessed powerful pyrophosphatase activity also. The relative speed of dephosphorylation of inorganic pyrophosphate and adenosinetriphosphate remained fairly constant without any sharp break during the various stages of purification of the enzyme.

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Poona 7.
March 8.

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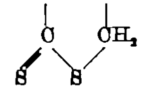
[1] Krishnan, P. S., *Arch. Biochem.*, 20, 272 (1949).

Mildew-preventing Activity of Rhodanine Derivatives

ALTHOUGH rhodanine (I) has some fungicidal activity[1], it was found to be ineffective as a mildew- or rot-preventing agent on cotton cloth. Through condensation of rhodanine with aldehydes and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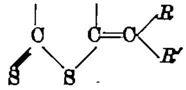
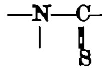

II

ketones, derivatives (II) having marked mildew-proofing activity may be obtained. More than a hundred such derivatives have been prepared and tested in our laboratory. It is interesting to note that the new mildew-proofing agents contain the structure $-\underset{|}{N}-\underset{\overset{\|}{S}}{C}-S-$ present in many plant fungicides (tetramethylthiuram disulphide and the salts of dithiocarbamic acid), as well as a carbonyl group conjugated with an ethylenic linkage, found in another class of fungicides[2].



Uniform strips of dyed herring-bone cotton twill were impregnated with 2 per cent of the fungicide under examination and incubated for two weeks on mineral salts agar with pure cultures of *Aspergillus niger* and *Chaetomium globosum*. Other such strips were buried for two weeks or four weeks in soil. In each case the percentage loss in tensile strength was determined.

The majority of the compounds of type II tested were effective in preventing deterioration of the cloth in the pure culture tests (less than 5 per cent loss in tensile strength). Eighteen of the compounds afforded similar protection in the two weeks soil burial test. Under the same conditions cloth strips impregnated with chloranil lost 80 per cent or more of their tensile strength.

In four weeks soil burial tests, the most active five compounds were the 2-thenylidene-, p-methyl*cyclo*hexylidene-, α-n-amylhexylidine-, o-methyl*cyclo*hexylidene- and p-chlorobenzylidene-rhodanines. All these prevented tensile strength losses greater than 25 per cent.

Details of this work, which was supported by a contract with the Medical Division, Chemical Corps, U.S. Army, will be reported elsewhere.

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Durham, N.C.
April 9.

College of Science Physics Dept. Upper Circular Rd, Calcutta

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[1] U.S. Patent 1,962,109.

[2] Geiger and Conn, *J. Amer. Chem. Soc.*, 67, 112 (1945).

Improved Sampling Method for Demonstration of Local Antibodies in the Vagina

IN infections with pathogens of low virulence strictly localized to a few or single organs, it is often difficult, if not impossible, to obtain reliable diagnostic findings by means of tests for antibodies circulating in the blood stream. This holds true in particular if only some parts of a mucous membrane are involved. In such cases, however, it may prove practicable to utilize the local antibody production for diagnostic purposes.

Serological examination of vaginal mucus has been employed by Pierce[1] for the diagnosis of bovine trichomoniasis, and by Stegenga and Terpstra[2] for the diagnosis of vibriosis (due to *Vibrio fœtus*). The local production of antibody has also been used to detect bulls with brucellosis localized to the genitals[3].

The procedure hitherto employed for collection of vaginal mucus by suction with a glass tube is cumbersome as well as time-consuming; besides, it is applicable only to cows with sufficient secretion in the vagina. On the other hand, on account of its great dilution, the usually abundant œstral discharge is less suitable for the demonstration of antibodies. Therefore, this sampling technique is not very serviceable for routine examination.

A gauze tampon (about 15 cm. × 19 cm., weighing 1·1 gm.) placed in the fundus of the vagina will absorb on an average about 3 gm. of secretion, and even when the vagina is 'dry' the tampon will take up about 1 gm. This rather wide variation has no influence upon the outcome of the routine examinations, and, if desired, corrections for the variation can be made by means of dilution. The fluid absorbed by the tampon can also be used for bacteriological examination.

Technique. A piece of gauze, about 15 cm. × 19 cm., weighing about 1·1 gm., is rolled up, tied with ordinary string and wrapped around the end of a thin stick, while the end of the string is tied around the other end of the stick. This swab is then packed in paper and sterilized. For sampling the secretion in the vagina, the tampon is placed in the fundus, for example, through a speculum or by means of a tube made for this purpose[4]. Then the stick and the speculum are removed. After 20–30 min., the tampon is pulled out by means of the projecting end of the string, the vulva being kept wide open. The sample is placed in a glass tube. The secretion is extracted by 4–6 ml. of distilled water or saline. For the various tests, some of this extract is withdrawn by means of a pipette.

This tampon method has proved serviceable in practice in examinations for the presence of antibodies against *Vibrio fœtus*. It has also proved practicable in this way to demonstrate the presence of complement-binding antibodies against pleuropneumonia-like organisms isolated from the same tampon samples taken from a herd with pronounced post-œstral discharge and difficulties in fertilization. (On examination of the blood serum, Edward[5] was unable to demonstrate any complement fixation with homologous strains.)

It may be possible by means of this technique also to throw some light on the much disputed question in human medicine about the relation between unspecific vaginitis or urethritis and pleuropneumonia-like organisms.

L. SZABÓ

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Royal Veterinary and Agricultural College,
Copenhagen.
March 14.

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[2] Stegenga, Th., and Terpstra, J. I., *Tijds. Diergeneeskunde*, 74, 293 (1949).

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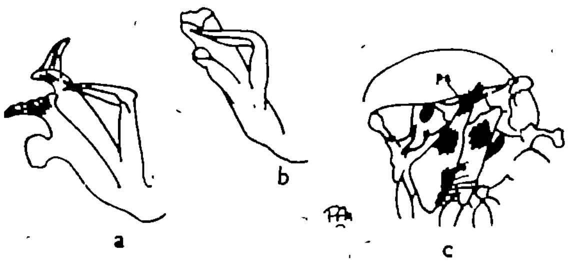
[5] Edward, D. G., *J. Gen. Microbiol.*, 4, 4 (1950).

Culex (Culex) torrentium Martini, a Mosquito New to Great Britain

FOURTH instar larvæ and pupæ referable to *Culex* (*Culex*) *torrentium* Martini were taken in some abundance from water-tanks on allotments at Isleworth, Middlesex, by Mr. Bowles, of the Health Department, on June 19 of this year. They were sent for identification, together with emergent adults, to the British Museum. The name *torrentium* is applied provisionally since, as Natvig[1] has pointed out, the synonymy of the group is somewhat obscure and requires further investigation. There can, however, be little doubt that this is the Scandinavian species described by Natvig as *torrentium*.

The principal difference between this species and *C. pipiens* lies in the structure of the phallosome, which is absolutely diagnostic (see diagram). Among external characters the best for diagnostic purposes is the presence in *torrentium*, but not in *pipiens*, of a prealar scale patch at the tip of the sternopleura.



Culex spp. *a*, *c*, *C. torrentium* Martini, *b*, *C. pipiens* Linnaeus. *a*, *b*, lateral plates of phallosomes; *c*, side view of thorax; *pa*, prealar scale patch

This character has not previously been applied to the Palæarctic *Culex* but was used very successfully by Edwards[2] in dealing with the Ethiopian species. It is considered that it will almost certainly prove to be reliable. Natvig considers certain small differences in wing venation to be diagnostic. The stem of the upper fork cell is said to be about a quarter to a third the length of the fork itself in *torrentium* and a fifth to a sixth the length of the fork in *pipiens*. In *torrentium* the radio-medial cross vein is said to be placed about twice its length distally to the mediocubital cross vein. In *pipiens* it is said to be about one and a half times its length distal to the mediocubital cross vein. It is not known whether these characters will prove to be constant in British populations.

The Isleworth form is quite strikingly different from *pipiens* with respect to certain colour characters, notably the presence in most specimens of far more numerous dark scales on the abdominal sternites. It is, however, a very dark form as compared with topotypic specimens from Thuringia in the British Museum and, as dark and light forms are extremely common in the genus *Culex*, colour differences are of doubtful value. It exhibits numerous pale scales on the underside of the male palps, as does the Scandinavian form, but these would probably be much less conspicuous in a light variety. A few small larval differences are given by Martini[3], who refers to *torrentium* under the name *exilis* Dyar. These may or may not prove constant.

It is not known whether *C. torrentium* bites man; but many members of the *pipiens* group do so. The normal breeding places are fresh natural waters of various kinds; but Natvig has a record—comparable with the present one except that in his case the water was very foul—from a garden pail. It is not known whether this is a recent introduction into Great Britain or whether the species has previously escaped detection owing to its resemblance to *pipiens*. The former explanation is thought to be more probable. If this is a rare, though established, species, it is possible that its detection may have been due to a local increase in population arising from some unusual chain of favourable climatic conditions. In either event it seems desirable to direct attention to its presence in Britain, so that a search may be made for it in other localities.

P. F. MATTINGLY

Department of Entomology,
British Museum (Natural History),
Cromwell Road,
London, S.W.7.
June 23.

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[1] Natvig, L. R., *Norsk entom. Tidsskr.*, Supp. 1 (1948).

[2] Edwards, F. W., "Mosquitoes of the Ethiopian Region", 3 (1941).

[3] Martini, E., in Lindner, "Die Fliegen", 3, 11, 12 (1931).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Lecturer in the Electrical Engineering Department (industrial experience on the power side of electrical engineering is essential)—The Secretary of University Court, The University, Glasgow (August 7).

Deputy Mechanical Engineer (with a university degree in Engineering, or corporate membership of either the I.C.E., I.M.E., or I.E.E.)—The Engineer and Manager (General), Sunderland and South Shields Water Company, 29 John Street, Sunderland (August 10).

Development Engineer in the Production Department at London headquarters—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/359 (August 11)

Lecturer in Physics—The Secretary, Royal Technical College, George Street, Glasgow, C.1 (August 11).

Scientific Officer (Physicist with interest in aerodynamics or Mathematician prepared to do experimental work, with a first- or second-class honours degree or equivalent qualification) for theoretical and experimental duties in connexion with marine aircraft performance, etc. (Ref. 199/51A), and an Experimental Officer (with H.N.C. or equivalent qualification in electrical or telecommunications engineering, preferably with experience in the design and maintenance of aircraft electrical systems) (Ref. D.316/51A), at a Ministry of Supply experimental establishment in Suffolk—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (August 11).

Soil Research Officer in the Irrigation Branch, Punjab Public Works Department, Lahore—The High Commissioner for Pakistan, 35 Lowndes Square, London, S.W.1 (August 13).

Assistant Advisory Officer (Grade IVa or IVb) in the Bacteriology Department, an Assistant Adviser in Horticulture, and a Fruit Trials Officer (Grade III or IVb) in the Horticulture Department—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (August 15).

Lecturer in Physics (preferably in Experimental Physics) at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (August 15).

Psychological Assistant in the Department of Psychiatry—The Registrar, The University, Leeds 2 (August 15).

Senior Experimental Officer or Experimental Officer in the Royal Naval Scientific Service—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4048/51 (August 16).

Senior Scientific Officers (2, with a first- or second-class honours degree in botany and well qualified in systematic botany) at the Royal Botanic Garden, Edinburgh—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4046/51 (August 16).

Chemists II (Ref. F.492/51A) with first- or second-class honours degree in chemistry or chemical engineering, or associateship of the R.I.C. or I.C.E., and Chemists III (Ref. F.493/51A) with first- or second-class honours degree in chemistry or associateship of the R.I.C., preferably with specialization in organic chemistry and wide industrial experience, in the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (August 18).

Junior Physical Chemist (with at least two years research experience in physical chemistry, and a first- or second-class honours degree) at the I.C.T.A., Trinidad—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (August 18).

Lecturer in Mathematics at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 18).

Research Officer (Biologist) at the Fisheries Research Station, Dunwich, Queensland, to assist in the programme of research on mullet and oysters (Ref. No. 3469), and an Officer-in-Charge, Physical and Mechanical Testing Laboratory, Division of Building Research, Highett, near Melbourne, to undertake and supervise research on physical problems associated with building materials and buildings generally, and to be responsible for physical and mechanical tests on a wide range of building materials (Ref. No. 3470)—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (August 18).

Junior Research Fellowship in the study of hydraulics by means of scale models—The Secretary, The University, Aberdeen (August 20).

Physicist or Electrical Engineer (Principal Scientific Officer grade) with a high-class honours degree, and research experience in telecommunications with special emphasis on all radio telephony methods and high speed telegraphy, a Physicist (Senior Scientific Officer grade) with a high-class honours degree, with research experience and a considerable knowledge of electronic circuitry, and a Physicist or Electrical Engineer (Senior Scientific Officer grade) with a high-class honours degree, and experience in telecommunication research with emphasis on radio telephony and high speed telegraphy problems, in the Royal Naval Scientific Service—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4049/51 (August 23).

Physicists (Scientific Officer grade) (with a first- or second-class honours degree in physics, and experience in optical and photographic work, preferably using high-speed cameras) at a Ministry of Supply design establishment near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.188/51A (August 24).

Physicists at a Ministry of Supply research establishment near London, for work connected with the handling and measurement of radioactive materials and associated health physics problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.200/51A (August 24).

Assistant Director (Engineering) at the Atomic Energy Research Establishment, Harwell, to be responsible to the Chief Engineer for direction and management of large drawing office and particularly of large engineering workshop engaged in the manufacture of wide variety of experimental plant, mostly to high standards of precision—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.417/51A (August 25).

Lecturer (graduate, with professional experience) in Civil Engineering—The Registrar, King's College, Strand, London, W.C.2 (August 25).

Operational Research Posts in the Field Investigation Group of the Directorate of Scientific Control—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/361 (August 25).

Assistant Chemist (with a specialized honours degree, or the A.R.I.C. qualification) in the Department of Geological Survey—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (August 31).

Assistant Lecturer in the Department of Biochemistry and Chemistry, to teach inorganic and physical chemistry to first M.B. standard—The Dean, Guy's Hospital Medical School, London Bridge London, S.E.1 (August 31).

Junior Fellow (with veterinary qualifications, and postgraduate experience in the subject would be an advantage) in Clinical Parasitology in the Veterinary School—The Registrar and Secretary, The University, Bristol (August 31).

Lecturer or Senior Lecturer in Mechanical Engineering at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

Professional Engineers, General Service Class (Main and Senior grades) in the Admiralty—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Street, London, W.1, quoting S.86/51 (August 31).

Plant Physiologist (well qualified in botany, with specialization in plant physiology) at the Wattle Research Institute, University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 15).

Assistant Lecturer (probationary) in Applied Mathematics, and an Assistant Lecturer (temporary) in Philosophy—The Registrar, University College, Singleton Park, Swansea.

Assistant Lecturer and Demonstrator in the Physiology Department—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

Civil Engineers, Main Grade (Ref. E.251/51) and Assistant Civil Engineers, Recruitment Grade (Ref. E.252/51), in the Directorate General of Works, Air Ministry, in London and the Provinces—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

Civil, Mechanical and Electrical Engineers for National Defence Projects and developmental works in all States of the Commonwealth and in New Guinea—The Public Service Board Representative, Australia House, Strand, London, W.C.2.

Demonstrator for Electrical Engineering, and Demonstrators (2) for Mechanical Engineering including (a) strength of materials, metallurgy and desirably metrology and (b) applied thermodynamics and mechanics of fluids with preferably aerodynamics—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants.

Electrical Engineer (Mechanical) by the Central Electricity Board, Federation of Malaya—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.28370.B.

Experimental Officer (male) to assist in hydrographic research and chemical analysis of sea-water—The Director, Marine Station, Millport, Isle of Cumbrae.

Geologist Stratigrapher with an honours degree in geology (Ref. M.27565.B), and a Marine Biologist with an honours degree in zoology and a knowledge of the establishment of marine fisheries (Ref. M.27588.B), in the Falkland Islands Dependencies Survey for service in the Antarctic—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting the appropriate Ref. No.

Lecturer (a degree in electrical engineering is essential) for work on electrical measurements—The Secretary, Royal Technical College, Glasgow, C.1.

Lecturer in Mathematics—The Clerk, Northern Polytechnic, Holloway, London, N.7.

Physicists, Chemists or Electrical Engineers (well qualified, with postgraduate experience) for basic research on the electrical properties of materials, particularly dielectrics—The Director, Electrical Research Association, 5 Wadsworth Road, Perivale, Middx.

Principal Scientific Officer (with a good honours degree in engineering and some research experience) in the Engineering Division, to undertake investigation of the problems associated with the mechanical harvesting, handling and processing of underwater seaweed—The Secretary, Institute of Seaweed Research, Inveresk, Midlothian.

Senior Water Engineer in the Water Supply and Irrigation Department, Cyprus—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London S.W.1, quoting No. 27322/218.

Soil Chemist (Ref. 4/124), and an Entomologist (Ref. 4/41), in the Research Division of the Ministry of Agriculture, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting the appropriate Ref. No

Statistician (with a good degree in mathematics and some industrial experience)—The Divisional Chief Scientist, N.E. Division, National Coal Board, Roundwood Colliery Offices, Parkgate, Rotherham, Yorks.

Telecommunications Engineers and Physicists (Principal Scientific Officer or Senior Scientific Officer grade) at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.158/51A.

University Honours Graduate (preferably with a degree in organic chemistry) for training as a microanalyst—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

REPORTS and other PUBLICATIONS

(*not included in the Monthly Books Supplement*)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 25 (N.S.), No. 16 : The Evolution of the Earth's Atmosphere. By J. H. J. Poole. Pp. 201–224. 4*s.* Vol 25 (N.S.), No. 17. Observations on the Inheritance of Field Resistance to Leaf Roll of Potatoes (Shamrock × Skerry Champion). By Dr. Robert McKay and Dr. Phyllis E. M. Clinch. Pp. 225–234+plates 7–8. 3*s.* 6*d.* (Dublin : Royal Dublin Society, 1951.) [155

Gas at your Service. Pp. 72. (London : Gas Council, 1951.) [155

Ancient Britain : a Map of the Major Visible Antiquities of Great Britain Older than A.D. 1066. North Sheet 32½ in. × 40½ in. With Foreword, Introduction and Combined Index to North and South Sheets. Pp. 36. South Sheet. 32½ in. × 40½ in. With Foreword, Introduction and Combined Index to North and South Sheets. Pp 36. (Chessington : Ordnance Survey, 1951) 6*s.* 0*d.* each. [155

Glencoe and Dalness. Pp. 64. (Edinburgh : National Trust for Scotland, 1951.) 1*s.* [155

Bulletins of the Theory of Differential Periodicity. By G. F. Sleggs. No 2. Pp. 17–28. (Avoca, Co. Wicklow : The Author, Templelusk, 1951.) [165

Economic Reform Club. A Report on the Cost of Living. Pp. 12. (London : Economic Reform Club, 1951.) 1*s.* [165

London County Council : The Horniman Museum. Catalogue of the Adam Carse Collection of Old Musical Wind Instruments. Pp. 88. (London : Staples Press, Ltd., 1951.) 5*s.* [165

Department of Industry and Commerce : Meteorological Service. Geophysical Publications, Vol. 3, No. 4 : The Computation of Atmospheric Pressure at the 8 km. Level of Constant Air Density. By Dr. M. Doporto. Pp 17. (Dublin : Stationery Office, 1951.) 7*s.* 6*d.* [165

Board of Trade. Report of the Committee on Weights and Measures Legislation (Cmd. 8219.) Pp. iv+147. (London : H.M. Stationery Office 1951.) 3*s.* 6*d.* net. [165

The Registrar General's Statistical Review of England and Wales for the Two Years 1946–1947. Text, Vol. 1, Medical. Pp. vi+326. (London : H.M. Stationery Office, 1951.) 6*s.* 6*d.* net. [175

Catalogue of an Exhibition Illustrating Prehistoric Man in Health and Sickness. (Published for the Wellcome Historical Medical Museum.) Pp. 56+4 plates. (London : Oxford University Press, 1951) 2*s.* 6*d.* net. [175

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INTERNATIONAL NATURE CONSERVATION

THE English version of the Proceedings and Reports of the second session of the General Assembly of the International Union for the Protection of Nature, which was held in the Solvay Institute of Sociology at Brussels during October 18–23, 1950, has now appeared. The other, the French, version was published somewhat earlier. It is therefore a convenient moment to take stock of the position, to review the course of events which led to the establishment of an international body with the object of preventing the threatened extermination of species or associations of plants and animals, and to survey what has been accomplished and what is contemplated in the future.

The concept that Nature needs protection from the multifarious activities of man was first recognized in comparatively recent times, for it was only in the industrial age, when he had harnessed to his use mechanical power, that the destruction of the wild life of extensive areas was seriously threatened. The first incident to attract the attention of the civilized world was the disappearance in the seventeenth century of the helpless and harmless dodo, not of intent, but through sheer thoughtlessness and negligence. A greater disaster was narrowly averted in the nineteenth century, when with the rapid extension of the cultivation of the prairies of north-west America the bison diminished in numbers with corresponding rapidity. Thanks, however, to the timely action taken by the Governments of the United States and Canada, the animals that still survived were gathered together into safe-keeping in reserves, and the species was saved. Another phenomenon which attracted even wider attention, because commercial interests were involved, was the marked diminution in numbers, almost to the point of extinction, of whales in the Arctic seas. Late in the nineteenth and early in the present century, many nations spontaneously formed societies and took legislative action, in order to safeguard the wild life in their respective countries. It was, however, soon realized that individual action was not enough, and that international co-operation was needed, because in so many instances animals, especially birds, disregarded national frontiers, and it was of little use one country protecting a species if its neighbours destroyed it; moreover, life in the open seas necessarily demanded mutual understanding among the maritime nations.

In the early years of the present century, spasmodic efforts were made to initiate some form of international agreement for the protection of Nature; but beyond the passage of pious but fruitless resolutions they led to no positive results. The celebrated Swiss naturalist, the late Dr. Paul Sarasin, whose name is perpetuated by a tablet on a slab in the Swiss National Park, may justly be said to have laid the foundations upon which others built. At the eighth International Congress of Zoology, held at Graz in 1910, his proposal for an international commission was adopted, and, what is more, a provisional committee was appointed to follow the matter up. As a consequence, in 1913, under the auspices of the Swiss Federal Government, an international conference was held at Berne, and resulted in the adoption of an Act of Foundation of an Advisory Commission for the International Protection of Nature with its seat at Basle. With the ratification of the Act by a sufficient number of nations it looked as if success had been achieved. Unhappily, the First World War supervened, and the movement was not only temporarily brought to a standstill, but was also found impossible of resuscitation on the restoration of peace. Dr. Sarasin did make a determined effort to revive the movement at the International Congress for the Protection of Nature at Paris in 1923, but without definite result; and he died in 1929. His work was, however, carried on by Dr. P. G. van Tienhoven, who had taken a prominent part in securing the protection of Nature in the Netherlands. He was successful in forming the International Office for the Protection of Nature; but, in spite of his valiant efforts, the general response throughout the world was lukewarm, and, although the Office carried on, and indeed still functions, the lack of sufficient financial support has limited its activities to the accumulation of documents relating to the subject.

It may be noted in passing that, although the Second International Congress for the Protection of Nature, held at Paris in 1931, failed to achieve general international co-operation, it led directly to the Conference of the African Powers in London in 1933, which resulted in the Convention for the Protection of the African Fauna and Flora. A very similar convention for Nature protection and wildlife preservation in the western hemisphere was drafted at the Eighth Pan-American Scientific Congress, held at Washington in 1940, and became effective in 1942.

At the close of the Second World War, the Swiss League for the Protection of Nature, mindful of Dr. Sarasin's achievements, bestirred itself, and as a start invited naturalists from various European countries to visit the Swiss National Park and Reserves in the summer of 1946; and at the end of their visit they were induced to discuss informally the international aspect. Stimulated by this experience, the League embarked upon a more ambitious project, and issued invitations to governments, government institutions, and voluntary societies to participate in an international conference at Brunnen in the summer of 1947. The object in view appeared to be the revival of the Act of Foundation of 1913; but the general feeling among the delegates was that it would be a mistake not to take note of the change in political conditions, and especially the creation of the United Nations Organization, and that what was needed was not an Advisory Commission but an international union which could be linked up with the United Nations Educational, Scientific and Cultural Organization (Unesco). An appropriate constitution was accordingly drafted, and, after approval by the Conference, was transmitted to Unesco with the request that it should convene an international conference for the purpose of founding a union. After some hesitation owing to the fact that doubt was felt whether the proposed union might be considered to come within its objects, Unesco agreed and under the joint auspices of it and the French Government an international conference, attended by delegates from thirty-two countries, took place at Fontainebleau at the beginning of October 1948.

As a result of this conference, the International Union for the Protection of Nature was formed with its seat at Brussels, Dr. Ch. J. Bernard being elected president and Mr. Jean-Paul Harroy secretary general. Its constitution was largely based upon the one adopted at Brunnen. Its membership is unusua in character, being a combination of official and private bodies; it is of four classes: (*a*) governments; (*b*) public services concerned with the protection of Nature; (*c*) international (inter-governmental and non-governmental) organizations, institutions and associations concerned with the protection of Nature; (*d*) non-governmental national organizations, institutions and associations concerned with the protection of Nature. In order to assure the over-riding power of governments, in the General Assembly the government of each country has two votes, but all its national bodies together only one vote. In view of this voting arrangement, the British Co-ordinating Committee for Nature Conservation was formed as a committee of the Society for the Promotion of Nature Reserves, in order to formulate a common policy for the non-governmental bodies of Great Britain; the appropriate government departments are, however, represented at meetings of the Committee by observers, as also are certain other British countries. By Treasury regulation, subscriptions to the Union from private bodies have to be transmitted through the Committee, the maximum amount in any one year being restricted.

The first major piece of work to be undertaken by the newly formed Union was, at the request o Unesco, the organization of an International Technical Conference at Lake Success in August 194 concurrently with the United Nations Scientifi Conference for the Conservation and Utilization o Resources. The subjects discussed were groupe under two main headings, education and ecology and a large number of resolutions were adopted fo submission to the General Assembly of the Union The second session of the General Assembly was hel at Brussels towards the end of October 1950, an was attended by 103 delegates representing thirty one countries, together with eighteen observers from eleven international organizations; the actual number of persons present was not so large, because i many instances the same individual represented mor than one body. After consideration of the report o the Union's activities since its formation two year before, the main business was the consideration o the resolutions submitted by the Lake Success Conference, the Unesco representative relating what tha body had already done to implement them. Sinc the success of the Union must ultimately depend upo the public support it is able to attract, an importan step towards this end was taken by setting up a

Educational Section, with wide discretionary powers, at Washington under the chairmanship of Mr. Ira N. Gabrielson. A Survival Service was formed with the object of stimulating measures for the preservation of the species in grave danger of extinction which had been listed at Lake Success. Another important piece of work, which was rendered possible by financial assistance from Unesco, was the collecting and collating of information about the state of Nature conservation in different countries throughout the world; the volume has now appeared. The urgent need for an official periodical to provide information about the Union and its activities was recognized, but the stumbling block which was found impossible to circumvent was the absence of funds adequate to meet the inevitable cost, at least initially.

In fact, the obstacle blocking the Union's progress is the want of adequate financial resources. It is in the grip of the familiar vicious circle: on one hand it is starved of funds, and on the other criticized for apparently doing so little. Under the constitution, government and non-government bodies are expected to subscribe annually 50 American dollars, whereas the subscriptions for governments depend upon the population of their respective countries, ranging from 250 dollars for those with less than 5 million inhabitants to 2,000 dollars for those with more than 20 million inhabitants. It therefore follows that the contribution by the government of a large country is equal to the combined total of forty organizations. Moreover, in the existing difficult circumstances, comparatively few societies can easily afford the unit subscription, in view of the fact that with the rise in costs they can barely meet their commitments. It would obviously make all the difference if governments generally were to adhere to the Union; but unhappily as yet only those of four countries—Belgium, Luxembourg, the Netherlands and Switzerland—have done so. In the United Kingdom the Government has not itself adhered; but the British Museum (Natural History) and the Nature Conservancy have become members. For the sake of the future of the Union, it is sincerely to be hoped that it may be supported by a larger number of governments. In certain instances there may be some hesitation for fear lest the government might be committed to a course of which it did not approve; but this objection has been met by the provision that no government is bound by a decision of the Union, even if at the time it was approved by its own delegates.

A FEAST OF FAREY FRACTIONS

The Farey Series of Order 1025

Displaying Solutions of the Diophantine Equation $bx - ay = 1$. Designed and compiled by E. H. Neville. (Royal Society Mathematical Tables, Vol. 1.) Pp. xxix+405. (Cambridge: At the University Press, 1950.) 105s. net.

THE Farey series F_n of order n is the ascending series of irreducible fractions between 0 and 1 the denominators of which do not exceed n. For example, F_5 is 0/1, 1/5, 1/4, 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 1/1, and so contains eleven terms. The series compiled by Prof. E. H. Neville is F_{1025}; it contains 319,765 fractions and occupies four hundred pages. In addition, tables of F_{50} (with decimal equivalents), F_{64} and of the denominators in F_{100} are given as appendixes. A loose card containing the factors of all the numbers between 1 and 1049 is issued with the volume. The preparation of a table of this magnitude is a considerable feat, and Prof. Neville must be congratulated on having completed such a formidable task.

Farey series have a variety of interesting properties and uses. If a/b, a'/b' and a''/b'' are consecutive fractions of such a series, then (1) a'/b' is the mediant of a/b and a''/b'', that is, $a'/b' = (a + a'')/(b + b'')$, and (2) $ba' - ab' = 1$. Properties of this kind can be used when it is desired to approximate to a given irrational number α by means of a rational number a/b. It is first necessary to find the consecutive fractions a/b, a'/b' of F_{1025} between which α lies; convenient ways of doing this are described. If it is desired to approximate to α more closely than this, the problem becomes essentially that of finding the fractions of a Farey series of higher order which lie between a/b and a'/b'. Prof. Neville shows how this can be done in an economical way by making further use of his main table.

Another use of Farey series is to provide solutions x and y of the Diophantine equation $bx - ay = 1$ for given a and b without a common factor. If b does not exceed 1,025, the property (2) suggests a solution, since the equation is satisfied by $x = a'$, $y = b'$ where a'/b' is the successor of a/b in F_{1025}; other neighbouring terms also give solutions in certain cases. If b exceeds 1,025, the fraction a/b belongs to a Farey series of higher order, and the methods mentioned in the preceding paragraph can be used to provide solutions. In fact, by using the main table, or that of F_{50} with its decimal equivalents, the equation can be reduced by stages to one which is easily solved.

When one is confronted with a work of the magnitude of Prof. Neville's, one cannot help reflecting upon the grounds which justify the publication of tables in the theory of numbers. A list of gear-ratios arranged in order of magnitude is a Farey series, but even the engineers of the distant future are likely to find the scope of the present table beyond their requirements. Thus, so far as can be foreseen, other grounds of justification than those of practical use must be sought. It is possible that some would claim that the compilation of such a table is a contribution to human knowledge and so requires no further justification. Most of us would feel, however, that some discrimination must be exercised, and that the main justification of this kind of work lies in the use made of it. There are at least three different ways in which number-theoretical tables can be used. First, such a table may assist and shorten calculations made for purposes which are conceded to be of importance; a table of prime numbers is an obvious example. Secondly, a table may help to decide the truth or falsity of some important conjecture; Ramanujan's conjecture concerning the magnitude of his function $\tau(n)$ is a case in point. Thirdly, the study of a table may reveal the existence of hitherto unknown properties of the numbers tabulated; thus it was after studying Henry Goodwyn's table of Farey fractions that John Farey observed the mediant property (1), and in more recent times multiplicative properties of arithmetical functions have been discovered in a similar way.

As has been indicated, Prof. Neville's table can be used to solve particular problems of Diophantine analysis. Even a number-theoretician could not pretend, however, that such problems are of common occurrence, although the associated general problems are among the most interesting and difficult in number theory. It may be, of course, that future researches will make extensive use of the table for these or similar purposes. However, in my opinion it is largely for its possible uses to future Ramanujans in suggesting general properties hitherto unnoticed that Prof. Neville's table is justified. Whether such hidden properties do, in fact, exist it is not possible to say, although the recent elegant extension by Mahler, Ledermann and Cassels of Farey series to fractions in certain algebraic fields suggests that the subject is by no means exhausted and that there may still be scope for Farey's "curious calculators".

The book is beautifully printed in the usual competent style of the Cambridge University Press and is very appropriately dedicated to Srinivasa Ramanujan.

R. A. Rankin

THEISM AND THE INDIVIDUAL

The Christian Challenge to Philosophy

By the late W. H. V. Reade. Pp. xiii+195. (London: S.P.C.K., 1951.) 13s. 6d. net.

THIS book is the work of a Fellow of Keble College, Oxford, who died in 1943, leaving his manuscript prepared for publication. The author's character is sketched for us, simply and sympathetically, in a preface by Mr. Cyril Bailey, to whom the reader will be under a considerable debt. We are confronted by the picture of a master mind, embedded in a personality at once saintly, witty, artistic and shy. Mr. Reade cannot have been easy to know; but he made a lasting impression both as a teacher and as an official. Add to these conditions, the evening of a longish life, plus retirement from active academic affairs amid the darkest period of the Second World War, and we have the setting for the composition of these remarkable essays.

Perhaps their most outstanding feature is an utter lack of self-consciousness in following a theme to the bitter end, a theme not merely committed to paper, but lived and tested. To read these pages without realizing all this would be a sad mistake.

So, a beginning is made with the year A.D. 529, when the Emperor Justinian closed the Academy, and Greek philosophy was thereby officially declared to be dead. Oddly enough, we are not escorted forwards chronologically from here, but backwards towards its birth. This process brings to light—among other things—the almost incredible heterogeneity of the Pythagorean society, in which learned men found themselves apparently in close association with incorrigible purveyors of old wives' fables. Yet, in some respects how modern. Music was studied as a theoretical discipline, having little or no regard for composition or technique, and the fact that strong emotions were engendered by "sheer sound" only serves to remind us how primitive the basis must have been.

Nevertheless, philosophy was a way of life; it was, indeed, something to be used, something to be experienced. Above all, it had not yet become a 'subject' for study in the sense assigned to it by a university faculty. Its leaders, however, made a decisive step, commonly unknown, but if recognized, then seriously belittled. They invented theology as a protest against religion; not against established religion, but against all sorts of debased superstitions and myths. Yet theologians themselves must have increased in mental stature at a very uneven rate. Originally they appear as tale-tellers about the gods, nothing more, whereas Aristotle, having early contrasted them with 'physicists', later raises their status to that of a class interchangeable with "first-philosophers" or metaphysicians. Evidently, no longer had they anything to do with myths, and something quite fresh had been added to the Pythagorean outlook. All of which goes to show the complexity of the *logos* concept on its way to become a Christian tenet, central for doctrine and devotion alike.

From here it is a natural step to the fundamental position which this volume takes up regarding the absolute rejection of Platonism by Christianity. There is no half-way house, only complete incompatibility. Plato never seriously considered whether the altars (as he conceived them) about which, some centuries later, the Apostle to the Gentiles made his well-known comment, were dedicated to the one eternal Spirit, or whether their aim was essentially mythical. Thus there is for him (Plato) no theophany in history, no revelation of God "beyond the scope of science" to be uncovered by faith. Closely coupled with these elemental distinctions is Mr. Reade's major demand that religion was never for the few—in particular, the intellectually gifted—but for all from the least to the greatest. Here, certainly, the Christian challenge to philosophy is made manifest.

The reader is invited to study the later chapters of this book more especially if he is interested in modern problems thrown up by twentieth-century civilizations. He would be well advised, however, to receive this considerate suggestion with caution, since an understanding of the medieval scene, brilliantly delineated in the middle sections, is absolutely necessary if any significant judgment is to be reached regarding our present discontents. Incidentally, there is a valuable discussion concerning the relative positions of theology and philosophy in the hierarchy of learning. Mr. Reade avoids the decisive grading of the Western tradition: if philosophy is not exactly a "serving-maid", theology is no more than a first among equals, or perhaps between equals. This is no mere playing with words; it represents very fairly the Anglican position at its best, and markedly so when account is taken of the isolation of scholarship some eight years ago.

Along paths like these, the author approaches the climax of his argument. It amounts to a stern warning against all forms of riding roughshod over the individual, whether that word denotes persons or things. Every person is unique, and to be held in reverence on that account; moreover, many 'things' are unique—objects of great art, for example—and incapable of statistical evaluation. This axiological outlook is of the very core and substance of all Christian striving, and is bound to do battle against any philosophical system involving mass-production, mass-thinking, mass-behaviour, and the rest. It is inappropriate to enlarge upon the purely ecclesiastical functions implicit in such a way of life—suffice it to add that they receive their share of Mr. Reade's erudition and good sense. But there is one phrase (on p. 27), which seems like a slip, namely, "the opinionated man, tenacious and dogmatic . . .". Surely this is, in part, a tautology if the Greek δόξα is accorded its usual rendering.

The proof-reading must have been exemplary, and the format is attractive. This is a book to be bought rather than borrowed. It will not find easy acceptance, nor make rapid converts. But if neglected, it may well be at our peril. F. I. G. Rawlins

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PURE AND APPLIED CHEMISTRY OF STARCH

Chemistry and Industry of Starch

Edited by Dr. Ralph W. Kerr. Second edition, revised and enlarged. Pp. xii+719. (New York: Academic Press, Inc., 1950.) 11.50 dollars.

Before the first edition of this book was published in 1944, more than four thousand papers had appeared on the subject of starch, and the late H. E. Armstrong once used the expression "the tragedy of starch" in reference to the subject. Since 1939 matters have changed, and so far as chemical structure is concerned a much clearer picture is now possible, although one would welcome further advances in the physical properties and the industrial applications of starch and its products.

This excellent book—now in its second edition and greatly enlarged—is described as "Edited by Ralph W. Kerr", and it is true that his co-authors have contributed a number of chapters, but it is largely the author's own work. In many parts, particularly those in which he is dealing with scientific aspects of the subject and in which his own investigations have contributed to what is known, the author writes critically, with a command of his subject and adequate familiarity with the work of others.

The book is in five sections, of which the first deals with the starch granule and the chief varieties of starch. Section 2, comprising five chapters, is concerned with the manufacture of various types of native and modified starches, the chapter on corn starch having been rewritten for this edition. Section 3 comprises two chapters on the physical properties (by Dexter French) and the chemical properties of starch, both critically written and including developments, almost up to the time of writing, in the synthesis of starch components.

Section 4 deals with reactions and includes chapters respectively on the hydrogen bond as a basis for interpreting certain starch properties and on dextrinization, both by G. V. Caesar, oxidation (by J. M. Newton and G. T. Peckham), the manufacture of dextrins and acid hydrolysis of starch, and a long one (by Ed. F. Degering) on derivatives, with more than three hundred references. Most of these chapters have been enlarged in the present edition and give clear evidence of the authors' practical experience of the matters under discussion. The amylases are excellently reviewed by E. Kneen, and modification of starch by enzymes treated by G. M. Severson. A chapter on miscellaneous reactions has been greatly enlarged in this edition to include new work on the interaction with iodine.

Section 5 comprises one chapter on the analysis of starch (this is a new chapter) and six on its uses in industry—for example, modern fermentation products (by L. M. Christensen), food, paper, textiles, adhesives (by A. Frieden) and miscellaneous uses. The chapter on starch in fermentation industries has been enlarged, while the practical, technical and commercial aspects are well treated in the various chapters on the uses and applications of starch.

There are pages of references to each chapter of the book, and complete author and subject indexes and numerous illustrations, both photographic and diagrammatic. The photographic illustrations are better finished than in the first edition. An error in many of the page headings in the chapters on the physical and chemical properties of starch reverses these titles. The book will be invaluable to the pure scientist and the technologist. R. H. Hopkins

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THE ELECTRON MICROSCOPE IN METALLURGY

Metallurgical Applications of the Electron Microscope

A Symposium held at the Royal Institution, London, on 16 November 1949, and organized by the Institute of Metals in association with the Chemical Society, the Faraday Society, the Institute of Physics, the Institution of Electrical Engineers, the Iron and Steel Institute, the Physical Society, and the Royal Microscopical Society. (Institute of Metals Monograph and Report Series, No. 8.) Pp. vi+164+50 plates. (London: Institute of Metals, 1950.) 21s.

Magnifications beyond the range of the ordinary microscope are of metallurgical importance in many directions. Examples are to be found in the nature of the irresolvable constituents of hardened and tempered steels, the mechanism of age-hardening, the nature of the crystal boundaries and precipitations of ultra-microscopic films there. Further, the fundamental nature of plastic deformation, the real nature of slip bands, and the size of the fragments into which metallic crystals are broken down, all demand a technique beyond the range of normal microscopic vision.

Therefore, the symposium on the "Metallurgical Applications of the Electron Microscope", organized by the Institute of Metals in November 1949, in conjunction with a number of other societies interested in the same or similar problems, served to bring together a considerable mass of information regarding the potentialities of this instrument in the metallurgical field. The symposium was perhaps the more justified in that there has been, at any rate in some quarters, a feeling of disappointment at the progress so far made. The thirteen papers are now published by the Institute of Metals as Monograph No. 8, and cover the whole field, ferrous and non-ferrous, metal powders, heat treatment and mechanical working.

The widespread interest in the subject is exemplified by the fact that universities, research associations and industrial laboratories in Great Britain, United States, France and Germany have all contributed. To all those concerned, either from the fundamental or technological point of view, this collection of data is to be strongly recommended. Techniques for the production of replicas are discussed; and, although what the metallurgist would most like, namely, a direct picture of the metal surface, is unfortunately not yet available, the design and construction of a reflexion electron microscope may not be long delayed. F. C. T.

BRITAIN'S SCIENTIFIC SHRINES (5)

By ENG.-CAPT. EDGAR C. SMITH, O.B.E., R.N.

SCOTLAND

FOR carrying the survey of Britain's scientific shrines into Scotland, the plan adopted for the English counties is scarcely applicable, for some of Scotland's largest counties are the most sparsely populated, while for the greater part the homes and haunts and memorials, if not the birthplaces, of notable Scottish men of science are to be found in her university towns. The story of science in Scotland centres around her universities far more than is the case in England, and Scotland presents few parallels to the careers of such as Gilbert, Hales, Priestley, Jenner, Cavendish, Herschel, Dalton, Joule and Darwin. Some of England's most eminent men of science, owing to the religious tests, never entered Oxford or Cambridge, and were debarred from holding professorships in them. But in Scotland, with her educational traditions handed down from the days of John Knox, any student who could fend for himself on a meagre ration found the doors of the universities open, and, after the Reformation, the religious question seems to have shut them against very few. In attempting in a brief, and admittedly inadequate, sketch to recall to the reader some of those whose names are inscribed on the rolls of honour in science in Scotland, some part of the story of the universities must inevitably form the background.

Of the four Scottish universities, those of St. Andrews, Glasgow and Aberdeen came into existence before the Reformation, and that of Edinburgh just after; and their fortunes were affected not only by the struggles between Catholics and Protestants but also by the constant disputes between rulers, nobles, chieftains and clans, all of which were accompanied by much disorder. Recalling the circumstances, the impoverished state of the country, and the smallness of the population, it is not a little surprising that the universities managed to exist at all. In one of his many studies of the social history of Scotland, the Rev. H. G. Graham (1842–1906) said that even by 1650, after the Crowns of England and Scotland had been united, the total population of the country was only about 900,000, while the inhabitants of Glasgow numbered about 10,000, those of Aberdeen some 6,000, and those of St. Andrews a mere 1,500. One of Mr. Graham's essays was entitled "Glasgow University Life in Olden Times", in which he gave a striking picture of the hard and penurious life of both teachers and taught. Here, as elsewhere, the religious upheaval had its baneful effects on the young university, and with the coming of the Reformation, wrote Mr. Graham, "away fled Popish churchmen, students and masters, and when we see the august University once more all that is left of it consists of twelve individuals: a principal, three regents, four poor students, the principal's servant, an œconomus, a cook and a janitor. To such a miserable remnant are the functions and privileges left, with a meagre revenue of £25 yearly." From this deplorable state of things the University was rescued by the reformer and universal scholar, Andrew Melville (1545–1622?), who in 1574 at the age of twenty-nine, constituting the whole teaching staff in himself, lectured on Greek, Hebrew, Chaldee, Syriac, philosophy, physics, logic, rhetoric and chirology, and soon filled his rooms with students. In 1580 Melville returned to St. Andrews; but he had put the University of Glasgow on its feet again and by 1631 the half-ruined houses and tenements sheltering both professors and students were being replaced by the College in the High Street, which was destined to see the labours of a long line of distinguished men, including Adam Smith, Cullen, Black and their great successors, Thomas Graham, Rankine and Lord Kelvin. The ancient cathedral, in a part of which the University first met, still stands majestically at the top of the High Street, and at the foot of the hill the visitor can stroll through Glasgow Green, where on one Sunday afternoon in 1765 James Watt, pondering over the working of the University's model Newcomen engine, conceived the idea of a separate condenser. But all traces of the College which served the University for more than two centuries have been swept away, though some fragments of its masonry are incorporated in the Gatehouse at Gilmorehill.

With such a curriculum as that of Melville there was little room for mathematics; but it is worth noting that Melville's career coincided almost exactly with that of John Napier (1550–1617), who in the seclusion of Merchiston Castle, near Edinburgh, spent the greater part of his life in study and gave to the world his famous work on logarithms. He, like Melville, had studied at St. Andrews, and spent some time on the Continent, before marrying and settling down in his ancestral home. Ball says of him that "the business of his life was to show that the pope was anti-Christ but his favourite amusement the study of mathematics and science". It may be presumed that to-day no one reads Napier's commentary on the Apocalypse, but logarithms are in use all the world over. His famous book, "Mirifici Logarithmorum Canonis Descriptio", was published in 1614, and its tercentenary was the occasion of a notable commemoration by the Royal Society of Edinburgh, presided over by Lord Moulton, "a distinguished mathematician before he was a great lawyer". In his inaugural address, Lord Moulton said that though every fact known about Napier had become commonplace, it "left the man very imperfectly disclosed, but sufficed to show him strong and self-reliant, of solitary habits, of profound and untiring industry . . .", while "the invention of logarithms came on the world as a bolt from the blue. No previous work had led up to it, nothing had foreshadowed it or heralded its arrival. It stood isolated, breaking in upon human thought abruptly without borrowing from other workers or following known lines of thought." There were many other contributions to the tercentenary commemoration, which were all published in a special volume edited by Dr. C. G. Knott, a member of the staff of the University of Edinburgh, which was founded when Napier was engrossed in his studies at Merchiston Castle. Napier died on April 4, 1617, and was buried in the old church of St. Cuthbert. Among the memorials to him is his statue, which stands beside those of John Hunter, James Hutton, Sir Henry Raeburn and others in the Scottish National Portrait Gallery.

The next important figure in the history of science in Scotland is that of James Gregory (1638–75), who was educated in the University of Aberdeen and held the chair of mathematics first at St. Andrews and then at Edinburgh. The University of St. Andrews was founded in 1411 by Bishop Henry Wardlaw, that of Glasgow was founded in 1451 by Bishop Turnbull on a bull issued by Pope Nicolas V, a great patron of art and literature, while that of Aberdeen was founded in 1494 by Bishop William Elphinstone on a bull issued by Pope Alexander VI, who has been described as the most profligate prelate who ever sat on the apostolic throne. Whatever Alexander's misdeeds, Aberdeen benefited by his sanction for the establishment of its University, and it was not long before the present King's College was built, to be followed about a century later by Marischal College, founded in 1593 by George Keith, the Earl Marischal of Scotland. The present Marischal College dates only from 1906, when it was opened by King Edward VII.

Among those who were educated at King's College was Dr. Duncan Liddel (1561–1613), to whom Aberdeen owed its first chair of mathematics. A native of Aberdeen, Liddel spent the years 1579–1607 at various places in Germany, studying and teaching philosophy, medicine and mathematics, and making the acquaintance of Tycho Brahe. Returning home in 1607 with a comfortable fortune, he gave land to the University of Aberdeen and before his death made provision for founding a chair of mathematics at Marischal College. His death took place on December 17, 1613, and a memorial to him was placed in St. Nicolas Church. It was about forty years after Liddel's death that James Gregory became a student at Marischal College, and it was at Aberdeen he published his treatise on optics and invented the Gregorian form of reflecting telescope. He further increased his reputation by his visits to London and to Padua, and on June 11, 1663, was elected a Fellow of the Royal Society. Soon after this he was made professor of mathematics at St. Andrews, and in 1674 he was elected the first exclusively mathematical professor in the University of Edinburgh. His inaugural address was delivered in November 1674. Eleven months later, while showing his students the satellites of Jupiter, he was struck blind and died three days later at the age of thirty-six. He had, however, already done enough to give him a place among the immortals, and in 1938 both St. Andrews and Edinburgh joined in commemorating the tercentenary of his birth.

But James Gregory was only one of a remarkable family of men of science, members of which for two hundred years held professorships in one or other of the Scottish universities. They were the Bernoullis of Scotland. The founder of the family was David Gregory, minister of Drumoak, near Aberdeen, and from his two sons David (1627–1720) and James (1638–75) the dynasty descended. Science seems to have been in their blood, and one of them belonging to the sixth generation, Duncan Farquharson Gregory (1813–44), a Cambridge wrangler and the first editor of the *Cambridge Mathematical Journal*, appears to have been cast in the very same mould as his famous ancestor James. Omitting much that is of interest, a word or two should be said about the third David Gregory (1661–1708), one in a family of thirty-two children, because in 1683 he was elected to the chair previously held by his uncle; secondly, because he was the first in Edinburgh to teach the Newtonian philosophy; and thirdly, because he was the first Scottish mathematician to occupy a chair in an English university, being appointed in 1691 Savilian professor of astronomy at Oxford. That his influence was felt far outside Edinburgh is shown by Whiston, who in his memoirs said that in his own study of the "Principia" he was "greatly excited thereto by a paper of Dr. Gregory's when he was professor in Scotland wherein he had given the most prodigious commendations to that work, as not only right in all things, but in a manner the effect of a plainly divine genius, and had already caused several of his scholars to keep acts, as we call them, upon several branches of the Newtonian philosophy; while we at Cambridge, poor wretches, were ignominiously studying the fictitious hypotheses of the Cartesian, which Sir Isaac Newton had also himself done formerly . . .". Among Gregory's students who had "kept the acts" was John Keill (1671–1721), who accompanied his instructor to Oxford, opened at Hart Hall the first course of lectures in the new philosophy given in the University, and afterwards was given the Savilian chair of astronomy. In a previous article, mention has been made of David Gregory's monument at Maidenhead. His successor's tomb is in St. Mary's Church, Oxford.

The progress of scientific studies in Scotland in the seventeenth and eighteenth centuries and the outlook of her men of science were affected by many causes. With the union of the Crowns of England and Scotland in 1603 and the union of their Parliaments a century later, together with the diminution and disappearance of internal strife in both countries, came a loosening of the bonds between Scotland and France, and an increase in the intercourse between north and south of Britain with advantage to both. With London as the capital of the united kingdoms, it was only natural for the more adventurous to seek their fortunes in it, and from the early eighteenth century onwards Scottish men of science are found in ever increasing numbers taking their place in the scientific institutions of the capital. The very first president of the Royal Society was the Scotsman Sir Robert Moray, and among his successors in the eighteenth century were the Earl of Morton and Sir John Pringle. Pringle, like Moray, Watt, Telford, John Hunter, Baillie, Simpson, Lyell, Kelvin and Ramsay, is among the Scottish men of science buried or commemorated in Westminster Abbey.

It is generally admitted that in the eighteenth century the study of mathematics made little progress in England. It was much the same in Scotland, although in Colin Maclaurin (1698–1746) Scotland had one of the first mathematicians of the day, and his death in the Archbishop of York's Palace through illness brought on by his exertions in organizing the defences of Edinburgh against the Jacobites in 1745 was a very great loss. Maclaurin was much interested in astronomy, and had encouraged his pupil James Short (1710–68), the famous London telescope maker; but on the whole astronomy attracted few Scottish students. There was, however, much greater activity in the realms of chemistry and physics, which, like botany, were regarded as the handmaids of medicine, and were studied as such and not as separate sciences to be pursued for their own worth. Almost without exception, teachers in the Scottish universities possessed a medical degree, and it was as a great centre of medical education that Edinburgh became famous. On this matter there are many interesting notes in a paper by Mr. J. N. J. Hartley, entitled "The Early History of the Museum of the Royal College of Surgeons of Edinburgh", and published in the *Edinburgh Medical Journal* of 1948.

Mr. Hartley is the conservator of the museum housed in Surgeons' Hall, and in the course of his remarks he gives particulars of some of the many teachers and schools of medicine and anatomy, referring especially to the first Alexander Monro (1697–1767) or Alexander Monro "*Primus*", who was appointed in 1720 by the Town Council to be the first professor of anatomy in the University. Of this distinguished man, Sir Alexander Grant wrote: "he was not only the Father of the Edinburgh Medical School, but also the first professor of any kind who drew great attention to the University of Edinburgh from without and gave it the beginnings of its celebrity".

It was while Monro was thus adding to the reputation of Edinburgh that the University of Glasgow became almost as famous, partly through the work of William Cullen (1710–90) and Joseph Black (1728–99). A biography of Black was the last book written by Sir William Ramsay. In it is an illustration of the old College in the High Street, in which Black lived and worked, and reproductions of Kay's portraits of Cullen, Black, Adam Smith and James Hutton. Cullen was the first to teach chemistry at Glasgow as a separate subject, he was the first to lecture in the vernacular instead of Latin, and in 1755 at Glasgow he published his fruitful essay on "Cold produced by Evaporating Fluids". From 1746 onward the careers of Cullen and Black were linked together, for Black was Cullen's pupil and his successor in the chair of chemistry at Glasgow in 1756, and again in the chair of chemistry at Edinburgh ten years later.

Though Black lived to the age of seventy-one and came to be regarded as the Nestor of British chemists, his two great discoveries of the nature of 'fixed air' and the doctrine of latent heat were made while he was a young professor at Glasgow. Among other men of science associated with Glasgow in the eighteenth century were Dr. Robert Simson (1687–1768), professor of mathematics for nearly fifty years, whose "Elements of Euclid" formed the basis of numerous editions; John Anderson (1726–96), the somewhat litigious professor of natural philosophy, who sent a gun to Paris as evidence of his sympathy with the French Revolutionaries, and who by his will founded the famous Andersonian Institution, now incorporated in the Royal Technical College, Glasgow; Alexander Wilson (1714–86), who while engaged in typefounding became Glasgow's first professor of astronomy; Thomas Melvill (1726–53), the young divinity student who with Wilson recorded the temperature of the upper air by means of kites, and was the first to use a prism for examining the effect of introducing salts into the flame of burning spirits; John Robison (1739–1805), the close friend of Watt, who during 1774–1805 was professor of natural philosophy at Edinburgh; and William Irvine (1743–87), who held the chair of chemistry at Glasgow during 1770–87. In the story of Scotland's heritage of science, all these Glasgow worthies hold an honourable place.

Black's removal to Edinburgh occurred at a time when, in the words of Sir Archibald Geikie, "the Scottish capital had not yet begun seriously to suffer from the centripetal attractions of London. It was the social centre of Scotland, and retained within its walls most of the culture and intellect of that ancient kingdom." At Edinburgh, Black not only found his old master Cullen but also the philosopher Adam Ferguson (1723–1816), then professor of "pneumatics and moral philosophy", and Matthew Stewart (1717–85), the professor of mathematics. To Edinburgh in 1768 came the farmer–manufacturer–naturalist James Hutton (1726–97), to devote himself to scientific pursuits and to gain for himself a place among the giants of the heroic age of geology. These famous men were afterwards joined by John Playfair (1748–1819), preacher, writer, geologist and natural philosopher, who introduced the works of the French mathematicians into Scotland; Daniel Rutherford (1749–1819), the professor of botany who discovered nitrogen; and the wealthy landowner Sir James Hall, Bart. (1761–1832), of Dunglass, like Playfair an enthusiastic supporter of Hutton's views and himself the founder of experimental geology. In the whole range of science there were no more admirable characters than Hutton and Playfair. Of Hutton, Geikie wrote: "His character was distinguished by its transparent simplicity, its frank openness, its absence of all that was little or selfish, and its overflowing enthusiasm and vivacity"; while Dugald Stewart in his sketch of Playfair wrote: "Independently, in short, of his high attainments, Mr. Playfair was one of the most amiable and estimable of men: delightful in his manners, inflexible in his principles and generous in his affections, he had all that could charm in society or attach in private".

In Edinburgh in the eighteenth century, as elsewhere, there were clubs and convivial gatherings of writers, artists, lawyers and others, and it was from one of these, the Philosophical Club, formed in 1739, that sprang the Royal Society of Edinburgh, inaugurated in 1782, with John Robison as one of its secretaries. A few years before this, in 1776, Edinburgh had seen the laying of the foundation stone of the observatory on Calton Hill, which has in turn belonged to the City and to the Government and again to the City. It has seen many ups and downs, has often suffered from neglect—even as a Royal observatory—but after being reconditioned was taken over by the Astronomical Society of Edinburgh in 1938 and in October of that year was formally reopened by the late Sir James Jeans. Under the inspiring directorship of Mr. N. S. Matthew, it is now widely used for educational purposes.

Edinburgh's first official astronomer appears to have been the naval surgeon Dr. Robert Blair, who in 1783 was appointed professor of practical astronomy. His appointment came about in a very unusual manner. In 1782 Blair was serving in the West Indies in H.M.S. *Resolution*, in which on January 23, 1782, Captain Lord Robert Manners died of wounds received some months before. Now Manners was a son of the famous Marquess of Granby who had fought at Culloden, and a brother of Charles Manners, fourth Duke of Rutland, who was well known in government circles. Blair's devotion to his captain becoming known, the family, wrote Dr. John Doran in his "Memories of our Great Towns", "With generous alacrity importuned the Government to do something for him, and at their solicitation the Crown actually founded for Blair a Professorship of Practical Astronomy in the University of Edinburgh! The naval surgeon and physician had seen enough of the stars to know Orion's belt from Charles' Wain; but had he been ignorant of both it would not have much mattered, as the Astronomical Professorship was a sort of nominal office, without any charge. But if Dr. Blair was not a practical astronomer he was an experimental philosopher of great repute and his experiments and observations on the refrangibility of light excited considerable interest in his own day. . . ." Blair continued to hold his office until his death on December 22, 1829, at Westlock, Berwickshire. For a few years after this, the chair of astronomy remained vacant, but in 1834, shortly after his return home from South Africa, Thomas Henderson (1798–1844), the advocate's clerk who had risen to be the Astronomer Royal at the Cape, was appointed to it, and about the same time was given charge of the Calton Hill Observatory and made Scotland's first Astronomer Royal. Henderson's immediate successor was Charles Piazzi Smith (1819–1900), who was born at Naples and had the Italian astronomer Giuseppe Piazzi as his godfather, and he in turn was followed by Ralph Copeland (1837–1905), who superintended the building and equipment of the new Royal Observatory at Blackford Hill, made possible by the generosity of the Earl of Crawford.

Of greater importance to learning in Edinburgh than the erection of the Calton Hill Observatory was the building of the "New College of Edinburgh", the foundation stone of which was laid in the fateful year 1789. Unlike those of Glasgow, St. Andrews and Aberdeen, the University of Edinburgh owed nothing to bishops and popes, for its original college was opened by the Town Council and given university status by James VI, afterwards James I of England. Its constitution differed from those of the other universities, and in many matters, even in the appointment of professors, the Town Council held the control. This lasted until the University gained its independence by statute in 1858. The new College was not erected before it was needed, for its principal, the historian William Robertson, had written in 1768 that "a stranger when conducted to view the University of Edinburgh might, on seeing such courts and buildings, naturally enough imagine them to be almshouses for the reception of the poor . . ." ; while twenty years later, a writer in the *Scots Magazine* said that "the buildings of the University are in the same ruinous condition that they were in 1768 and the most celebrated University at present in Europe is the worst accommodated".

With the completion of the new College fresh faces appeared among the staff, and the lecture rooms became even more crowded. Black's death in 1799 had left open the way for his deputy, the botanical professor's son, Thomas Charles Hope (1766–1844), who had held the chair of chemistry at Glasgow and had learnt something of the new chemistry direct from the lips of Lavoisier and Berthollet. For forty-three years he lectured and experimented, and it is recorded that at one time his students numbered 575, while the total number who had listened to him was something like 16,800. There was nothing like this in the English universities. His famous colleague, John Leslie (1766–1832), who was born in the same year as Hope, had abandoned a career in the Church for science, had travelled on the Continent and in the United States and had become known for his experiments in radiation before succeeding Playfair in 1805 in the chair of mathematics, which he exchanged for that of natural philosophy in 1819. His first appointment, owing to something he had said about cause and effect, led to an unfortunate controversy, in the course of which Sir Joseph Banks, the president of the Royal Society, wrote to Leslie sympathising with him and adding : "Surely a man may fulfil his duty to his Creator without assenting unconditionally to every undigested tenet which our half-informed predecessors have left behind as a legacy to their more enlightened posterity. If it has pleased God to permit his creatures to increase in wisdom He will not condemn them for assenting to new opinions which their reason demonstrates to be just." Leslie was knighted at about the same time as Brewster, John Herschel and Charles Bell, and died on November 3, 1832. It was some time before the youthful James David Forbes (1809–68) was appointed to succeed him, and for a few months the natural philosophy lectures were given by John Scott Russell (1808–82), afterwards a famous naval architect. Another of the new professors was William Wallace (1768–1843), who held the chair of mathematics from 1819 until his retirement in 1838, when the Town Council paid Cambridge a compliment by choosing as his successor the Rev. Philip Kelland (1808–79), a Somerset curate's son who had been senior wrangler and first Smith's prizeman. Kelland proved unequalled as a teacher, and he died while president of the Royal Society of Edinburgh.

In such a sketch as this it would be only proper to include a mention of some of the famous Scottish inventors and engineers of the time, such as Watt, Telford and Rennie ; William Murdoch, Sir William Fairbairn and James Nasmyth ; Henry Bell and William Symington, the pioneers of the steam boat ; the Napier family of marine engineers and the Stevenson family of lighthouse builders, but space does not permit more. In view, however, of the approaching meeting of the British Association in Edinburgh, it is only appropriate to conclude by recalling the part played by Scottish men of science in its formation.

The story of the British Association was told in its official history published in 1921 ; but many more details are to be gleaned from such works as the "Home Life of Sir David Brewster" (1869), "The Life and Letters of James David Forbes" (1873) and other memoirs. It was Brewster and Forbes together with John Robison (1778–1843), the wealthy son of the natural philosopher, and the soldier-administrator-astronomer Sir Thomas Makdougall Brisbane, Bart. (1773–1860), who were prominent in founding the Association ; and they were among the Scottish contingent who, with their English and Irish supporters in September 1831, by coach or chaise, on horseback or foot, converged on York for the inaugural and epoch-making gathering. At York the founders received a warm welcome from the Yorkshire Philosophical Society, finding in the keeper of its Museum, John Phillips (1800–74), a most willing secretary ; in the Rev. William Vernon Harcourt (1789–1871) a far-sighted vice-president, and in his father, the Archbishop of York, a graceful host. From the Archbishop's Palace at Bishopthorpe, at one in the morning of September 30, after a lecture by Scoresby on magnetism, Brewster wrote that "the assemblage of beauty, fashion, and philosophy was really splendid . . .", while "the Archbishop has invited fifty or sixty of the philosophers to dine here to-morrow, among whom are Sir T. Brisbane, Thos. Allan and the rest of our Scotch party. . .".

In 1832 the newly formed Association met at Oxford and in 1833 at Cambridge ; and then, largely through Forbes, at Edinburgh with Sir Thomas Brisbane as president and Robison as local secretary. Some supporters had suggested Dublin, but Forbes would have none of this and wrote to Brisbane in 1833 : "It appears to me that it is little short of the duty of the Royal Society [of Edinburgh] to convey to the meeting of the British Association an invitation to make Edinburgh the place of their next meeting. . . . It has always been considered that the origin of the Society was in a great measure Scottish, and Sir D. Brewster, Mr. Robison and yourself have always been looked upon as its founders. . . ." A copy of this letter he sent to Sir Roderick Murchison, saying: 'My dear friend, you are a Scotsman, and though a deserter, you should not quite desert what is due to your country. Only look back and remember what Scotland did for the Association. . . ." Forbes had his way. The meeting was successful and he had the pleasure of entertaining Whewell, Peacock and Vernon Harcourt, of the last-named of whom he wrote, "I learn every year to look with more admiration and affection on that remarkable man". Brisbane, whose name is perpetuated by the capital of Queensland, it may be added, died at his birthplace, Brisbane House, Largs, at the age of eighty-six, and Brewster died at the same age at Allerly, Melrose, but Forbes died at Clifton at the age of fifty-nine. Forbes's grave is in the Dean Cemetery, Edinburgh, and that of Brewster in the grounds of Melrose Abbey.

RESEARCH IN OCEANOGRAPHY

THE sea, covering as its does three-quarters of the surface of the earth, presents unnumbered problems to whet intellectual curiosity and adventure, while economic and utilitarian motives for its scientific study are also pressing. Marine biology has always been actively pursued; in earlier days largely by amateurs and latterly by professionals at a number of well-equipped and well-staffed marine laboratories. Since zoology cannot be studied without regard for marine species, the universities of Britain have always fostered and, no doubt, always will foster, marine research on a considerable scale. Fewer botanists have found such interest in the plants of the sea. Economic stimulus has stimulated investigation of the shore seaweeds, and a research association now exists for this purpose alone.

Fundamental marine zoology has found its economic counterpart in fisheries research undertaken by the Laboratories at Lowestoft and Aberdeen, both full of vigour and ideas. These laboratories have had to study not only fish but also the food of fish and the waters which nourish and transport it. Study of the invertebrate fauna of the sea and the sea bed is in a healthy state; so is the physical and chemical study of the waters which fill the shallow seas frequented by fishing vessels. A re-deployment of effort is in progress; more hands would provide quicker results, but, in relation to the scientific man-power of the country, the staff available, especially in quality, is reasonable.

The Antarctic has become one of the best known of the major oceans by the tireless work of the Discovery Committee and its ships and staff, the contributions of which both to marine biology and to physical oceanography have been great. None the less, the motive for all their work has been economic —to provide a scientific foundation for the whaling industry. There have been huge fields of physical investigation which were neither proper for their study nor could they be undertaken with their limited staff. The entire expenses of the Discovery Committee have been met by the Government of the Falkland Islands from a cess levied on all whales processed in the Falklands or their territorial waters. Great Britain's contribution has been a negative one—revenue derived by taxation of the staff who live here.

Investigations to secure safer navigation hav always been and remain the concern of the Hydro grapher of the Navy. There was a time when th British Hydrographic Office unaided charted the sea of all the world. To-day the Admiralty's fleet o survey ships forms only a part of the survey fleet o the world, but the quality of its work ranks as hig as ever. Tidal investigations flourish both at th Admiralty and at the Liverpool Tidal Institute, th annual report* of which has just been published.

Theoretical investigations of much importance especially in hydrodynamics, have been made by few gifted free-lances in the universities, but physica oceanography has been ill organized. Apart fro nuclear physics, oceanography is probably the mos expensive of all scientific techniques, so that ther has been little opportunity for experimental physica investigation or for deep-sea research. Submarin geology and geophysics are in the hands of a fe men at a single university, who have had to borro ships when needed as best they could.

At a meeting of the Scientific Advisory Committe of the War Cabinet in January 1944, Vice-Admira Sir John Edgell, then Hydrographer of the Navy expressed the view that Great Britain, in its con tribution to research in oceanography, had falle seriously behind other countries, and suggested tha a British oceanographical institute should be set u without delay. Inquiry showed that there was considerable body of opinion in favour of concentrating the efforts upon physical studies, which ha been neglected as compared with marine biologica research. However, the Scientific Advisory Committee considered that the work of the propose institute should embrace both physical and biologica oceanography. In July 1946, the Colonial Offic raised the question of the future of the Discover Investigations. This matter was considered b various government departments interested and b the Advisory Council on Scientific Policy in conjunction with the earlier proposals, and as a resul the National Oceanographic Council and the Nationa Institute of Oceanography came into being (se *Nature*, March 17, p. 415). The steps leading to th formation of the Institute are indicated in its firs annual report†.

The National Institute, with Dr. G. E. R. Deaco as first director, has taken over the Oceanographi Group of the Royal Naval Scientific Service at th Admiralty Research Laboratory at Teddington, an also the Discovery Investigations, which had cease to be the responsibility of the Falkland Islan Dependencies on March 31, 1949; the Institute i also gradually taking over part of the work of th Oceanographical Branch of the Hydrographer of th Navy. The R.R.S. *Discovery II* and R.R.S. *Willia* *Scoresby* were purchased by the Admiralty from th Government of the Falkland Islands Dependenci and presented to the Institute. The shore work o the Institute remains dispersed among five establishments in the London area and one in Cornwall. Th very desirable concentration under the director i one place remains to be achieved.

Both the research vessels were under requisitio during the War, and their equipment in store wa destroyed by enemy action. Both ships have neede extensive refitting and re-equipment before resuming the Discovery Committee's programme in the southern hemisphere. R.R.S. *William Scoresby* was first to sea in January 1950 and proceeded to survey the Benguela Current off the coast of south-west Africa. It can be seen already that much information of first importance on the physics and chemistry of the current and on its faunistic content was obtained, and that the resources of the Institute will be strained to evaluate and publish the results in reasonable time. This ship also carried out fishing experiments in South African waters, some whale-marking and a considerable amount of work on the Agulhas Current before returning to England last autumn.

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* Liverpool Observatory and Tidal Institute: Annual Report 1950. Pp. 16.

† Annual Report of the National Institute of Oceanography 1949-50. Pp. 48. (Cambridge: At the University Press, 1951.) 5s. net.

The larger R.R.S. *Discovery II* put to sea in May 1950 and proceeded to the southern hemisphere to undertake investigations on the lines of those between the Wars, but at seasons and in parts of Antarctic and Australasian waters previously least investigated. There was also a considerable number of other programmes for investigation. She is still at sea, but it is clear already that she will return prepared to add much to knowledge. The sea programme of the Discovery Committee will then have been completed. The working up of the vast faunistic collections must continue for many years. Similarly, the complete evaluation of the chemical and physical observations by the two ships at about four thousand stations during twenty years will require much effort.

The work on waves, swell, microseisms and currents initiated at the Admiralty Research Laboratory is being continued by the Institute. Although the main object of the wave research is to obtain quantitative information about the factors which influence the generation, propagation and decay of waves, such as will allow the wave conditions at any place to be predicted from wind charts and a knowledge of the local hydrography, the techniques which have been developed have immediate applications in places where meteorological information is not available. Such a possibility is being considered for Mauritius, where there is need of warning of the approach of a cyclone or heavy swell over the off-lying shoals used by local fishermen.

Modern oceanography demands larger ships, manned by officers and crew well versed in their specialized duties. The experience of the Discovery Committee, shared by the marine laboratories, is that it takes time to select and train such staffs and that it is a tragedy if key personnel have to be dispersed when a ship has to be laid up. But the larger ships have the capacity of collecting at a great rate. Even under the most favourable conditions, it will take a man ten weeks to work up observations which he can collect in one. Yet it would seem that the two vessels will have to be kept at sea and their collections and results appreciated, and the parallel laboratory investigations continued, by a staff of no more than sixteen scientific and six experimental officers. If these valuable, but expensive, ships are to be put to best use, a very considerable recruitment of staff would seem necessary.

In most fields of marine study the days of collecting for the sake of collecting are ended. The museums are stuffed with millions of specimens and station lists with hundreds of thousands of observations, woefully inadequate to give a true picture of the ocean it is true, but beyond the capacity of the systematists and physical oceanographers of Great Britain or, for that matter, of the world to work up. Support is more readily obtained for dispatching a spectacular expedition than for the quiet working up of the results afterwards or for their publication. An adequate theoretical background and due selection of problems for work at sea is now possible and can lead to great economy. There is no doubt but that the National Institute of Oceanography under its present director will seek to achieve this.

Cost of publication everywhere presents a grave problem often met by the compression of papers to the point of incomprehensibility. In chemistry the high reproducibility of experimental results and standardization of techniques may make possible compression intelligible to the initiated, but not so in oceanography. In the sea the same situation never repeats itself and, the cost of getting observations being what it is, each one has to carry all the interpretation it can bear. The cost of the many necessary illustrations is now very high, and it seems less easy to get the relatively small funds for publication than for the prosecution of the actual research. May one hope that the Institute will be able to maintain the high standard of presentation of Discovery Reports ?

Great Britain should be grateful that the creation of the National Institute of Oceanography has been courageously tackled and that investigations are proceeding on a wide front. It should get good value for the annual grant of £115,000 which departments of the home Government and certain Dominion Governments are providing. L. H. N. Cooper

BRITISH INSTRUMENT INDUSTRIES' EXHIBITION

The Exhibition of the British Instrument Industries, which took place during July 4–14, in the National Hall, Olympia, London, owed its inception to a suggestion made by the Department of Scientific and Industrial Research. Some two years ago, the Department put forward the suggestion that it might be helpful and instructive to industry if an exhibition could be staged at which equipment, covering the entire range of industrial instrumentation, could be displayed and its use demonstrated. This suggestion was put before a meeting of interested trade associations who, while accepting the Department's recommendation, felt that the scope of the Exhibition should be extended to include the products of the whole field of British instrument manufacture, covering every variety of the use of instruments. This wider conception provided the background of the Exhibition which has recently concluded, and the successful achievement of these aims has been an event of unusual significance in the long history of instrument-making in Great Britain.

There has been a tendency for instrument interests to become sectionalized, according to the broad uses of various classes of instruments, and the five participating trade associations (British Electrical and Allied Manufacturers' Association ; British Industrial Measuring and Control Apparatus Manufacturers' Association ; British Lampblown Scientific Glassware Manufacturers' Association ; Drawing Office Material Manufacturers' and Dealers' Association ; and the Scientific Instrument Manufacturers Association of Great Britain, Ltd.) have emerged as representing groups of manufacturers of instruments having certain specific fields of use, although the last-named association, S.I.M.A., covers instrument manufacture of great diversity. One reason for the special significance of the Exhibition is to be found in the fact that it involved a major co-operative effort on the part of these Associations, and demonstrated that the common ground of instrument manufacture is of sufficient extent both to permit co-operative effort and to render it highly desirable. The Exhibition has, therefore, served an excellent internal purpose, since it may well have checked a tendency for the total effort of instrument manufacture in Great Britain to be hampered by excessive emphasis being placed on sectional differences. There has, in the past, existed some confusion among the users of instruments in regard to methods of approach to the industry, and it is to be hoped that the common effort which has now been made may lead to a more unified system of access.

The Exhibition was also significant in its comprehensiveness. Previously, there have been displayed at various industrial exhibitions instruments peculiarly relevant to particular industries: a rather wider display of instruments has been staged at the British Industries' Fair; and in the very noteworthy exhibitions of the Physical Society the emphasis has been on instruments of immediate scientific interest. This most recent Exhibition of instruments, however, has given, for the first time, a complete picture of instrument manufacture in Great Britain, and has provided an opportunity of assessing the extent to which the extremely diverse and widespread requirements for instruments are being met by the range of products of the instrument industries. The display of instruments at Olympia gives solid grounds for the belief that instrument makers in Great Britain are, in general terms, adequately fulfilling their tasks, and that the diversity of requirements for instruments is being matched by an equal diversity and a commendable ingenuity of production.

Of the Exhibition itself it should be said that it was admirably staged. It was, naturally, a specialist exhibition, and it was not to be expected that the Hall would be thronged with people; one of the most pleasing features of the Exhibition was the genuine interest in instruments and their use which characterized almost every visitor. The area devoted to the exhibits was of an extent which allowed ample gangway space, and the lack of fatigue usually associated with a tour of an exhibition was quite exceptional. The organizing authorities are to be congratulated both on the general lay-out of the Exhibition and on the achievement of a very marked impression that this was indeed a display of very special products.

The diversity of instrument types is such that it would be impossible, and would serve no useful purpose, to give in any detail an account of the actual instruments which were displayed. A conspectus of modern instruments, such as that provided at Olympia, does emphasize the manner in which the use of instruments has been extended and entirely changed in emphasis during the past generation or two. It is not so long ago that Lord Kelvin devised electrical instruments specifically for use in the application of science rather than in the pursuit of fundamental knowledge. To-day, the majority of electrical instruments are designed to meet the requirements of the great electrical industry, and the need for precise electrical measurements in so many industrial and civil activities. Many visitors to the Exhibition must have remembered the time when such principles as those of thermo-electricity and hydrodynamics were little known and little used outside the curricula of universities. The control of all industrial processes to-day is dependent upon the concrete application of these and other principles in the form of instrument devices. The provision of complicated scientific glassware was, at one time, only achieved through the skill of individual glass workers here and there, who served, almost entirely, individual laboratories. From the display at Olympia it is apparent that scientific glassware of the utmost intricacy can be obtained by routine ordering through the appropriate section of the industry. Much of the time of the research worker used to be taken up in improvisation and the devising of particular apparatus necessary to the prosecution of his investigations. To-day, instruments are available which will fulfil practically every research need, and the days of almost complete dependence upon the laboratory workshop are largely a memory. In an entirely different field, the set-square, ruler and dividers have been supplemented by a whole series of drawing-office devices, and both the preparation and reproduction of drawings and blueprints have been revolutionized. It is realized to-day that full productivity is dependent upon the provision of the tools most appropriate to each field of endeavour, and it is equally apparent that effective activities in science, whether they be in the acquisition of new knowledge or in the application of knowledge to utilitarian purposes, require that there shall be available the requisite and appropriate instrumental aids. The Exhibition at Olympia has demonstrated that the range of such aids emanating from British instrument industries is most satisfactory in its comprehensiveness.

It must be obvious to any observer with an intimate knowledge of industry that the proportion of effort covered by research and development in the production of scientific instruments is abnormally high. There is frequently heard a complaint that a particular type of instrument with certain peculiar features is not available from any British manufacturer, whereas it can be obtained from some other country. It is, of course, equally true that in other countries the complaint is made that particular types of instrument with peculiar characteristics can only be obtained from Great Britain. While, superficially, it might appear to be desirable that every conceivable instrument or device should be produced by the instrument makers in Great Britain, yet it should be remembered that instrument-making is no more free from economic considerations than is any other industrial undertaking. There is much to be said for the view that it would, in fact, be a retrograde step if the instrument makers of every country attempted to produce every variety of instrument which can possibly be required by the scientific workers of that country, irrespective of considerations of the total universal demand for any one type. It is apparent that the instrument industries of Great Britain have attempted to meet, as completely as possible, the general requirements for instruments. Too often the magnitude of the achievement of the instrument maker is minimized through a sense of irritation caused by an inability to obtain from any maker an instrument exactly suited to a small but specialist use. It is very doubtful whether an extensive range of instruments, such as has been shown at Olympia, could have been made available had the instrument industries not been compelled, by economic necessity, to maintain a sense of proportion in their manufacture.

NEWS and VIEWS

Plant Industry in Australia: Dr. O. H. Frankel

Dr. O. H. Frankel has been appointed chief of the Division of Plant Industry, Commonwealth Scientific and Industrial Research Organization, Canberra. Dr. Frankel has had wide experience in the botanical field and has made outstanding contributions as a geneticist. He has been on the staff of the Department of Scientific and Industrial Research, New Zealand, since 1929. He was appointed first as a geneticist at the Wheat Research Institute, and later became chief executive officer of the Institute; more recently, he has been director of the Crop Research Division of the Department. A British subject by naturalization, Dr. Frankel was born in Vienna in 1900. He holds the degrees of doctor of agriculture of the University of Berlin, and master of agricultural science and doctor of science of the University of New Zealand. Dr. Frankel and his co-workers at the Wheat Research Institute have succeeded in breeding wheats which are suited to the unfavourable New Zealand environment and yet which combine the desirable properties of high yield and high quality. Thus New Zealand farmers can now grow wheats suitable for high-quality bread-making, whereas previously their wheats produced only low-grade biscuit flour.

Technical Personnel Committee

In a written answer to a question in the House of Commons on July 26, Mr. Alfred Robens, Minister of Labour and National Service, said that it has been decided to reconstitute the Technical Personnel Committee, which, under the chairmanship of Lord Hankey, dealt with questions of scientific and technical man-power during the Second World War and during the immediate post-war period.

The terms of reference of the Committee are: (1) To consider, make recommendations and deal with questions relating to the home and overseas demand for the available supply of scientific and technical personnel of professional or approximately professional standards, including the making of recommendations on its economic use and the need for increasing the available supply. (2) In connexion with the overseas demand for such personnel: (*a*) to make recommendations upon appropriate steps to promote the recruitment from the United Kingdom of persons required to assist the economic development of under-developed countries; (*b*) to consider any special steps which are required to provide opportunities for training in the United Kingdom of persons from under-developed countries. The Committee will be empowered to invite representatives from other Government departments or outside interests to be present when matters of concern to them are being discussed.

The membership of the reconstituted Committee is as follows: Chairman, Lord Hankey; members nominated by the Federation of British Industries, Sir Arthur Fleming, Sir Wallace Akers, and Captain A. M. Holbein; representative of the Universities, Sir Edward Appleton; chairman of the University Grants Committee, Sir Arthur Trueman; deputy chairman of the Advisory Council on Scientific Policy (nominated by the Lord President), Prof. S. Zuckerman; one representative each of the Treasury, Foreign Office, Colonial Office, Board of Trade, Commonwealth Relations Office, Ministry of Labour, Ministry of Supply, and Lord President's Office. The secretary will be Mr. A. J. S. James, Ministry of Labour and National Service.

Productivity of British Land

A Sub-Committee of the Research Committee of the Rural Reconstruction Association has published a report on "The land which would be required to produce the food requirements of Great Britain and Northern Ireland on the basis of present yields of crops and livestock". The Committee has taken the consumption of food in 1946 as a year when the diet was adequate and of which accurate estimates exist. By taking each of the main items in the diet it worked back to the land which would be required for total production, which was found to be 49,553,000 acres of crops and grass, whereas the total actually available is only 35,530,000, plus some nine million acres of rough grazing. It is thus concluded that Britain could feed herself if the average annual yield of crops could be increased by about 40 per cent. Alternatively, the calculations show that the target of the Ministry of Agriculture of 55 per cent home production of essential foods is modest. The report has very interesting appendixes on land requirements for poultry, cattle and pigs. The Committee in its calculations suggests that a much greater proportion of the meat requirements should be obtained from pigs and that if five million acres of cropland were devoted to production of pig foods the number could be increased to about 16 million, providing nearly 60 per cent of the estimated meat consumption. The report is one which deserves careful study.

Scottish Hill Farm Research Committee: First Report

The first report of the Scottish Hill Farm Research Committee of the Scottish Advisory Council has now been published (pp. 134+16 plates; Edinburgh and London: H.M. Stationery Office, 1951; 3*s*. 6*d*. net). Set up in 1945, this Committee was appointed to advise on the development and co-ordination of research in relation to technical problems of hill farming in Scotland. Three research farms have been established, each affording facilities for different types of investigation. At Sourhope, Roxburghshire, the management of grass hills is the dominating question; at Glensaugh, Kincardineshire, wintering problems are under consideration; and at Lephinmore, Argyll, the co-ordination of hill farming with forestry is being studied. The work carried out during 1945–49 is reviewed in detail. Among the interesting questions investigated is the possibility of applying fertilizers to hill land by means of aeroplane. Preliminary trials indicate that satisfactory distribution of lime can be effected in this way, but that reduction in costs is essential before the method can become an economic proposition. Problems concerned with sheep naturally form a major part of the agricultural research work in Scotland, and co-ordination of field trials regarding sheep-dips has been attained and a survey made of the breeding systems used in hill flocks. Various diseases cause unnecessary loss, and the Committee emphasizes the need for extension of the veterinary service. Special attention has been paid to heather. A review of the literature on the subject is included in the report, and recommendations made as to profitable lines of work to be undertaken with regard to this valuable plant. A new Committee to continue in office for a three-year period was set up in 1949. Among other activities, its programme will include economic studies and detailed surveys of the districts in which the three experimental farms are situated.

Reviews of Pure and Applied Chemistry

The first issue of *Reviews of Pure and Applied Chemistry*, published by the Royal Australian Chemical Institute, Melbourne (quarterly, £1 5s. a year), will be welcomed by chemists in Australia, but should prove of interest to a much wider circle of readers. The facilities for the publication of original researches in Australia are now quite well served by many journals, and the decision of the Institute to start a review journal is very sound. According to the opening editorial, the aim is to provide "a journal in which general articles and critical reviews in all branches of chemistry could be published". The contents of the first issue include a discussion of the mechanism of chemical change by Prof. F. G. Soper and an article dealing with the impact of chemistry on biology and medicine by Prof. A. R. Todd; the chemical engineering problems in the generation of nuclear power are outlined by Prof. J. P. Baxter, while Dr. K. L. Sutherland has reviewed the change of surface tension with time. Clearly the aims of this journal are different from those of either *Chemical Reviews* or *Quarterly Reviews*, since, if the first number reflects future policy, articles as well as detailed reviews receive equal prominence. Undoubtedly the more general articles, as well as the detailed reviews, will be welcomed by the members of the Institute, who vary from the pure research worker to the wholly administrative chemist. However, it should be appreciated that some articles are by no means as comprehensive or as detailed as those to be found in the two review journals quoted above. The editor rightly rejects any purely nationalistic objective in the inauguration of this journal; nevertheless, it is to be hoped that readers throughout the world will be able to look to it for periodical reviews of work in those branches of chemistry in which certain Australian schools are most active. The printing is good, and the diagrams are well reproduced. Within the limits which have been laid down, *Reviews of Pure and Applied Chemistry* has made a good start.

Bulletin of the Research Council of Israel

The *Bulletin of the Research Council of Israel*, the first number of which has recently been published (1, Nos. 1–2; pp. 168; March 1, 1951; Jerusalem; annual subscription (4 issues) £I 2; single copy 500 prutot, double number 750 prutot), is intended primarily to facilitate the publication of scientific papers dealing with problems of regional importance but of wider interest. In addition, preliminary communications on both fundamental and applied research will be accepted in the form of letters to the editor, and the present issue contains forty-one such letters. The nine papers included deal with such varied subjects as the geomorphogeny of Israel; long-range forecasts of rainfall; the formation of 'salt tables' in natural and artificial solar pans; the iodine number estimation of bitumen; the vegetation of the Kurkar Hills; egg-development and diapause in the Moroccan locust; estimation of the incidence and destructiveness of plant diseases (terminology and outline of the technique of visual appraisal); fractionation of whey proteins as a means of grading milk powders and detecting adulteration of fresh milk with milk powder; and investigations on *d*-limonene, a by-product of the citrus industry. It is intended in future to publish four numbers annually.

Bibliography of French Mathematics and Astronomy during 1940–48

The December 1950 issue (No. 6) of the *French Bibliographical Digest* (pp. 109; New York: Cultural Division of the French Embassy, 1950) lists the most significant books on mathematics and astronomy published in France during 1940–48, together with some works published in French by Belgian and Swiss men of science. Only works of at least university level are included; but special courses on higher mathematics given at French universities and college text-books of special interest are regarded as meeting this requirement. Some reviews which have been taken, with acknowledgment, from *Mathematical Reviews*, *Revue Générale des Sciences*, *Revue Scientifique* and the *Bulletin Critique du Livre Français* are included, and the books are listed alphabetically by authors' names in classified sections under mathematics and under astronomy. Prof. Arnaud Denjoy contributes an appreciation of French mathematics during the Second World War, and besides an index of authors and collective works there is a list of French periodicals dealing with these fields of science and a directory of publishers.

Bengal Immunity Research Institute, Calcutta

A pamphlet has been published by the Bengal Immunity Research Institute, Calcutta, on the occasion of its third anniversary on November 26, 1950, describing the origins and organization of the Institute. Research in medicine, chemistry, biochemistry, biology, physiology, bacteriology, therapeutics, materia medica, pharmacy and other subjects which bear upon the prevention, alleviation and cure of human diseases and disorders, is carried out. The Institute also seeks to develop new medicaments, to improve existing processes and products; it collaborates in the investigations on drugs at the Bengal Immunity Therapeutic Ward; and it organizes lectures and demonstrations. The research programme is scrutinized by a scientific advisory board. The number and character of the departments of the Institute are elastic: departments of bacteriology, biochemistry, chemistry and pharmaceutical chemistry and of pharmacology have been established, as well as a museum to accommodate specimens of Indian medicinal plants and their active principles, and a library containing more than six thousand volumes. The Institute has already published nearly five hundred papers.

Safety in the Laboratory

A manual on safety in the laboratory prepared by the Dunlop Rubber Co., Ltd., primarily for the guidance of its own technical staff, contains some excellent advice and information which will be found useful by all laboratory workers. It emphasizes that safety is largely a matter of exercising forethought and reasonable care. General safety policy, fire and first aid, and a safety code for laboratory practice are the headings of the three sections into which the manual is divided. An appendix deals with electrical procedure in laboratories. The safety code lists the various items and the appropriate precautions to be taken, as, for example, "Cathode ray tubes—wear eye-shields when handling cathode ray tubes in case of implosion", in alphabetical order. Messrs. Dunlop are to be congratulated on the way in which they have tackled the vital problem of safety in the laboratory and for making such excellent provision against laboratory and technical hazards.

Northampton Polytechnic

Dr. P. F. Soper, head of the Electrical Engineering Department of the Nottingham and District Technical College, has been appointed head of the Electrical Engineering Department of the Northampton Polytechnic, St. John Street, London, in succession to Dr. J. S. Tait, who has been appointed principal of the Woolwich Polytechnic. Mr. K. J. Hume, at present metrology superintendent of the De Havilland Engine Co., Ltd., has been appointed head of the National College of Horology and Instrument Technology (which is housed in the Northampton Polytechnic) in succession to Mr. R. A. Fell, who is returning to industry.

Medical Research Council : Travelling Awards

The Medical Research Council has made the following travelling awards for the academic year 1951–52 : Rockefeller Travelling Fellowships in Medicine : Mr. W. Burnett, surgical registrar, Professorial Unit, Aberdeen Royal Infirmary ; Dr. O. Garrod, outpatient registrar and medical tutor, Postgraduate Medical School of London ; Dr. J. N. Hunt, senior lecturer in physiology, Guy's Hospital Medical School, London ; Dr. G. C. Kennedy, temporary member of staff, National Institute for Medical Research, London ; Dr. B. P. Marmion, senior bacteriologist, Public Health Laboratory Service (at the Virus Reference Laboratory, Colindale) ; Mr. J. H. Peacock, lecturer in surgery, University of Bristol ; Dr. S. W. Stanbury, Junior Beit Memorial Research Fellow, Department of Medicine, University of Manchester ; Dr. E. M. Vaughan Williams, Schorstein Research Fellow in medical science, Department of Pharmacology, University of Oxford. Dorothy Temple Cross Research Travelling Fellowships in Tuberculosis : Mr. R. W. Baldwin, research assistant, Chemistry Department, University of Birmingham ; Dr. G. J. Cunningham, senior lecturer in morbid anatomy and histology, St. Bartholomew's Hospital Medical College, London. Travelling Scholarships in Medical Science (tenable in France under an exchange scheme with the Centre National de la Recherche Scientifique) : Mr. S. V. Boyden, Wellcome Fellow of the Animal Health Trust, Department of Animal Pathology, University of Cambridge ; Dr. J. L. Gowans, Medical Research Council research student, Sir William Dunn School of Pathology, University of Oxford.

Colonial Service : Recent Appointments

The following appointments in the Colonial Service have recently been announced : G. W. Lines (deputy director of agriculture, Sierra Leone), director of agriculture, Sierra Leone ; E. H. Probyn (assistant conservator of forests, Cyprus), senior assistant conservator of forests, Cyprus ; J. S. Smith (senior assistant conservator of forests, Cyprus), conservator of forests, Federation of Malaya ; J. H. Keast (senior surveyor, Nigeria), assistant director of survey, Nigeria ; R. N. Lissett (senior surveyor, Tanganyika), senior surveyor, Uganda ; T. W. Wignall (senior surveyor, Gold Coast), surveyor general, North Borneo ; J. S. Dunbar (draughtsman, Geological Survey Department, Tanganyika), chief draughtsman, Geological Survey Division, Tanganyika ; Miss L. M. Horne (woman nutrition officer, Trinidad), woman nutrition officer, Windward Islands ; M. J. Jacovides (forest assistant, Cyprus), assistant conservator of forests, Cyprus ; S. D. Watson (draughtsman, Lands and Mines Department, Tanganyika), chief draughtsman, Surveys and Town Planning Department, Tanganyika ; J. Heathcote, education officer (science), Kenya ; J. F. Cowie, veterinary officer, Uganda ; R. G. Erskine, veterinary officer, Nigeria ; G. A. Currie, statistician, East Africa High Commission ; W. J. England, principal, Egerton School of Agriculture, Kenya ; S. A. Granville, statistician, Statistics Department, East Africa High Commission ; A. M. Hobdey, temporary agricultural survey officer (cocoa), Gold Coast ; R. R. Philp, soil survey officer (temporary), Gold Coast ; P. D. Proud, fisheries officer, Aden ; S. A. Radwanski, soil survey officer (temporary), Gold Coast ; W. Rides, temporary agricultural survey officer (cocoa), Nigeria.

Announcements

The honorary degree of D.Sc. of the University of Oxford has been conferred on Dr. G. G. Simpson, of the American Museum of Natural History, New York.

The Royal College of Physicians has awarded the Weber–Parkes Prize to Dr. P. M. D'Arcy Hart, for his contributions to the epidemiology and prevention of tuberculosis ; and the Baly Medal to Prof. G. de Hevesy for his work on radioactive indicators and their application in biochemistry, animal physiology and pathology.

The Committee representing the Royal Society and the University of Sheffield has appointed Dr. B. A. Bilby as Sorby Research Fellow from October 1, to work in the Metallurgy Department of the University of Sheffield on martensitic transformation and deformation twinning in crystals. The Committee representing the Royal Society and the Armourers and Brasiers' Company has appointed Dr. A. J. Kennedy as Armourers and Brasiers' Company Research Fellow from October 1, to work at the Royal Institution of Great Britain on transient creep in polycrystalline metals.

The Royal Society has arranged a 'Sir Isaac Newton' Exhibition on the occasion of the Festival of Britain. The Exhibition will be held during August 13–31 from 11 a.m. to 4 p.m. (except on Saturdays and Sundays) in the Society's rooms, Burlington House, London, W.1. Admission will be free.

The Parsons Memorial Lecture for 1951 will be entitled "Sir Charles Parsons and Optical Engineering", and will be given by Mr. F. Twyman, in the Science Museum Lecture Theatre, on October 25, under the auspices of the Physical Society.

A conference on "The Chemistry and Physiology of the Nucleus" will be held at Brookhaven National Laboratory during August 15–17. This conference, which is being organized and sponsored by the Biology Department of the Laboratory, will include eighteen speakers and five demonstrations. It is hoped to publish invited papers. Inquiries should be addressed to the Biology Department, Brookhaven National Laboratory, Upton, L.I., New York.

THIRD WORLD PETROLEUM CONGRESS

WITH nearly three hundred papers from leading petroleum technologists in every oil-producing or oil-refining country, the Third World Petroleum Congress which met in The Hague during May 28–June 6 covered the whole range of the sciences concerned with the petroleum industry—geology, geophysics, engineering in all its branches and chemistry, as well as statistics, documentation and economics.

At least sixty sessions were held and all were well attended. In general, discussion was lively and to the point, being restricted only by the time factor, which was somewhat limited by the time taken to read in two languages the instructions regarding discussion.

Geology and Geophysics. In the session on the origin and migration of oil, when papers were presented by Margaretha Brongersma-Sanders (University of Leyden), by I. A. Breger and W. L. Whitehead (Massachusetts Institute of Technology), and by C. E. ZoBell (Scripps Institute of Oceanography), the consensus of opinion was that there is need for generally accepted definitions and methods of analysis of organic matter occurring in geological formations. This is particularly true for crude oils in relation to migration and classification studies, but also applies to maltha, asphalt, asphaltic, pyrobitumen, etc. The setting up of a committee to study these matters was recommended, and it was suggested that it should consist of Prof. V. C. Illing (United Kingdom), M. Louis (France), G. R. Schultze (Germany), H. M. Smith (United States), and K. van Nes (The Netherlands). It was also resolved that the Permanent Council of the World Petroleum Congress take the initiative in clarifying the terms relating to oil migration.

Several papers on palæontology and sedimentology were discussed in two sessions, an important contribution being that of T. F. Grimsdale, who proposed geological correlation on a world-wide scale. In comparing Venezuelan and Middle East rock sequences of the Tertiary, Mr. Grimsdale uses pelagic (open ocean) foraminifera. From this subsection of the geological section came two resolutions. The first, based on a paper by D. J. Doeglas, stressed the desirability of regional investigations into sedimentary deposits and environments, as proposed in Project 5 of the American Association of Petroleum Geologists; but such studies should not be limited to the Gulf Coast area. The second resolution recorded the opinion that world-wide correlations could be established in the Upper Cretaceous and in the Tertiary formations by means of the pelagic foraminifera.

Regional geology of oilfield areas was the subject of several papers, a session with four papers on the Middle East being concerned mainly with Persia. There were also sessions on Italy, with seven papers, and on Mexico.

In the subsection on geophysics, there were nine papers dealing with seismological, gravitational, and electrical methods.

Drilling and Production. In this section there were about fifty papers covering all aspects of this important branch of the industry. In the session on drilling technique, the papers were mainly devoted to mechanical processes associated with the drilling of oil wells. Two resolutions concerned the standard testing of casing centralizers, and a proposal that the American Petroleum Institute consider standard specifications for integral-joint casing.

Opening the session on drilling, completion and production technique, the chairman pointed out that the papers clearly showed how technique has advanced since the early days of the industry. For several of the papers a considerable mathematical background was necessary.

Discussion on the type of mud used in completing oil wells demonstrated that oil-well performance could be materially improved by choice of the proper drilling fluid. The general opinion was that oil-base muds are equal or superior to oil-in-water emulsion muds, or to normal clay–water muds for well completions, but that water alone is probably the best fluid as far as drilling speed is concerned.

The value of laboratory investigations for the development and improvement of drilling and production technique was evident in the discussion on several papers. Investigations into the properties of the cements used in deep wells were reported in a paper from the Institut Français du Pétrole, and it was recommended that blast furnace slag cements should be used for the purpose. Work on the effect of particle size on the physical properties of drilling mud makes it possible to predict the viscosity of a clay-base fluid for a given concentration of solids, provided particle-size distribution is known.

A new approach to the knowledge of the behaviour of crude oil emulsions was outlined in a paper on a universal size-frequency distribution law for emulsion particles. When water and oil are produced together, their separation causes difficulties in practice. A formula has been derived statistically for describing droplet size distribution and has proved its value also in other oil-industry operations.

The importance of additional recovery from oilfields was pointed out in several papers, and methods of secondary recovery were reviewed. There were also several reports of laboratory investigations. It was also stated that in Digboi notable increases in production-rates have been obtained by washing waxy wells with kerosine. The effect is to soften, rather than to dissolve, wax in and near the well.

Physical Refining Processes. In this section an interesting discussion on calculations in relation to distillation apparatus and information was given from the Polytechnic Institute of Brooklyn of a new laboratory apparatus for the determination of equilibrium flash curves of complex mixtures. This apparatus is a modified type of recirculating equilibrium still, is compact, of low initial cost, and is expected to provide an improved basis for calculations.

Chemical Refining Processes. The session on hydrogenation and hydrocarbon synthesis was attended by a large audience, and discussion centred mainly on the development of synthesis. It seems that vapour-phase processes are likely to receive competition from the liquid-phase processes now being developed. Although fluid-catalyst technique is largely applied in the vapour-phase processes, the fixed-bed process still received much attention. An improved large fixed-bed plant is shortly to come into operation in Germany.

The development in Germany of the one-stage process for destructive hydrogenation of crude oil to gasoline with new catalysts occupied most of the discussion as regards hydrogenation. Combined hydrogenation and catalytic or thermal cracking processes are likely to be used on a large scale in Germany.

In the session on catalytic reforming, an interesting paper was that by E. V. Murphree on a fluid hydroforming process, which is claimed to produce gasoline of improved octane rating. The fluid-process plant was said to cost 40 per cent less than fixed-bed units.

A paper on a new process for the polymerization of gaseous olefins to motor gasoline gave rise to interesting comparisons with the well-established solid phosphoric acid process.

The importance of sulphur removal and recovery from petroleum products was reflected in the five papers in the session on chemical treating processes. Methods for sulphur removal ranged from conventional soda sweetening of gasoline to hydrofining —selective hydrogenation of sulphur compounds. The latter process has attractive prospects.

Petroleum Chemicals. This section was concerned with the properties and the application of petroleum-based chemicals. Thus, in the detergent session, the five papers related to the extraordinary growth of petroleum detergents in the United States, where such materials now account for 55 per cent of the total American production of synthetic detergents. It was clear that the market outside the United States cannot be forecast from American developments, and it appeared that although the alkyl aryl sulphonates lead in the detergent field, alkyl sulphates, when prepared from petroleum, are likely to challenge their position. The influence on detergent properties of the hydrocarbon constitution was specially discussed.

In regard to biocides, it was stated that our knowledge of the chemical and physical compositions of mineral oils is still insufficient to guarantee that a certain oil would be suitable for agricultural use without previous field testing.

Composition of Petroleum. During the discussion of a group of papers on pure hydrocarbons, attention was directed to the fact that international exchange of data on these materials could be improved. It was therefore recommended that the extension of such exchange of research data should be explored. The discussion dealt mainly with the suitability of different criteria for determining hydrocarbon purity, and with the applicability of various physical constants for identifying and analysing hydrocarbons.

Properties of crude oils were considered from two aspects: first, the classification and evaluation of crude oils; and secondly, their commercial evaluation. It was considered that characterizing factors now used do not correlate with chemical composition but mainly summarize the physical properties. It would be convenient, although it did not appear possible, to combine the two aspects into one simple factor. It was concluded that knowledge of the chemical composition of crude oils necessitates a more complicated scheme of analysis, which would require more uniformity in methods of investigation in order to correlate results obtained all over the world.

Ten papers in this section were devoted to various aspects of the constitution of petroleum. The investigation of the complex mixtures of which petroleum fractions are composed has been simplified by modern methods of group analyses. In regard to determination of oil composition by spectrographic analysis, it was considered that the emphasis should be more on so-called type analyses.

Utilization. Papers in this section dealt with the utilization of such petroleum products as engine fuels, lubricants, heating fuels and bitumen.

In the session on gasoline engine fuels, the reduction of engine friction was suggested as an alternative to higher compression ratios in order to reduce fuel consumption. It was also pointed out that there is room for improvement in automatic control of spark advance. In the overall economic picture, increased cost of high-compression engines should be weighed against increased cost of producing higher anti-knock gasoline.

The gas turbine fuel session discussed three aspects of the general subject. First to be considered was the complicated position which exists because the severe cold-test requirement of aircraft turbine fuel specifications limits the supply sources. Opinions varied widely as to the extent to which engine and fuel should contribute to the solution of the problem. Secondly, on the use of boiler-type fuels in stationary and marine gas turbines, the economics are not favourable without a cheap fuel. Difficulties due to varying percentages and composition of ash from the fuel are still serious. Finally, the Pescara system as applied to locomotives was dealt with. In this system a free-piston diesel is combined with a turbine, through which it develops its power and which functions simultaneously as a variable-torque transmission element.

Four papers on motor lubricants all dealt with some aspect of additives; the general comment was that the large amount of research being carried out is insufficiently stressed. It was also suggested that viscosity-index improvers may not be effective at high rates of shear, the effect of pressure not having been investigated. Industrial and special lubricants and electrical oils were also discussed.

Construction Materials. This section dealt mainly with materials, construction, equipment and corrosion. One interesting proposal made by two French authors is for a method of heat exchange whereby the two fluids are in direct contact. It was stated that it is effective where there is no danger of emulsions being formed due to the nature of the oil or of the cooling water.

Miscellaneous. Sections 9 and 10 dealt respectively with transport, storage and distribution of petroleum products, and with economics, statistics, documentation, education and training.

HUMAN PROBLEMS OF THE SCOTTISH HIGHLANDS

In an article in a recent issue of the *American Scientist* (39, No. 2; April 1951), Dr. Fraser Darling discusses recent concepts of human ecology. Human ecology, he suggests, deals with the structure of animal communities which man dominates and their development through the ecological principles of succession. With Paul Sears he believes that "the social function of ecology is to provide a scientific basis whereby man may shape the environment and his relations to it as he expresses himself in and through his culture patterns". To-day it would not be wise to set up human ecology as an exact science but rather to say that human problems may be nearer solution if they are tackled ecologically. Human ecology and social science can be good science but should not be confused with social service, as is so often done.

Dr. Fraser Darling also considers whether there is any difference between human ecology and social anthropology. If there is any difference between them, he suggests, it is that human ecology deals essentially with process, and the value of the ecologist in society will be in his power and accuracy in elucidating causes and forecasting consequences.

The West Highlands of Scotland, for example, may serve to illustrate the ecological approach to the study of behaviour. In the Highlands there is a very old and, in many ways, primitive human culture existing in an administratively awkward and physically refractory terrain set on the fringe of a highly industrialized urban civilization. Highlanders have been part and parcel of the national structure of Britain for only two hundred years, having until then lived a different kind of life in standards, laws, language and techniques from the rest of Britain. Yet Highlanders are not New Hebrideans or Eskimos over whom British people, try as they may to the contrary, feel some kind of mental superiority. The Highlanders are a race of people of probably greater average intelligence and intellect than the rest of the British community though indistinguishable from it in physical appearance. As members of this race moved so smoothly and successfully in the 'dominant' civilization, it was overlooked how different was the inner rhythm of life and the style of thought and tradition. The new centralized British government of that day merely extended its administrative, economic and social regime to include the Highlands, and with some ameliorations and some encrustations this applies to-day.

In human ecology, too, history can never be neglected; a cross-sectional social survey is not ecological unless it studies origins and successions or, in other words, process. The significance of political action as an environmental factor must also be remembered. The manipulation of the salt tax, for example, in the last part of the eighteenth and early nineteenth centuries had profound results on the lives of Highlanders, and the transposition of the English system of poor relief had amazing consequences. Again, the island of Islay was immune from spirit duty in the late eighteenth century, distillers flocked in, the bread corn of the people was deflected to whisky, the distillers were soon making money advances (at their own rates) on the barley crops of small tenants, and drunkenness was rife and the people were reduced to an appalling social state. The detailed research into population movement conducted by the West Highland Survey shows that this island has suffered more than any other part of the Highlands from excessive emigration.

Another historical factor at the root of the Highland problem to-day is the exploitation which natural resources suffered in the past. Among these was the cutting down of forests to supply wood for ship-building and iron making. The destruction of the forests meant the removal of cover, and this environmental factor is of great importance in human lives. Lack of cover imposes various social problems in certain kinds of urban communities, and in the Highlands has imposed a set of conventions almost the exact opposite of our own. Darkness is the only cover; but this is supplemented by a build-up of psychological cover. The Tiree crofter visits the Duke of Argyll's factor on the nights of no moon, though he could just as well go in the day. A man and a girl in the Hebrides will ignore each other in daytime should they meet on the road; but he will be calling at her home just about the time of night when in our culture we should have taken our leave. Good manners require that he be gone before it is light.

The ultimate disappearance of the forest was followed by the introduction of sheep farming on the extensive extractive system in the second half of the eighteenth century. The immediate social consequences of this were unfortunate in that the people were pushed to the coast and suffered a forcible social break. In other parts the sheep–cattle ratio is grossly disturbed and conditions for the peasantry become desperate. In the Highlands it is now possible to gauge the social health of the people by knowledge of the sheep–cattle ratio in an area. If the ratio is wide, 30–50 or more sheep to one cattle-beast, there are grave social problems; if it is less than ten, there are few. The sheep–cattle ratio can also be correlated with the age-structure of the population. It is children who keep milk-cows on the land and when the population grows old, as it did in Assynt in 1931, the number of milk-cows goes down.

Nor should the human ecologist forget the diet of the people he is studying. The introduction of the potato in the West Highlands has raised many social problems caused by an increase in the population and a fall in the standard of living.

The attempt to study social and economic problems apart from the ecological background is bound to cause difficulties. Yet, contrary to biological principles, politicians have recently decided to give a substantial subsidy to hill ewes in Scotland. This idea may have worked well in the Southern Uplands of Scotland but in the poor terrain of the Highlands might have been specially designed for further deterioration of the habitat and for fostering social unhealth.

Depopulation and deterioration of the age-structure go together, but they bring a new set of social problems. People in and out of the Highlands have said often that industries should be established there, industries of the kind where wheels go round in an important way. But what has happened? Where such industry has been established, there has been even greater depopulation in the adjacent rural areas; yet the big problem is how to maintain dispersion. Fort William and Kinlochleven may have provided Britain with aluminium; but they have created new social problems and solved none.

In small communities problems of human ecology arising from depopulation and deterioration of the age-structure are manifold. In the first place, the old remain in power and so prevail that they can initiate an era of reaction in the life of a community; so that in a region of strict Presbyterianism, all gaiety for the young is frowned upon and nowhere do the young show greater consideration for the old than in the Highlands. There are many townships where there are but few married couples. Brothers and sisters have cared for their old folk, and now that they are gone they continue living in their parents' houses and cannot bring themselves to the considerable upset of getting married. The social urge and necessary gaiety are not there. This depression of the vivid social life of man is likely to lead to such undesirable consequences as burning of the hills in an excitement bordering on hysteria.

Religion is also a considerable ecological factor; but it must always be related with other environmental characteristics. In the Highlands a small remote community with poor services might have much more chance of survival if it were Catholic than if it were free Presbyterian; there is a greater sense of freedom in the old liberal and almost Columban style of Catholicism. Dr. Darling also suggests that, despite the fact that tradition and accumulated experience are part of man's environment, and for all the importance of the physical and biological factors, the ethos is still the biggest ecological factor of all in the life of the individual.

MECHANISM OF RESISTANCE TO INSECTICIDE IN HOUSEFLIES

By Dr. J. R. BUSVINE

London School of Hygiene and Tropical Medicine

LABORATORY tests have revealed interesting differences in the type of tolerance of two strains of insecticide-resistant housefly. The strains investigated were:

Italian Resistant Strain. Following one of the earliest observations[1] of DDT-resistant houseflies, a laboratory colony was started at the Istituto Superiore di Sanita in Rome. A sub-colony was kindly sent to us in 1948 and has been cultured at the London School of Hygiene and Tropical Medicine since, with occasional selection for resistance to DDT[2], but no other insecticide.

Sardinian Resistant Strain. During 1947–50 there was widespread house-spraying with residual insecticides in Sardinia, in connexion with a campaign for the eradication of Anophelines[3]. Flies were observed to have become resistant to 'Chlordane' and gamma benzene hexachloride, as well as to DDT. In October 1950 Mr. J. F. Newman brought to England a colony of these flies and kindly let me have a sub-culture.

Normal (Rome) Flies. A colony started from normally susceptible flies in Rome before wide use of DDT, sent to us in 1948 and maintained here since.

The flies were reared and tested in rooms kept at 27° C. Two methods were used to assess resistance:

(1) *Application Test.* Minute drops (0·4 $mm.^3$) of insecticides dissolved in mineral oil were applied to individual flies, narcotized with carbon dioxide, by an 'Agla' micro-injection apparatus. Median lethal concentrations were estimated graphically from probit/log concentration curves based on 24-hr. kills.

(2) *Knock-down Test.* Observations were made of the rate of knock-down of flies in a 500-ml. beaker treated with acetone solution of DDT to leave a residue of 0·01 mgm. per sq. cm.[4].

Resistance to DDT

Effect of solvent used. Mineral oil was used in application tests rather than acetone (which has been used by other investigators) because of the difficulty of dealing with minute drops of a highly volatile solvent. Some comparative tests with oil and acetone showed how greatly this small point of technique affects the degree of resistance recorded (Table 1).

Table 1

	Median lethal dose (micrograms per fly) Normal flies	Median lethal dose (micrograms per fly) Sardinian flies	Ratio Sardinian/normal
DDT in oil	0·44	7·2	16
DDT in acetone	0·12	36	300

The results obtained with acetone are in line with those of other investigators who have recorded resistance ratios of several hundred to one; but the oil solution results seem more reliable for the following reasons.

The thorax of a treated fly remains covered with a film of oil, forming a primary toxic phase which, by the partition law, saturates all phases (tissues) in the proportion of the original solution. Internal depletion by metabolism could be made good from this reservoir. Losses of the film, by contacts of the fly with the cage, should be equal at all doses, since the volume applied is constant. After application in acetone, the solvent evaporates in a few seconds, leaving supersaturated liquid; this crystallizes out in an hour or so, leaving tiny scales and blobs of DDT crystals at higher doses. As there is no oil film, the cuticle wax of the insect must form the primary phase. There is very little of this, so it is easily saturated, and this saturates other tissues with DDT; therefore, the toxic action on susceptible flies is greater than with oil applications. The resistant flies, however, are able to metabolize the DDT (see below) and deplete the small reservoir in the cuticle wax. The relatively large crystals aggregated on the outside are an inefficient means of maintaining the saturation of the wax, apart from the fact that they may be dislodged by the movements of the fly. This accounts for the higher doses needed to kill the resistant flies.

Speed of 'knock-down' by DDT. In tests in which DDT was applied to the thorax, flies of the Italian and Sardinian strains were about equally resistant to DDT; but in the beaker tests there was a very marked difference, as shown by the results in Table 2.

Table 2

	Normal Rome strain		Italian strain		Sardinian strain	
	Males	Females	Males	Females	Males	Females
Percentage down in 20 min.	86	35	7	0	69	27
Percentage down in 40 min.	100	93	24	11	93	80
Percentage dead after 24 hr.	100	100	19	8	30	11

The Sardinian flies are almost as rapidly paralysed by the DDT as the normal strain, but most of them recover if removed from the surface after 40 min. The Italian flies, as shown by Harrison[5], are highly resistant to the paralysing effect.

Toxicity of DDT after injection. The relative resistance of the three strains of fly to DDT (in oil) was very similar if the insecticide was injected into the thorax instead of being applied to the outside. The median lethal concentrations obtained were about half those in application tests, thus: Rome 0·06 per cent; Italian 1·0 per cent; Sardinian 0·9 per cent. The paralysing effect of DDT was exhibited earlier by the Sardinian flies than the Italian ones, after injection as well as after application of the poison, though the final kills were about the same.

Table 3. Median lethal concentrations of DDT analogues for three strains of housefly compared with rates of dehydrochlorination *in vitro* (according to Cristol, ref. 5)

Compound	Median lethal concentration			Ratio of M.L.C.s III/I	Dehydrochlorination (lit./sec./mol.)
	Rome I	Italian II	Sardinian III		
Bromine-DDT	0·15	2·1	1·9	13	3,470
pp′ DDT	0·11	1·7	1·8	16	2,480
DDD	0·22	1·65	1·85	8·4	568
op′ DDT	1·3	13·5	4·1	3·2	37
Dimethyl diphenyl trichlor-methane	0·36	7·1	0·75	2·1	11
'Methoxy-chlor'	0·12	1·25	0·27	2 3	10

These observations suggest that the difference in rate of action of DDT on flies of the two strains cannot be explained by differences in rate of penetration of the cuticle.

Resistance to DDT analogues. The relative toxicities of a selection of DDT analogues to the two resistant strains of flies were made by application tests. In Table 3 the results are compared with the ease of dehydrochlorination, *in vitro*, according to Cristol[5]. It will be observed that those compounds which readily split off hydrogen chloride and leave the non-insecticidal ethylenic compound are tolerated by both strains: but the analogues which are more stable in this respect are relatively toxic to the Sardinian strain. Fig. 1 shows that the relative resistance of the Sardinian strain, as compared with the normal (Rome) strain, is roughly proportional to the logarithm of the rate of dehydrochlorination.

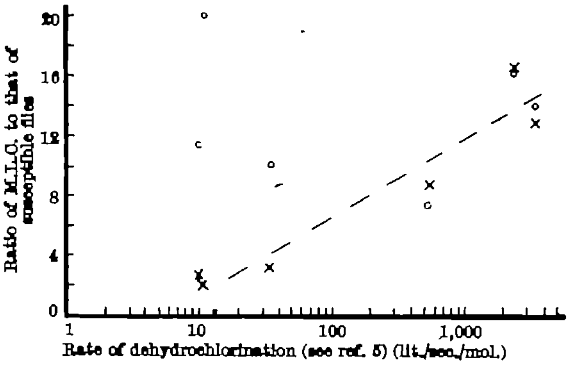

Fig. 1. Relation between resistance to various DDT analogues and their rate of dehydrochlorination (*in vitro*). Resistance is indicated by ratios of the median lethal concentrations for Italian (○) and Sardinian (×) flies to corresponding doses for normal (Rome) flies

Resistance to a Range of Insecticides

The degrees of increased resistance of the two resistant strains, as compared with normally susceptible flies, is shown in Fig. 2 and Table 4 for a range of insecticides. The following points may be noted.

(1) The Italian strain is distinctly resistant to DDT and to pyrethrins, but towards the other insecticides it is as susceptible as the normal (Rome) strain.

The moderate, but quite definite, resistance to pyrethrins is surprising and inexplicable. Houseflies which have so far developed resistance to insecticide in the field have only become tolerant of synthetic, chlorinated hydrocarbon insecticides; that they are capable of becoming resistant to pyrethrins may be of considerable practical importance.

Table 4. Median lethal concentrations of various insecticides, for two insecticide-resistant strains of housefly, compared with a susceptible strain from Rome

Insecticide	Median lethal concentrations			Ratios of M.L.C.'s to Rome strain	
	Rome (Normal)	Italian	Sardinian	Italian	Sardinian
DDT	0·11	1·7	1·8	15·5	16·5
Chlordane	0·04	0 038	2·8	0·95	70
Dieldrin	0·006	0·007	0·3	1·2	50
Aldrin	0·009	0·010	0·3	1·1	33
Gamma BHC	0·006	0·005	0·05	0·85	8·5
Toxaphene	0·09	0·09	0·90	1·0	10
'Lethane'	0·60	0·65	0·70	1·1	1·2
'Thanite'	0·80	0·90	0·85	1·1	1·1
Pyrethrins	0·07	0·35	0·06	5·0	0·86

(2) The Sardinian strain is about as resistant to DDT as the Italian strain. In addition, it is highly resistant to chlordane and several other chlorinated hydrocarbon insecticides. The resistance to chlordane is not surprising, in view of the wide use of this insecticide in Sardinia, but dieldrin and aldrin and toxaphene have not been used there. The two first are allied to chlordane in chemical constitution, but toxaphene is not very similar.

Discussion

It is difficult to imagine any single hypothesis which could explain the curious differences in the resistance of the Italian and Sardinian strains. Previous investigators have shown that resistant houseflies are able to break down DDT to a non-toxic compound by dehydrochlorination[6-8]. The data illustrated by Fig. 1 might suggest that the two strains owe their resistance to dehydrochlorination mechanisms with different specific actions; that of the Italian strain being more efficient in dealing with those DDT analogues most difficult to hydrolyse *in*

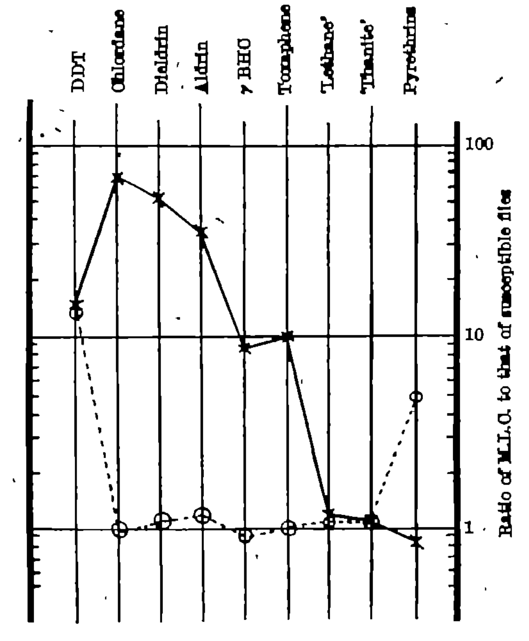

Fig. 2. Degrees of enhanced resistance to various insecticides shown by two strains of housefly. Resistance is indicated by ratios of the median lethal concentrations for Italian (○) and Sardinian (×) flies to corresponding doses for normal (Rome) flies (Logarithmic scale for convenience)

vitro. However, it is the Sardinian strain which is more efficient in resisting other chlorinated hydrocarbon insecticides, including dieldrin and aldrin, which are difficult to hydrolyse (if we are to judge from results *in vitro*). Furthermore, the resistance of the Italian strain to the early knock-down by DDT cannot be related to a more rapid dehydrochlorination, for Wintringham[8], who worked with this strain, found that it metabolized DDT very slowly (only 23 per cent in 5 hr.).

As earlier writers have suggested, the dehydrochlorination mechanism does not fully account for DDT resistance, and one is driven to postulate an additional defence mechanism. This would partially explain my results, assuming that the unknown mechanism predominates in the Italian strain, while the Sardinian strain relies mainly on dehydrochlorination.

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CARNEGIE INSTITUTION OF WASHINGTON

ANNUAL REPORT FOR 1949-50

THE annual report for 1949–50 of the Carnegie Institution of Washington* includes the report of the president of the Institution, Dr. Vannevar Bush, as well as those of the executive committee and the auditors, and also the yearly record of departmental activities and co-operative studies.

The feature of the president's report is the discussion of the nature of research, and especially the methodology of the basic scientific research with which the Institution is primarily concerned. This is defined as the effort to extend, for its own sake, our grasp of the workings of Nature and of man, while applied research seeks to produce a new and useful device, material or process by capitalizing the growing body of fundamental knowledge. In both types of research there are two general approaches. One is to improve the tools, including the use of mathematical analysis, and usually proceeding by refinement, painstaking examination of sources of error and by testing of available materials. In the second a concerted attack is made upon a specific problem, applying all possible methods and instruments, and creating new ones for the purpose. Dr. Bush points out that even the objective centralized attack often turns the investigator into unexpected paths, and it is essential to keep in mind the true relation between the man of science and the instruments he uses. These are aids, not objects, and are important only as they foster the creative activity of the investigating mind. What distinguishes the really great man of science is the ability to sense or discern those places where truly great significance lies and where the tools available can open up a really wide crack in the wall of the unknown. More than forty years of experience has justified Andrew Carnegie's conviction that an institution which sought out the unusual scientific worker and made it possible for him to create to the utmost would be worth while.

Reviewing the research activities of the year, Dr. Bush refers to the publication during the year by Dr. R. E. Wilson and Dr. A. H. Joy of the radial velocities of 2,111 stars, thus essentially completing a programme begun by the Mount Wilson Observatory in 1910 which has yielded velocities of about 14,000 stars of all spectral types. During the year the 200-in. Hale telescope and the 48-in. Schmidt camera took their place with the 100-in. and 60-in. telescopes on Mount Wilson on the regular observing schedules of the Observatories. On June 26, 1949, Dr W. Baade with the 48-in Schmidt camera discovered the trail of a very unusual asteroid which has now been found to possess the shortest period (409 days) of any known asteroid and comet and has been named Icarus.

At the Geophysical Laboratory of the Institution careful measurements on about three hundred specimens of quartz have shown easily measurable differences in the behaviour of crystals from granite and those believed to have been formed in the later stages of igneous activity. Measurements on the effect of pressure on the inversion-point of quartz indicate that at the maximum pressure reached—corresponding to a depth of twenty-miles below the surface of the earth—the inversion-point is raised by more than 200° C. Further work on the feldspars has yielded quantitative information on their co-existence and stability, and the conditions of temperature and pressure under which they have been formed. Measurements on the melting of silicates in the presence of water under pressure have also continued, and the high-pressure steam filter autoclave has been further developed. Studies, in co-operation with the Department of Terrestrial Magnetism, of the earth's crust using waves produced by large explosions resulted in agreement that the velocity of earthquake waves is 5·9–6·0 km./sec. and also, reducing our estimate of the thickness of the upper layer, bring into agreement the shear-wave arrival times for near earthquakes. The same Department has continued its measurements of the residual-magnetism properties of sedimentary rocks, and studies on the direction of easiest magnetization indicate that these directional magnetic properties had their origin when the rocks were laid down as sediments. A great increase of cosmic rays coincident with a great solar flare was again observed; these high-energy radiations appear to be a nucleonic component of cosmic rays coming to the earth from the vicinity of the sun, and the observed particles are not mesons. The study of proton–proton scattering has continued, and, as a result of biophysical studies using radioactive tracers on the effect of inorganic ions on cellular activity, the ability of organisms to concentrate potassium from their environment can be interpreted in terms of the formation of relatively stable potassium compounds within the cell.

Investigations on photosynthesis, in the Division of Plant Biology, have been concentrated primarily on the photochemical part of the reaction by which the light absorbed by the various chloroplast pigments is converted into chemical energy. It has been found that the fluorescence spectra of red algæ do not match the summations of the fluorescence spectra of their purified pigments, although the different pigments do function to some extent independently. A highly fluorescent pigment, present in the cells which surround the so-called guard cells controlling the openings through which gases enter the leaves of certain species of vetch, possesses a fluorescence spectra resembling those of certain types of porphyrins. A mutant of *Chlorella* has been found which contains chlorophyll, but is incapable of reducing carbon dioxide, although it can evolve oxygen when illuminated. Chloroplast experiments have shown that the reactivation by precipitation of disintegrated chloroplast material depends primarily upon the physical state of the precipitate, and similar results have been obtained by treatment with various salts, by increased acidity, and by very low concentrations of streptomycin, which combines specifically with the chloroplast material. Methods have been worked out for separating uronides from leaves, and it appears possible that the great variations, independent of photosynthesis or respiration, of sugar concentration in leaves, may be associated with a reversible formation of uronides, which ties up the sugars. The principles controlling the evolution of plants have been studied by examining the growth of contrasting climatic races under varied temperatures in controlled greenhouses at the California Institute of Technology. The *Poa* grasses included with hybrids of *Achillea* and *Mimulus* in these studies were also used in studies of the influence of environment on chromosomal pairing.

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* Carnegie Institution of Washington. Year-Book No. 49, July 1, 1949–June 30, 1950, with Administrative Reports through December 15, 1950. Pp. xxxvi+220+7 plates. (Washington, D.C., 1950.) 1 dollar.

In the Department of Embryology of the Carnegie Institution one of the chief advances on the anatomical side has been the achievement of sex reversal of the gonad in the opossum by experimental treatment in the embryonic stage with the female sex-hormone œstrogen. A detailed study of the embryonic development of the external muscles of the human eyeball was being prepared for publication, and studies on the developing brain and liver, with respect to chemical factors in the synthetic activities which characterize fœtal growth, indicate that specific chemical changes can be correlated with changes in the form of the developing nerve cells as seen under the microscope. The investigation on the physiology of the uterus has led to the development of the multi-channel tokodynamometer, by which obstetricians can record the contraction of all parts of the human uterus in childbirth and distinguish normal patterns of contraction from abnormal types which do not permit smooth and properly timed passage of the infant. Studies of the action of drugs upon the uterus were being continued, and an investigation of the biochemistry of uterine muscle in relation to the functional states of the reproductive system has shown that the presence of an effective amount of actomyosin in the uterus depends upon the ovarian sex hormone or œstrogen.

TEA RESEARCH INSTITUTE OF EAST AFRICA

A NEW research institute concerned with problems bearing on the cultivation and manufacture of tea has been inaugurated at Kericho, Kenya Colony, to serve tea producers in the three East African territories. Well-equipped laboratories have been built and a nucleus staff is in residence. At present the activities of the Institute are divided between a general agricultural department, covering agronomic and pathological problems, and a chemical department concerned with soils and plant biochemistry.

The funds for the support of the Institute are provided by the territorial Tea Boards of Kenya, Tanganyika and Uganda, which were recently established by legislative ordinances for the regulation of tea production, marketing and export.

Following the example of the British Grassland Research Station, the Institute has been incorporated as a company limited by guarantee without share capital, in Kenya, thus obviating the necessity for parallel legislative action in three territories of different constitutional status.

The governing body consists of ten members, six of whom (two from each territory) are nominated by the Tea Boards to represent producers, the remaining four being the directors of agriculture in the territories and the director of the East African Agriculture and Forestry Research Organization. The latter, Dr. B. A. Keen, has been elected chairman. During the preliminary stages of establishment, pending the working out of a constitution, the affairs of the Institute were sponsored by Messrs. Brooke Bond and Co., Ltd. On this account buildings and development generally were able to proceed without delay.

The tea industry in East Africa is relatively young and dates back about twenty-five years. The approximate acreage of mature tea in East Africa is 33,000, with a production of 19,000,000 lb. in 1950. East Africa has contracted out of the international agreement for restriction, and production is expanding. The immediate problems for a research institute are therefore largely concerned with soil and fertility conservation, establishment of young tea and the improvement of types of tea by selection.

DEVELOPMENT OF THE MAMMALIAN LYMPHATIC SYSTEM

By N. K. BALANKURA
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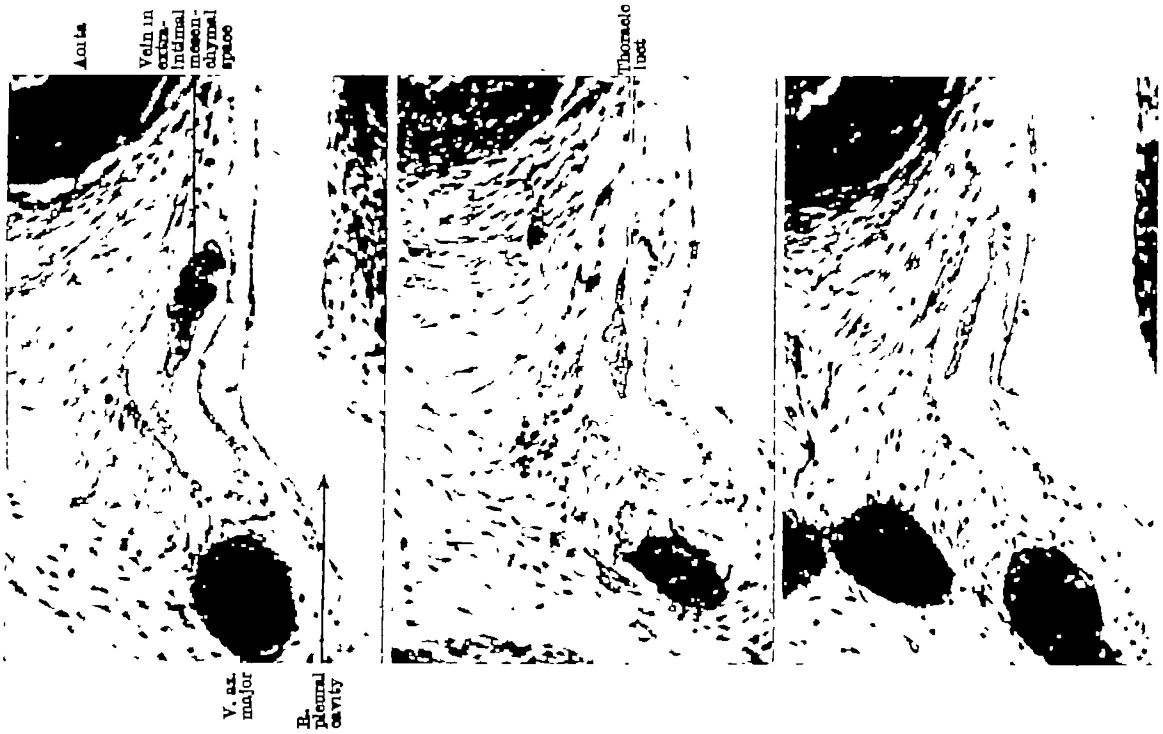
THE problem of the development of the lymphatic system in the mammal still remains unsettled. Sabin[1] regards the lymphatic vessels as direct derivatives of the embryonic veins. The lymphatic vessels make their first appearance at the four centres of radiation in relation to limb girdles. By the process of continuous and uninterrupted sprouting they extend centrifugally and invade almost the entire body. Lewis[2] believes that the lymphatic vessels are formed by the confluence of multiple venous outgrowths. These venous derivatives have previously become detached from the main venous channels and later they transfer *in toto* to the lymphatic system. Huntington[3], Huntington and McClure[4] and Kampmeier[5] have shown that the systemic lymphatic vessels are formed by fusion of the perivenous mesenchymal spaces. These spaces develop as separate lymphatic anlagen outside the intima of the early venous channels. They do not communicate directly with the veins except at definite points in the lymphatico-venous connexions which are secondarily formed. The connecting segments between the veins at the root of the neck and the proper systemic lymphatic vessels are provided by the paired jugular lymph sacs.



Three stages of degeneration in one of the right ventromedial tributaries of the azygos vein engulfed within the developing thoracic duct

The present investigation has been made into the development of the lymphatic system in the sheep and man. The findings confirm in the main the view advocated by Huntington, McClure and Kampmeier. Developmentally, the thoracic duct seems to consist of two separate components. The terminal part is formed by direct venous outgrowths forming the jugular lymph sac. The greater part (systemic lymphatics), on the other hand, arises *in situ* by the confluence of a system of mesenchymal spaces which in the majority of cases develops in close association with the degenerating veins. Therefore, the endothelium lining the greater part of the thoracic duct is derived from the undifferentiated mesenchymal cells, which never served previously as the lining of the venous channels. This is in sharp contrast with the development of the jugular lymph sac. The sac merely serves as a link between the great veins at the root of the neck and the rest of the proper systemic lymphatics; thus only the terminal parts of the thoracic duct and the right lymphatic duct are directly derived from the embryonic veins.

Three different stages can be recognized in the process of the formation of the systemic part of the thoracic duct: hæmal, transitional and lymphatic. The development proceeds in the cranio-caudal direction and different stages may overlap each other. In the hæmal stage venules and venous capillaries (venolymphatics of Kampmeier) are laid down along almost the entire distance eventually occupied by the thoracic duct. These venous capillaries possess two main functions: to drain the blood back towards the heart and to absorb the tissue fluid. During the transitional stage, these small veins become detached from the main venous channel and can no longer fulfil their previous functions. Thus the tissue fluid and the lymph which drains towards them accumulate to form cavities in the mesenchyme outside the lumina of the detached veins. The isolated cavities are known as the extra-intimal or perivenous mesenchymal spaces. They are in actual fact the primordia of the lymphatic channel. In the lymphatic stage the extra-intimal mesenchymal spaces become enlarged and coalesce with each other mainly in the cranio-caudal direction, thus giving rise to the continuity of the main lymphatic channel. The detached veins under the pressure of the expanding mesenchymal spaces degenerate and finally collapse and merge into the surrounding tissue.

In the 29–30 mm. stage human embryo, though the continuity of the thoracic duct from the innominate vein at the root of the neck to the first lumbar vertebra has been established, the detached veins in various stages of degeneration can still be observed, as shown in the accompanying three illustrations.

During the course of investigation, the posterior lymph sacs, the retro-peritoneal lymph sac and the mesenteric lymph sac were not demonstrated satisfactorily as direct derivatives of veins. The existence of these sacs must be regarded as doubtful. As in the case of the greater part of the thoracic duct, the cisterna chyli develops from the confluence of the extra-intimal spaces. However, it differs from the other systemic lymphatics only by the more extensive coalescence of the mesenchymal spaces and their subsequent enlargement. [March 22.

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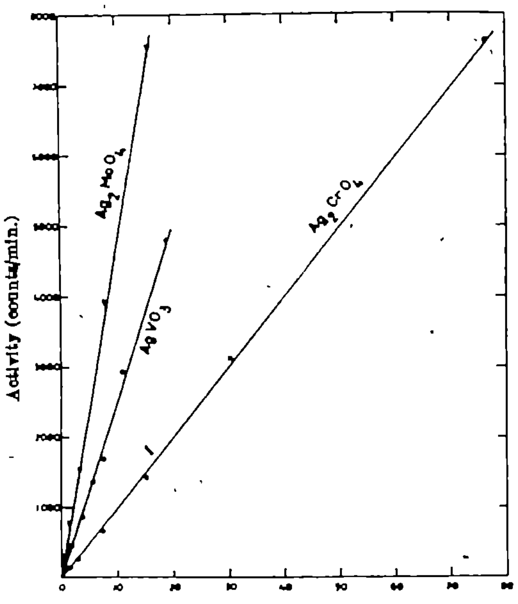
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Radiochemical Determination of Chromium, Vanadium and Molybdenum by means of Radioactive Silver

THE extreme sensitivity of measurements of radioisotopes makes it possible to use the artificial radioelements as an aid in analytical chemistry. In our experiments we have used radioactive silver for making quantitative estimations of small amounts of chromium, vanadium or molybdenum present, in steel or in various substances. Insoluble silver salts can be prepared by means of these elements. Previous investigations have shown that all these silver compounds are suitable for radioactive measurements, except silver vanadate, which gives no reproducible results. Therefore, we dissolve the silver metavanadate in boiling 50 per cent nitric acid, and silver is precipitated as chloride; the latter is filtered on a fritted glass filter, so giving directly a radioactive sample for counting. A Geiger–Müller tube (*R.C.L.* Chicago) with thin mica window is used for the radioactivity measurements.

Radioactive silver, $^{110}_{47}Ag$ (supplied by the Isotope Division, Atomic Energy Research Establishment, Harwell), is dissolved in nitric acid, and the solution is evaporated to dryness on a water-bath. A neutral solution of radioactive silver nitrate is prepared; and by means of this solution chromium is precipitated as silver chromate[1], vanadium as silver vanadate[2] and molybdenum as silver molybdate[3]. As shown in the accompanying graph, standard curves are obtained when the activities of the precipitate are plotted against the corresponding amount of metal used. From these curves, unknown concentrations of chromium, vanadium or molybdenum can easily be determined if the same experimental and geometrical conditions are reproduced.



Mgm. of molybdenum, vanadium or chromium

Less than 1 mgm. of metal can be determined. However, a solution of radioactive silver nitrate with very much higher specific activity can be used, and eventually the smallest amount of metal detectable is limited by the solubility product. This radiochemical method is very quick, accurate and also convenient, because the same radioactive indicator is used for the chemical determination of different elements.

One of us (C. B.) wishes to thank Prof. G. Guében for the opportunity of working in the Institute of Nuclear Studies, Liège.

J. GOVAERTS
CARLOS BARCIA-GOYANES

Institute of Nuclear Studies,
University of Liège. March 20.

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Structures of Uranium

Dickins, Douglas and Taylor[1] have recently pointed out that the tetragonal structure for β-uranium, proposed by Tucker[2] on the basis of the room-temperature X-ray examination of a quenched uranium – chromium alloy containing 1·4 atomic per cent chromium, is essentially the same as that of the σ-phase, which is of such great technical importance. Kasper, Decker and Belanger[3] have obtained similar results.

We have been engaged for some time in the X-ray examination of uranium at high temperatures and have succeeded in obtaining satisfactory powder photographs of β- and γ-uranium, using filings sealed off in an evacuated silica capillary tube. Attempts made to index the β-photographs by the method described by Ito[4] had led to a monoclinic unit cell containing 30 atoms and having the dimensions $a = 9{\cdot}99$ A., $b = 7{\cdot}85$ A., $c = 8{\cdot}67$ A. and $\beta = 101° 42'$; but comparison of these photographs with those of a 1·4 atomic per cent chromium – uranium alloy quenched from 720° C. showed that there was a very strong resemblance, although obviously the unit-cell dimensions of the two substances differed considerably.

Detailed analysis showed that all the lines of the β-uranium photograph could be explained with a tetragonal unit cell containing 30 atoms and having the dimensions shown in the accompanying table, with the exception of two very faint lines. Several small-angle reflexions, occurring only as spots on photographs of stationary specimens, were also explained more satisfactorily by the monoclinic than by the tetragonal unit cell; but there was no unequivocal evidence that the tetragonal structure is not essentially correct. However, there are marked discrepancies between the calculated and observed intensities which show, as Tucker himself says, that much more work is necessary before the final structure of the uranium – chromium alloy can be elucidated. More significant, perhaps, are the intensity differences observed between β-uranium and the uranium – chromium alloy, which show that the two structures, although based on the same theme, are not identical, and make it clear that the detailed structure of β-uranium will have to be worked out from X-ray observations on the element itself and not on the chromium alloy. (*Note added in proof:* X-ray photographs of the uranium–chromium alloy taken at 720° C. have confirmed these intensity differences.)

There is one feature of this alloy which may be of interest, although not strictly relevant in the present context; and that is its behaviour on filing. Filings prepared for X-ray examination gave only the α-uranium pattern if examined before re-heating to 720° C. and quenching. After the latter treatment, however, the σ-pattern was re-established.

The accompanying table gives the unit-cell dimensions and theoretical density for β-uranium and the uranium – chromium alloy as well as for the body-centred cubic unit cell of γ-uranium, together with previously reported values; and includes also the corresponding figures for α-uranium based on Jacob and Warren's results[5], taking into account that their dimensions almost certainly refer to kX. and not to angstrom units, and that they used a value of $0 \cdot 606 \times 10^{-24}$ for Avogadro's constant instead of $0 \cdot 6024 \times 10^{-24}$, the currently accepted value.

UNIT-CELL DIMENSIONS AND DENSITY

	α–U (room temp.)	β–U (720° C.)	γ–U (805° C.)	U–Cr (1·4%) (room temp.)
a (in A.)	2·858	10·759 ± 0·001	3·524 ± 0·002	10·590 ± 0·001
b (in A.)	5·877	—	—	—
c (in A.)	4·955	5·656 ± 0·001	—	5·634 ± 0·001
Density	19·00	18·11	18·06	18·56

PREVIOUSLY REPORTED VALUES

	α–U	β–U	γ–U	U–Cr
a (in A.)	2·852		3·49 (at 800° C.)	10·52
b (in A.)	5·865		—	—
c (in A.)	4·945	None	—	5·57
Density	18·97		18·6	19·02
Ref.	5		6	2

It will be seen that the unit-cell dimensions for the 1·4 atomic per cent chromium alloy are not the same as those reported by Tucker. The precise significance of this is not clear at the moment, but it may be noted that metallographic examination reveals no sign of segregation in the alloy, the composition of which (1·35–1·40 atomic per cent chromium) is not seriously different from that of Tucker's. An estimate of the density of such an alloy, of uncertain value perhaps, may be worked out from measurements of the bulk thermal expansion of uranium[7] in the β-range, extrapolating to room temperature and making an allowance for the effect of the chromium. The value so obtained is 18·8, which is intermediate between Tucker's value and that given by the present work.

It will also be noticed that the figures obtained for γ-uranium differ somewhat from those previously published. Density considerations suggest, however, that they are of the right order, the density at 800° C., calculated from measurements of bulk thermal expansion, being 17·8. A value of 18·6, as given by Wilson and Rundle's results, would therefore seem to be unreasonably high.

This note is published by permission of the Director of the Atomic Energy Research Establishment, and it is hoped to publish fuller details elsewhere. The uranium – chromium alloy was prepared, and the chemical analysis carried out, by the Metallurgy Division of this Establishment.

J. THEWLIS

Atomic Energy Research Establishment,
Harwell. April 30.

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Errors in Determination of Specific Activity and Turnover Rates of Radioactive Isotopes

In experiments designed to investigate the turnover rate of certain organophosphates by the use of phosphorus-32, a serious error has been detected in the results obtained by the use of conventional techniques.

For the determination of the radioactivity of the inorganic phosphate fraction of a trichloracetic acid extract of tissue, the phosphate is generally precipitated as a magnesium ammonium salt and counted as such. It is also customary to add unlabelled phosphate to serve as carrier and so ensure complete precipitation of the phosphorus-32. In order to avoid the loss of time due to the necessity for allowing the solution from which phosphorus-32 is being precipitated to stand several hours, we investigated the possibility of applying the method for the determination of inorganic phosphate described by Ennor and Stocken[1]. If it was possible to extract the inorganic phosphate from the aqueous phase with *iso*butanol in 10 sec. as has been reported, we believed that the phosphorus-32 content could be determined by counting the alcohol phase in a conventional liquid counter of 10 ml. volume. Preliminary experiments using a model system containing sodium dihydrogen phosphate, some of which was labelled, have indicated that not only can the phosphorus-32 be extracted quantitatively in 10 sec., but also that the counts obtained by this method agree with those obtained by counting the precipitate of magnesium ammonium phosphate.

When, however, a similar comparison is carried out on a trichloracetic acid extract of a liver from an animal injected with material labelled with phosphorus-32 two hours before death, divergent results are obtained.

From the results of the model experiment, it was expected that the counts in the magnesium precipitate would equal those in the *iso*butanol extraction of the trichloracetic acid extract. It is clear, however (see table), that the precipitate has many more counts. In both the examples cited, an extraction of the precipitate with *iso*butanol gives results practically identical with the extraction of the trichloracetic acid extract. This result is taken to indicate the presence of a compound containing phosphorus-32 which does not react with molybdate to form a phosphomolybdate complex, and so remains insoluble in *iso*butanol. This conclusion is strengthened by the fact that after wet-ashing in sulphuric and nitric acids, butanol

Magnesium precipitates were counted by means of a *GM*4 end-window counter and were mounted on disks of filter paper. All *iso*butanol extracts were counted in an *M*6 *GM* liquid counter having a capacity of 10 ml. All determinations were carried out in duplicate and counts were taken over such a period as to reduce the statistical error to 1–2 per cent. All counts are expressed in terms of the end-window counter

	Counts/min /ml. of extract	
	Exp. 1	Exp. 2
Magnesium ppt.	850	1,540
*iso*Butanol extraction of ppt.	560	1,240
,, ,, ,, trichloracetic acid extract	540	1,280
,, ,, ,, ashed ppt.	900	1,540
Specific activity (based on ppt.)	8·1	10·0
,, ,, (based on *isobut.* extraction of trichloracetic acid extract)	5·3	8·1

extraction now gives the same number of counts as did the precipitate.

The error which appears as a result of differences between the counts in the *iso*butanol and in the precipitate is reflected in the specific activities, as indicated in the accompanying table.

The question now arises as to the nature of the contaminant, and preliminary experiments indicate that the adenosine polyphosphates are co-precipitated as, in fact, has been noted by Lehninger[2]. It has also been established that the degree of co-precipitation is dependent upon the amount of carrier phosphorus which has been added.

The preliminary results indicate that the long-accepted method for determination of the radioactivity of inorganic phosphate is subject to considerable error and, therefore, that the conclusions that have been drawn in the past on the turnover rate, etc., of an organophosphate are also subject to error. Experiments are now in progress to determine the magnitude of this error. It has also been established that the method described by Ennor and Stocken[1] is suitable for the determination of both phosphorus-31 and -32, and that it is free from error. A full report of the work will be submitted for publication elsewhere.

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John Curtin School of Medical Research,
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May 18.

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A Particulate Impurity Found in Solutions of Radioactive Phosphorus

Experiments involving the use of radioactive phosphorus (phosphorus-32) incorporated into nucleoproteins have indicated that samples of nominally carrier-free radioactive orthophosphate contained, at various times during 1950, an appreciable proportion of activity associated with particulate matter. Recent samples of phosphorus-32 have, however, been free from this impurity. This impurity is of serious consequence when measurements of the radioactivity of proteins labelled with phosphorus-32 are to be made, as the impurity is carried down on protein precipitates, where it remains in spite of repeated washing.

	Total counts per min.	Percentage activity in precipitate	Phosphorus (μgm.)	Specific activity (counts per min. per μgm. phosphorus)	Ratio of spec. activities of precipitate to supernatant
Supernatant 1	196,000	—	858	228	—
Supernatant 2	198,000	—	900	222	—
Precipitate 1	10,800	5·5	3·9	2,700	11·8
Precipitate 2	7·8	0·004	4·5	1·74	0·008

The nature of this impurity has been investigated and a method for removing it from solutions of radioactive phosphorus has been devised. The uptake of the impurity by protein (crystalline horse serum albumin) precipitated from a carrier-containing solution by trichloracetic acid was unaffected by the amount of protein used or the amount of carrier present over a wide range. The protein precipitate (see table) was separated by centrifugation from the supernatant fluid, which was then neutralized, more protein was added and the precipitation repeated. The second precipitate was found to contain less than one-thousandth of the radioactivity found in the first, whereas both precipitates contained essentially the same amount of phosphorus. The degree of contamination of the first precipitate by carrier-free phosphorus-32 is indicated by the ratio of its specific activity to that of the supernatant fluid (final column of table), which in the absence of impurity cannot be greater than 1. This experiment has been repeated using a tissue homogenate instead of horse serum albumin, with similar results. A high activity persisted in the first precipitate after ten washings in phosphate-containing trichloracetic acid, whereas the second precipitate gave only background counts after six washings.

The impurity extracted has the same decay-rate as phosphorus-32 and was thought to be radioactive orthophosphate adsorbed on to, or combined with, some extraneous particulate matter suspended in the carrier-free solution. An attempt was made to remove the impurity by filtration of carrier-containing material through a 0·25-μ 'Gradocol' membrane. This proved as effective as protein precipitation in removing the impurity, only background counts being obtained on a washed precipitate from filtered material, an aliquot of which before filtration had given a highly active washed precipitate. The impurity may also be removed by extracting the orthophosphate in *iso*butyl alcohol as a phosphomolybdate complex, when the impurity remains in the aqueous phase; after alkaline hydrolysis the impurity behaves like orthophosphate and is found in the alcoholic phase.

In experiments involving nucleoproteins in which nucleic acid turnover is measured by means of phosphorus-32, Schmidt and Thannhauser's method of fractionating the nucleic acids is frequently used. In this fractionation the radioactivity due to the impurity is removed from the protein during alkaline hydrolysis and appears as radioactive orthophosphate in the ribose nucleotides fraction, where it will give rise to gross errors. If reliable results are to be obtained from experiments involving proteins labelled with phosphorus-32, it is essential to ensure that the tracer solution is free from this impurity. Filtration through a 0·25-μ 'Gradocol' membrane after addition of carrier provides a reliable and simple method of doing this, while at the same time sterilizing the solution.

J. E. Hotchin

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Mill Hill, London, N.W.7.
May 9.

nert Gas Effects in the Oxidation of Hexane

ACCORDING to one scheme of hydrocarbon oxidaion[1], a link in the gaseous reaction chain at low temperatures is the formation of a peroxide radical:

$$R + O_2 \rightarrow RO_2^*, \qquad (1)$$

followed by:

$$RO_2^* + RH \rightarrow ROOH + R. \qquad (2)$$

The formation of RO_2 appears to have been first proposed for the low-temperature oxidation of gaseous higher alkanes by A. R. Ubbelohde[1]. Other authors have proposed variants which still involve (1) as a tep in the oxidation mechanisms.) Until it can be dissipated, for example, by collisions with other molecules, the energy of reaction must be stored for a short time in the RO_2^* radical. Various physical properties[2] of the hydrocarbon molecule may facilitate his storage of internal energy in reaction intermediates for much longer periods than would be possible in the combination of simpler groups, as in

$$H + O_2 \rightarrow HO_2. \qquad (3)$$

The energy stored can be utilized in a subsequent process in the reaction chain, such as reaction (2), provided that this reaction can occur before collisions n the gas phase favour the competing deactivation eaction:

$$RO_2^* + X' \rightarrow RO_2 + X^*, \qquad (4)$$

where X is any third body. A possibility of this kind has been put forward (ref. 1, p. 373) as one of he factors which explain the much greater influence on reaction velocity of increasing the concentration of hydrocarbon rather than the concentration of oxygen.

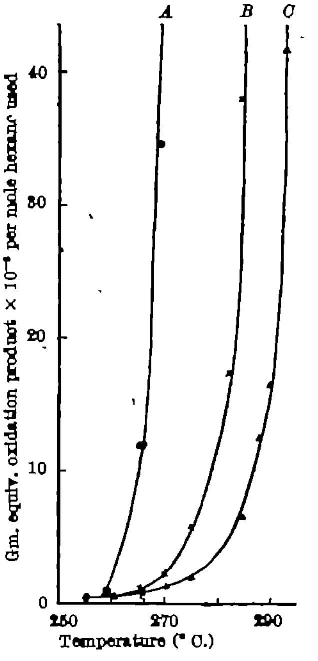

Fig. 1. Effect of diluents on hexane oxidations

	C_6H_{14}	O_2	N_2	Diluent
Reference mixture	2·87	1	4	—
With added nitrogen	2·87	1	4	4·26 . N_2
With added hydrogen	2·87	1	4	4·26 H_2

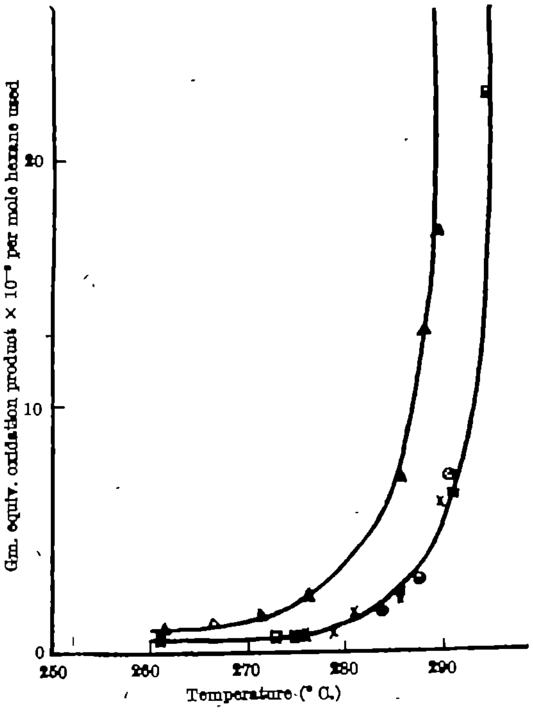

Fig. 2. Inhibition by mercury.
Mercury trough at 60° C, □; at 30° C., ×; at 0° C., ○

In the oxidation of gaseous acetaldehyde, it has recently been found[3] that dilution of the system by hydrogen leads to much more marked inhibition than dilution by nitrogen when introduced in comparable molecular proportions. Specific inhibition by hydrogen has now also been found for hexane oxidations using a flow system closely resembling that previously described[3]. In Fig. 1 the reaction temperature is plotted against the extent of oxidation, as measured by the total sum of peroxide, aldehyde and acid analysed in the condensible reaction products.

It seems likely that this specific inhibitory effect of hydrogen arises from energy-transfer processes in which collision with hydrogen is much more efficient in a reaction such as (4) than collision with nitrogen. The principle of microscopic reversibility indicates that if hydrogen is specially efficient in *removing* internal energy by collisions such as (4), it should also be much more efficient than nitrogen in other circumstances where the *supply* of internal energy by collisions involves the reverse of reaction (4). An elegant verification of the special efficiency of collisions with hydrogen for the transfer of internal energy is found in its influence on the thermal decomposition of ethers[4]. Similar evidence is obtained from ultrasonic measurements on vibrational specific heats[5].

We have also found that traces of mercury vapour slow down oxidation both in hexane + oxygen + nitrogen and in hexane + oxygen + (nitrogen + hydrogen) mixtures. For this purpose mercury was held (at the point A, see Fig. 1 in ref. 3) in a small trough heated electrically so that mercury could be vaporized into the gas stream at the desired temperature. For simplicity, only the inhibition observed in the presence of hydrogen as increased by the presence of mercury vapour is shown in Fig. 2. Since this added inhibition is not sensitive to the concentration of mercury, it may involve the action of mercury atoms as energy sinks in reaction (4). However, chemical inhibition such as could result from the removal of radicals by the formation of mercury derivatives in

$$R\cdot + \mathrm{Hg} \rightarrow R\mathrm{Hg}\cdot \qquad (5)$$

cannot yet be excluded on the basis of the evidence available.

An effect of hydrogen in suppressing the formation of cool flames in pentane[4] appears to be related to the present observations.

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A New Method for the Detection of Amino-Acids, Peptides, Proteins and Other Buffering Substances on Paper

During the past few years, a large number of papers have appeared dealing with the quantitative determination of amino-acids in paper chromatograms *in situ* or after elution; but no simple satisfactory general method has yet been developed. Chemical reactions of the amino-acids on paper cannot easily be controlled, and results obtained from such reactions must be considered semi-quantitative. Elution of amino-acids after location of the spots in ultra-violet light seems to be the most promising method for quantitative estimation hitherto described. This method is based on the interaction between cellulose and amino-acids, which produces fluorescent substances[1]. The amino-acids take part only in the formation of intermediate compounds, from which they can be recovered quantitatively or almost quantitatively. The reactions are complicated and not fully understood[2].

Our method depends on a different principle. If a paper to which several spots of an amino-acid have been applied is sprayed with dilute acid, hydrolysis of the cellulose occurs only in the regions not occupied by the spots, for the amino-acid buffers the latter regions to a pH at which hydrolysis does not occur to a measurable extent. The only remaining requirement is a method of developing the part of the paper which has been hydrolysed. This has been accomplished as follows. The paper previously sprayed with acid is heated to 110–120° C. and then treated with glucose reagents. Orcinol gave the strongest contrast. By replacing hydrochloric acid by sulphuric acid we obtained still better results, depending on more complete hydrolysis and probably on the easier formation of ω-hydroxymethylfurfural from glucose. By the action of sulphuric acid, ω-hydroxymethylfurfural can, however, be converted to lævulinic and formic acids. To avoid this further destruction the orcinol was dissolved in the sulphuric acid solution. In this final method amino-acids applied to the pap as spots could be detected in amounts as small as 0·1

The most satisfactory treatment seems to be th following. The chromatogram is dried and the uniformly sprayed with a solution of 0·1 per cen orcinol in 96 per cent ethanol, made 0·004 *N* i sulphuric acid. (The paper will possibly contain considerable excess of acid with respect to the buffe substances, but the acid concentration can be varie within wide limits.) The paper is dried at 110–120° C and after about half an hour the colour is develope The spots appear white against a red-violet back ground. In ultra-violet light the spots were easil detectable.

Twenty acidic, neutral and basic amino-acid some peptides and proteins have been investigated and all gave easily detectable spots. Fig. 1 show leucine in different concentrations. Fig. 2 shows chromatogram developed with butanol–acetic acid.

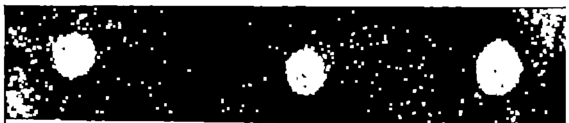

Fig. 1. Spots from left to right contain 5, 10 and 15 γ leucine respectively

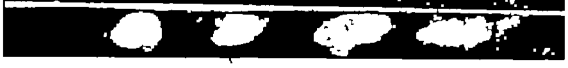

Fig. 2. Spots from left to right contain 5 γ glycine, 10 γ alanine, 15 γ tryptophane and 15 γ isoleucine

It should be noted also that minute amounts o citrate and borate buffers also gave well-defined spots

By eluting leucine, lysine and glutamic acid from paper and determining the amino-acids quantitatively according to the method of Moore and Stein[3], it wa found that the acids were not destroyed by orcino treatment. The results of these preliminary experi ments are given in the accompanying table. Th figures in the right-hand column refer to the orcinol treated paper, those in the left to the untreated paper The deviations are to a large extent due to variation in the ammonia content in the paper.

	Calc. (γ)	Found (γ)
Leucine	5·0	5·7
	10·0	9·5
	15·0	15·1
	20·0	19·9
Glutamic acid	10·0	9·0
	15·0	14·5
	20·0	21·2
Lysine	10·0	11·3
	20·0	19·7
	25·0	23·5

The experiments have shown that the metho described is suitable for the quantitative determina tion of amino-acids on paper chromatograms. Becaus of the greater specificity of the ninhydrin reaction we suggest that the following procedure should b adopted for amino-acid determinations. Two simultaneous chromatograms are run. One of them i developed with ninhydrin to simplify the exac localization of the amino-acids. After removal of th solvent, the other paper is developed with the orcinol reagent. The two chromatograms are then compared and the spots on the orcinol-treated paper corresponding to amino-acids are cut out, eluted and determined quantitatively according to some suitable method.

Peptides and proteins can be detected in minute amounts, although some hydrolysis may occur in the pots, which perhaps limits the method for preparative purposes.

The method should be of a great value also for the detection of other buffering substances which cannot be identified by more specific reactions. A possible generalization of our method would be to treat the paper with a substance the reaction of which is nhibited by the presence of spots of the compounds nder examination.

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Separation of Alkaloids by Paper Chromatography

References to the separation of alkaloids on olumns by partition chromatography have been made by Catch *et al.*[1] and Partridge[2]. The theory and use of buffered columns have been previously described[3-5]. In the separation of the penicillins, buffered filter paper has been used[6], and the difficulty of obtaining absolute R_F values for such separations has been noted[7]. The water-insoluble alkaloids of ergot have been separated on unbuffered paper[8].

We have successfully used buffered filter paper for the separation of the strongly basic solanaceous alkaloids, and the feebly basic water-insoluble alkaloids of ergot.

In the case of solanaceous alkaloids, separation of atropine and hyoscine occur, and buffers of *p*H 5–9 were used. A weak solution of iodine in potassium odide and water was used to detect the alkaloid on the paper. $M/15$ buffer was found to be the most suitable strength, and of the buffers tried phosphate and citrate-phosphate gave the best results, while of the various solvents used *n*-butanol gave the nicest separations. The graphical representation of separations obtained at various *p*H values of a mixture of apoatropine, methyl nitroatropine, atropine and hyoscine is shown in Fig. 1. Similar separations can be made of brucine and strychnine; morphine, narcotine, cocaine and the quinine alkaloids give spots of varying R_F, using butanol and buffered paper.

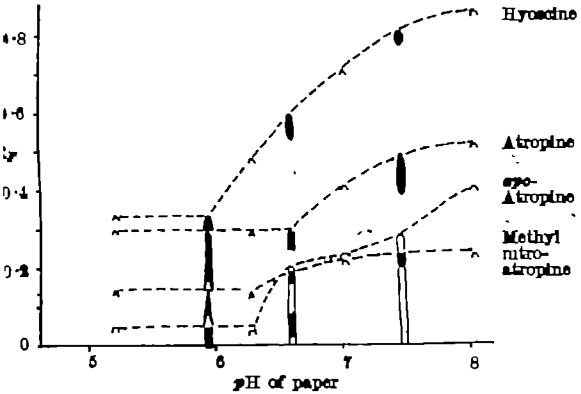

Fig. 1. Chromatograms of solanaceous alkaloids and related products

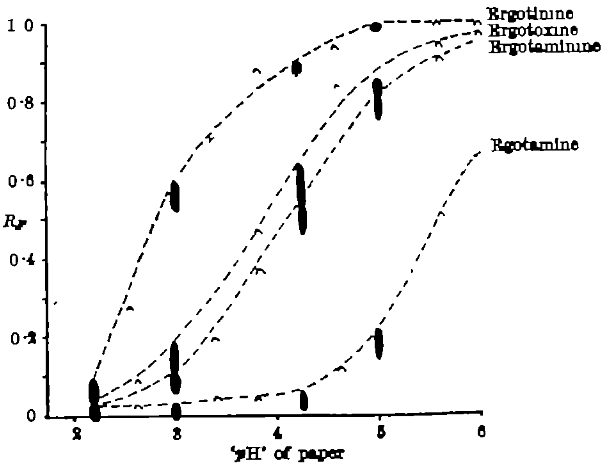

Fig. 2. Chromatograms of water-insoluble alkaloids of ergot

A similar method has been applied to the water-insoluble alkaloids of ergot, with the view of separating the physiologically inactive from the active alkaloids. By the use of buffered filter papers over the range '*p*H 2·2–6', varying degrees of separation of the water-insoluble alkaloids have been carried out. The most satisfactory solvent was diethyl ether saturated with water. In the accompanying graph (Fig. 2) the effect of the '*p*H' of the paper on the R_F value is shown, and the scope of the separations is obvious. With ether as solvent both lysergic and *iso*lysergic acid remain stationary. Ultra-violet light was used to detect the alkaloidal spots.

Quantitative estimations by elution of the alkaloid have not been satisfactory, recoveries varying from 75 to 88 per cent using 15–40 μgm. ergotoxine. These losses are being investigated. No resolution of ergotoxine into ergocristine, ergocornine or ergokryptine was observed in the systems used. Filter-paper chromatography is well suited to the qualitative analysis of the ergot alkaloids in view of the micro amounts used, but for quantitative work more promise is being shown by the use of buffered columns.

It is apparent that by the use of variations in *p*H and different solvents, very complex mixtures of alkaloids should be separable (provided that partition coefficients and/or the *p*K's differ). Thus, valuable information may be obtained for the 'scaling up' of comparable systems for macro separations, the very small amounts of material used in such preliminary investigation being a very desirable feature.

This work will be published in detail and an investigation is proceeding of the quantitative aspects of the separations described.

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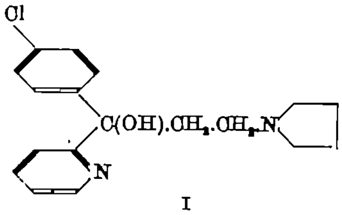
Geometrical Isomers in a Series of Antihistamines

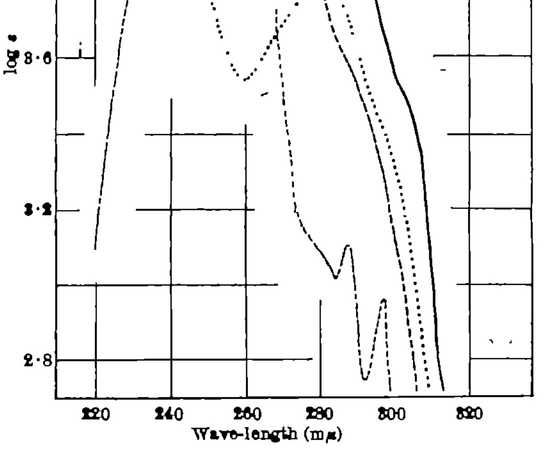
The dehydration of a series of 3-tertiaryamino-1-phenyl-1-α-pyridylpropan-1-ols (for example, I) by heating with 85 per cent sulphuric acid was described recently[1].



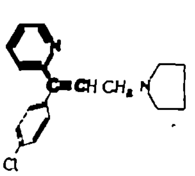
I

The allylamines so produced are of interest as antihistamines, in particular 1-p-chlorophenyl-1-α-pyridyl-3-pyrrolidinoprop-1-ene, also known as 405C49, which is among the most potent of known antihistamines. Further study of the preparation of this compound has revealed the presence of an isomeric base (496C50) in the product of dehydration. The isomers were separated by fractional crystallization of their oxalates (405C49 base, m.p. 61–62°; oxalate, m.p. 184° (decomp.); 496C50 base, oil; oxalate, m.p. 156–157° (decomp.)). The bases are apparently geometrical isomers, for each gave a high yield of the same ketone (p-chlorophenyl α-pyridyl ketone, m.p. 63°) on oxidation with chromic acid, and the same propylamine (n_D^{19}, 1·570; oxalate, m.p. 147°), when catalytically hydrogenated.

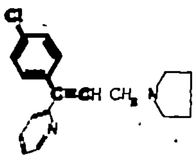
The ultra-violet absorption spectra of the isomers are remarkably distinctive, the one shown by 405C49 being almost identical with that of α-pyridylethylene, while that of 496C50 closely resembles that of p-chlorophenylethylene (see graph). We interpret these spectra as indicating that in 405C49, as in α-pyridy ethylene, the α-pyridyl and ethylenic groups a approximately co-planar, on the generally accepte assumption that this configuration is required f maximal electronic interaction of the two groups i which the characteristic light absorption is relate By the same reasoning, the p-chlorophenyl group 496C50, rather than the α-pyridyl group, is in th same plane as the ethylenic group. These configura tions are represented in formulæ II (405C49) an III (496C50), in which the approximately co-plana groups are heavily outlined. Chemical and physic evidence is being sought to determine the relativ configuration (cis- or trans-) of the aminomethylen moiety: it was not possible to make a decision o this point from examination of available molecul models.



Ultra-violet light absorption spectra. Ordinate, logarithm of molecular extinction coefficient, abscissa, wave-length in mμ ——, 405C49; . . , α-pyridylethylene; - - -, 496C50; – – –, p-chlorophenylethylene



II



III

Further, outstanding differences in chemical be haviour of the isomers have been observed. Fo example, 405C49 can be distilled unchanged unde reduced pressure, whereas 496C50 suffers decom position; 405C49 is unaffected by boiling aceti anhydride, whereas 496C50 is degraded to a mixtur of products of as yet undetermined constitution. W suggest that these differences in chemical reactivit may be attributed to the different resonance system preponderating in the isomers.

The dehydration of many related α-pyridyl carb inols has been re-investigated. In each case th results were similar to the example quoted above two isomers were formed, one being chemically stabl and exhibiting the α-pyridylethylene type of spectrum the other being relatively unstable and having spectrum similar to the corresponding substitute phenylethylene. Separation of the isomers wa usually effected by fractional crystallization of th oxalates or by chromatography, the progress of th separation being followed by measurements of th ultra-violet absorption spectra. The degradation o the unstable (phenylethylene type) isomer by aceti anhydride provided a convenient method for isolatin the stable (α-pyridylethylene type) isomer free fro the former.

The pharmacological properties of the isomer differ in an interesting manner. High and specifi antihistamine activity was shown only by the isomer having the α-pyridylethylene type of structure, th other isomer of each pair invariably being conside ably less active in this respect. In contrast, othe pharmacological activities were approximately of th same low order in both isomers. For exampl 405C49 is about eighty times more potent tha 496C50 when tested on histamine-induced spasm o guinea pig ileum; but the two compounds show onl minor differences in antagonism of acetylcholin spasm in guinea pig ileum, corneal anæsthetic activit in rabbits or toxicity in mice.

This series of isomers thus provides an illustratio of the selective influence of spatial configuration upo chemical and biological reactivity. We are followin up the more fundamental implications of these pre liminary results and intend to examine the application of these concepts to related compounds.

A more detailed description of the present work will be published elsewhere.

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Oxygen Uptake of Nucleated and Non-nucleated Halves of *Amœba proteus*

THE removal of the nucleus causes a slow decrease of the ribonucleic acid content of the cytoplasm of *Amœba proteus*[1]. This indicates that the ribonucleoprotein particles (microsomes) subsist in the cytoplasm only in the presence of the nucleus. However, this nuclear control is not immediate, for the ribonucleic acid content of non-nucleated fragments drops significantly only after the fourth day following enucleation.

It appeared of interest to find out whether the oxygen uptake is under nuclear control; a rapid decrease of respiration after enucleation, as stated by Clark[2], might mean that respiratory enzymes, known to be predominantly bound to mitochondria, are dependent on the nucleus for the maintenance of their activity.

Measurements were made on nucleated and non-nucleated fragments of *Amœba proteus*, cut into two approximately equal parts with the aid of a glass needle, and kept fasting; a cylindrical Cartesian diver (gas volume approximately 7 c.mm.) was used. Preliminary experiments indicated that oxygen uptake is proportional to the number of amœbæ when 10–30 amœbæ per diver are studied. We found an average value of 0·3 × 10^{-4} c.mm./hr./whole amœba; this figure is almost one-fifth of that given by Clark[2] (1·4 × 10^{-3} c.mm.).

Sixty-nine measurements were performed, using 50–100 nucleated and non-nucleated halves; the time interval after enucleation varied from 1 to 10 days and respiration was studied during 4–5 hr. Duplicate experiments gave consistent results within ± 10 per cent.

As Holter and Zeuthen[3] have shown for intact amœbæ (*Chaos chaos*), the oxygen uptake decreases progressively during fasting and a similar phenomenon was found in the present experiments. But, as is shown in Table 1, the ratio between oxygen uptake of nucleated and non-nucleated fragments remains constant for at least nine days, and the uptake of the enucleated fragments 35–45 per cent that of the total.

Table 2

Day after sectioning	1	2	3	8	10
Ratio between tyrosine content of nucleated halves and of non-nucleated halves (N/E)	1·12 1·22	1·29 1·50	1·42	1·78 1·44	1 84

In order to check if the oxygen uptake is proportional to the protein content of the two fragments, we determined their tyrosine content according to the principle adopted by Andresen and Holter[4]; we followed detailed instructions kindly sent to us by Dr. Holter. The equal intensity of the Millon reaction in both types of fragments[1] justifies the choice of this amino-acid. As is shown in Table 2, results of these determinations expressed as the ratio between both fragments are reasonably of the same order as those found for oxygen uptake.

It can thus be concluded from the results that: (1) the oxygen uptake due to the nucleus of the amœba must be proportionally small; (2) the absence of nucleus does not prevent the prolonged maintenance of a normal level of oxidation. It then seems probable that the respiratory enzymes bound to mitochondria are largely independent of the nucleus for the maintenance of their activity.

It has recently been shown by Mazia and Hirshfeld[5] that phosphorus-32 uptake by amœbæ is strongly dependent on the presence of the nucleus: after twenty-four hours, enucleation results in the ratios nucleated : enucleated varying from 3·1 to 6·5. One is therefore led to believe that enucleation leads to a break in the normal coupling between oxidations and phosphorylations: the non-nucleated amœba would thus behave like cells treated with dinitrophenol, which interrupts synthesis by blocking the coupling between oxidation and phosphorylation. Work is now in progress to find out if the nucleus, and in particular the nucleolus, takes any part in the synthesis of the coenzymes necessary for this coupling. Our results, added to those of Mazia and Hirshfeld, give us a better understanding of the 'control' of syntheses by the nucleus.

Table 1

Day after sectioning	1	2	4	5	6	7	8	9	10
Ratio between respiration of nucleated and of non-nucleated fragments (N/E)	1·36 1·26	1·49 1 49	1·48 1·63	1·26	1 47	1·42	1 35 1·22	1 32	1·86 1 71
Oxygen uptake of enucleated fragments as per cent of total	41 44	40 40	43 38	44	40	41	42·5 45	45	35 40

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Ergothioneine in the Seminal Vesicle Secretion

PROTEIN-FREE extracts from the secretory fluid of the seminal vesicles exhibit a marked reducing property towards potassium permanganate and Folin's phosphotungstic reagent in the cold, and towards 2,6-dichlorophenol-indophenol in acid solution. Boar vesicular secretion, which is available in large quantities, was chosen as a convenient source for the isolation of the reducing material. In the course of purification, it was found that the reducing power went parallel with two other chemical properties of the boar vesicular secretion, namely, a strongly positive diazo reaction and the occurrence of organically bound sulphur which could be oxidized by bromine to inorganic sulphate. This suggested to us that the reducing substance may be the imidazole base ergothioneine (the betaine of thiolhistidine), first discovered by Tanret[1] in ergot, and later shown to occur in low concentrations in red blood corpuscles[2-4]. The application of certain analytical procedures for the determination of ergothioneine[5-7], both in the vesicular secretion and blood of boars, showed that the level of ergothioneine in the vesicular secretion averages 40 mgm. per cent as against 6 mgm. per cent in the blood.

The vesicular secretion collected from the seminal vesicles of four boars (1,300 ml.) was diluted with an equal volume of water and centrifuged; the supernatant was deproteinized with zinc hydroxide[8], the extract concentrated to 400 ml., precipitated with an equal volume of ethanol, the alcoholic filtrate concentrated to 200 ml., treated with 10 ml. 10 *N*-sulphuric acid, filtered again, and the water-clear and colourless solution precipitated with a 50 per cent solution of phosphotungstic acid. The precipitate was decomposed with barium hydroxide, and the solution, after removal of barium, was concentrated *in vacuo* to a syrupy consistency. On gradual addition of ethanol and cooling, crystallization set in, and after two days at 5° C., 480 mgm. of crystalline material was obtained. This gave two further reactions characteristic for ergothioneine, namely, a crystalline derivative with mercuric chloride, and trimethylamine on treatment with alkali. After two recrystallizations from 66 per cent ethanol and drying at 105° C., the substance was analysed—found: C, 47·14; H, 6·57; N, 18·24; S, 14·02. $C_9H_{15}N_3O_2S$ requires: C, 47·14; H, 6·59; N, 18·33; S, 13·98 per cent.

The correlation between the reducing power and ergothioneine content in the seminal fluid of other animals is being examined; but preliminary experiments indicate considerable variations in this respect between species.

This investigation was carried out on behalf of the Agricultural Research Council; one of us (E. L.) is indebted to the British Council for a scholarship, and to Prof. D. Keilin for hospitality in this Institute.

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Inactivation of Adrenotropic Hormone (ACTH) by Plasma

The rapid disappearance from the blood of administered adrenotropic hormone (ACTH) has been demonstrated by Sayers *et al.*[1] using an infusion technique on human subjects, and Greenspan *et al.*[2], after intravenous injection into rats.

In view of the importance of these findings, we would like to report that we have observed the rapid inactivation of an adrenotropic hormone preparation during incubation with heparinized plasma from rats, rabbits and humans. Parallel incubation of the same preparation with the solvent containing an equivalent amount of heparin showed no measurable inactivation when assayed by the Sayers adrenal ascorbic acid depletion assay[3].

The Effect of Incubation at 37° C. for 5 min. on an ACTH Preparation with 80 per cent Plasma from Various Sources

Percentage of inactivation		
Rat	Rabbit	Human
74·9	93·5	90·6

These results will have to be borne in mind when attempting to assay the adrenotropic hormone content of blood of these species.

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Sensitivity to Tuberculin

While a reasonable account can now be given of most stages of the mechanism of the urticarial type of skin response to injected antigens, the observed facts concerning the tuberculin or delayed type of reaction cannot yet be adequately explained. One of the main difficulties has been the failure to demonstrate circulating antibodies by the classical Prausnitz–Kuestner technique. However, Chase[1] showed that sensitivity to tuberculin could be passively transferred by the intra-peritoneal or intravenous injection of white cell concentrates from sensitized animals. More recently, this finding has been confirmed by Lawrence[2], who achieved passive transfer in the human by the intradermal injection of white cells from sensitized donors.

On the basis of tissue culture experiments certain workers, notably Rich and Lewis[3], Moen and Swift[4], had previously suggested a theory of 'tissue' or 'cellular' sensitivity to tuberculin, having demonstrated *in vitro* a cytotoxic action of tuberculin upon tissues from animals with experimentally induced tuberculosis. They found unequivocal evidence of the toxic action of tuberculin upon 'sensitized' wandering cells and observed that, while fibroblasts grew out in culture, their growth-rate was reduced and their cytological appearances altered. Aronson[5] and Raffel[6] demonstrated that bone marrow explants from sensitized animals were killed by tuberculin *in vitro*. No susceptibility of cellular elements to the antigen has been demonstrated *in vitro* when the urticarial or Arthus type of sensitivity has been investigated by tissue culture methods.

The development of a technique for growing explants of adult skin in a fluid medium by Medawar[7] has provided an opportunity for observing the effect of tuberculin upon skin *in vitro*. This technique permits a closer analogy to be drawn between the events following intradermal injection of tuberculin *in vivo*

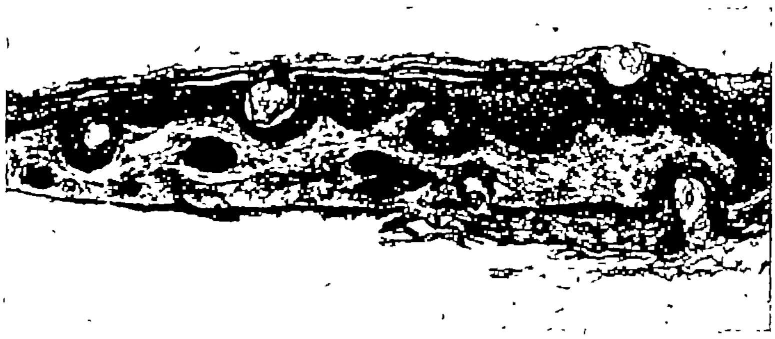

Fig. 1. A 2-day culture of guinea pig skin grown in medium containing purified protein derivative, 0·2 mgm./ml. Hæmatoxylin and eosin (× 100)

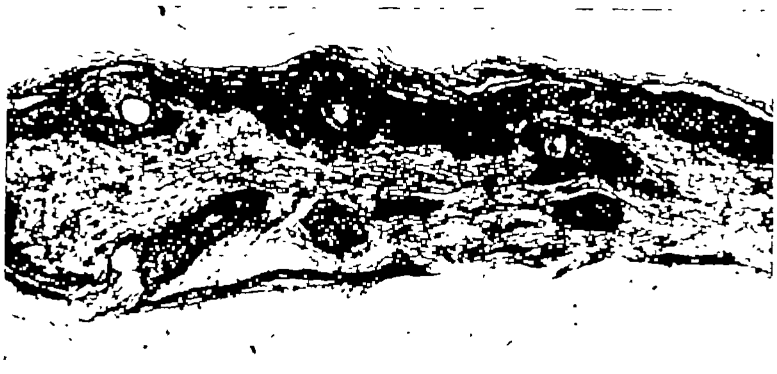

Fig. 2. A 2-day culture of skin from tuberculin-sensitive guinea pig grown in medium containing purified protein derivative, 0·2 mgm./ml. Hæmatoxylin and eosin (× 100)

and the submission of skin to various concentrations of tuberculin *in vitro* than the classical culture techniques using plasma jelly. The cells retain their normal growth pattern; epithelium from the epidermis migrates from the cut edges of the explant along the under surface of the dermis and is joined by epithelium spreading from the hair follicles. The dermis does not undergo any obvious change, but appears to retain its normal anatomical and cellular structure (Fig. 1).

In the experiments to be described a modification of the technique (suggested by Prof. Medawar) was used. Cultivation of skin explants 1–2 mm. square was carried out in 0·5 ml. of medium in 5-c.c. rubber-stoppered bottles in a gas phase of 60 per cent oxygen, 39 per cent nitrogen and 1 per cent carbon dioxide. The medium consisted of five parts serum (usually autologous), three parts Krebs–Ringer phosphate solution, one part 5 per cent glucose and 1 part streptomycin (500 units per ml.). The explants were lightly smeared with 'Vaseline' and floated on the surface of this medium. During cultivation the explants were rocked through 15° each way from the horizontal at about five times per minute.

The principle of the experiment was to compare the effects of tuberculin *in vitro* upon skin explants obtained from tuberculin-sensitive and normal guinea pigs. Sensitization was induced by the intradermal injection of heat-killed tubercle bacillus or by B.C.G. vaccination. The sensitized guinea pigs reacted to at least 1 : 1,000 old tuberculin and gave reactions from 1·5 to 2 cm. in diameter to 1 : 100 old tuberculin.

During cultivation for periods of up to three days, no differences could be detected in the amount and quality of growth between the sensitized and non-sensitized skin even in the presence of very high concentrations of tuberculin. In some instances the concentration of tuberculin (purified protein derivative, 0·2 mgm./ml.) was a hundred times that necessary to produce a tuberculin reaction *in vivo* (Fig. 2).

Proof of the presence of tuberculin in the medium after cultivation was afforded by the intradermal injection of 0·05 ml. of the medium into a sensitized animal in some of the experiments. Definite reactions were produced, although the diameter was somewhat smaller than that produced by the same concentration of fresh tuberculin.

The contrast between the non-reactivity to tuberculin *in vitro* and the tuberculin reaction *in vivo* is striking, and suggests that whatever the cause of the tuberculin reaction it is not associated with a direct cytotoxic effect of tuberculin upon sensitized skin. The evidence for the non-reactivity of the epithelium is weightier than that for the dermal cells, as the former is active in culture while the latter remain quiescent. The possibility cannot be excluded that biochemical changes may have occurred in the local tissue cells of the dermis which could not be detected by histological methods.

I wish to acknowledge the technical assistance of Mr. J. R. Cooper.

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Inheritance of the Human Blood Group Antigen *Jk^a*

A NEW human blood group antigen has recently been reported[1]. The antibody is called anti-*Jk^a*; it divides Europeans into two phenotypes, *Jk*(*a*+) and *Jk*(*a*−). The frequency of the antigen is the same in London as in Boston, Mass.

	Jk(*a*+)	*Jk*(*a*−)	Total
Boston	146 77·25%	43 22·75%	189
London	154 76·62%	47 23·38%	201
Combined	300 76·92%	90 23 08%	390

Fifty-one families have been tested for the new groups. The antigen *Jk^a* is clearly controlled by a gene capable of expressing itself in single or double dose, for $Jk(a+)$ by $Jk(a+)$ matings can have $Jk(a-)$ children, and $Jk(a-)$ by $Jk(a-)$ matings do not have $Jk(a+)$ children. Statistical analysis of the families confirms that the inheritance depends on such a 'dominant' gene. The gene frequencies $Jk^a = 0{\cdot}5196$ and $Jk^b = 0{\cdot}4804$ can be derived from the tests on the 390 unrelated persons. From these frequencies can be calculated the proportion of children expected to be $Jk(a+)$ and $Jk(a-)$ from each of the three types of mating. Table 1 shows that the coincidence of the number of children in these categories, expected and observed, is very close.

Table 1. FIFTY-ONE FAMILIES WITH 124 CHILDREN TESTED FOR THE ANTIGEN Jk^a

Matings			Children				
				$Jk(a+)$		$Jk(a-)$	
Type	Exp.	Obs.	Total	Exp	Obs	Exp	Obs.
$Jk(a+)\times Jk(a+)$	30·2	31	80	71·6	72	8·4	8
$Jk(a+)\times Jk(a-)$	18·1	14	31	20·9	20	10·1	11
$Jk(a-)\times Jk(a-)$	2·7	6	13	0·0	0	13·0	13

Because of certain objections to this manner of analysis, Fisher[2] devised a more critical method for dealing with A_1A_2BO family data which can be easily adapted to the *Kidd* groups by treating $Jk(a+)$ as group B and $Jk(a-)$ as group O. Table 2 shows the good agreement between the observed families and those expected when the calculations are made in this way.

Table 2. ANALYSIS OF $Jk(a+)\times Jk(a+)$ AND $Jk(a+)\times Jk(a-)$ MATINGS

Class of mating	Class of family	Expected No. of families	Observed No. of families	χ^2	d f
$Jk(a+)\times Jk(a+)$	All children $Jk(a+)$	24·5	24	0·05	1
	Some children $Jk(a-)$	6·5	7		
$Jk(a+)\times Jk(a-)$	All children $Jk(a+)$	7·3	5	1·51	1
	Some children $Jk(a-)$	6·7	9		
				1·56 $p = 0{\cdot}42$	2

In the earlier communication[1] it was stated that χ^2 tests failed to show any relationship between the new antigen and the antigens of the *ABO*, *MNS*, *P*, *Rh*, *Lewis* or *Duffy* systems, or sex. The London results support this and also show no relationship to the antigens of the *Lutheran* or *Kell* systems, or to the ability to taste phenyl thiocarbamide.

Although all the 51 families were tested for the other blood groups, and most of them for phenyl thiocarbamide tasting, linkage information is so far rather scanty. The evidence, such as it is, is against the *Kidd* genes, Jk^a and Jk^b, being partially sex-linked or linked to the genes of the *ABO*, *MNS*, *Rh*, or *Kell* blood-group systems, or to the genes for phenyl thiocarbamide tasting.

The *Kidd* blood group is the tenth normal character in man, apart from sex, of which the manner of inheritance is known. The others are, in the order of their discovery: the *ABO*, the *MNS* and the *P* blood groups, the ability to taste phenyl thiocarbamide, the secretion of the *ABO* antigens in the saliva (with which is associated the *Lewis* blood group), and the *Rh*, the *Lutheran*, the *Kell* and the *Duffy* blood groups.

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An Extension of Kosambi's Formula

KOSAMBI[1] proposed the formula

$$y = \tfrac{1}{2}\tanh 2x \qquad (1)$$

as an approximate representation of the relation between the genetical map-length x of a segment and y the amount of recombination over that segment. As corollaries, we have for adjacent segments x_1 and x_2:

$$y_{12} = 2y_1y_2y_{1+2} = 2y_1y_2\,\frac{y_1+y_2}{1+4y_1y_2}. \qquad (2)$$

I have indicated[2] the conditions under which these approximations are valid. If, in particular, the interference is represented by the intercept function $4u \exp -2u$ employed in previous work[2-4], then, for a segment near the (metrical) midpoint of a long arm, we obtain the relation

$$y = \tfrac{1}{2}\,(1 - \cos 2x.\exp -2x).$$

For segments less than 35 cM. in length this function differs from $\frac{1}{2}\tanh 2x$ to an inappreciable degree, the difference in the values of y as given by the two formulæ being only 8 parts in 302 when x is 35 cM. Thus, Kosambi's formula regarded as an approximation receives a simple theoretical justification, and it is seen that it is likely to apply in median segments.

In such a region an elegant representation is available if complex numbers are employed. Introducing the auxiliary quantity z, defined by

$$z = \tfrac{1}{2}\sin 2x \exp -2x,$$

and defining a *complex recombination fraction*, $y + iz$, written as w, we have the identities:

$$1 - 2w = \exp\{-2x(1+i)\},$$

and

$$w_1w_2 = \tfrac{1}{2}(w_1 + w_2 - w_{1+2}).$$

Therefore,

$$\begin{aligned} y_{12} &= \tfrac{1}{2}\,(y_1 + y_2 - y_{1+2}) \\ &= R\{\tfrac{1}{2}(w_1 + w_2 - w_{1+2})\} \\ &= R(w_1w_2) = R(w_{12}), \end{aligned}$$

if we write w_{12} for the product w_1w_2. It is seen that w satisfies the same relation as would be obeyed by y if there were no genetical interference. Thus for two adjacent segments the introduction of complex recombination fractions formally removes the effect of interference, making the 'complex coincidence' w_{12}/w_1w_2 equal to unity.

Also,

$$y_{12} = R(w_1w_2) = y_1y_2 - z_1z_2;$$

but since this relation approximates to that implied by (2), we obtain the useful approximate equation :

$$x_1x_2 \bumpeq (1-2y_1)(1-2y_2)/(1+4y_1y_2), \qquad (3)$$

which holds when x_1 and x_2 are sufficiently small. This last approximation, though deduced for adjacent intervals, clearly holds for non-adjacent ones also.

Hitherto there has been no extension of Kosambi's formula for simultaneous recombination to the case of non-adjacent intervals or to more than two adjacent intervals. This defect can now be remedied. Let y_1, y_2, y_3 ; y_{12}, y_{23}, y_{13} ; and y_{123} refer to adjacent intervals x_1, x_2 and x_3 located in a median region on a long arm. Then using the method of calculation previously indicated[2], we obtain :

$$y_{13} = y_1y_3 - x_1x_3 \exp -4x_2$$

and

$$y_{123} = R(w_1w_2w_3) + \tfrac{1}{2}x_1x_3(1 - \exp -4x_2). \qquad (4)$$

In the case of two adjacent intervals y_{12}, the frequency of simultaneous recombination is given by $R(w_1w_2)$. However, formula (4) shows that in the case of three such segments the analogous quantity $R(w_1w_2w_3)$ under-estimates y_{123}, as is otherwise obvious, because, relative to their lengths, the interaction between x_1 and x_3 is less than that between two adjacent segments.

Employing formulæ (1) and (3), we obtain as further approximations

$$y_{13} = y_1y_3\left\{1 - \frac{(1-2y_2)}{(1+2y_2)} \cdot \frac{(1-2y_1)(1-2y_3)}{(1+4y_1y_3)}\right\},$$

and

$$y_{123} = y_1y_{23} - y_2y_{13} + y_3y_{12}.$$

These formulæ have the merit of containing only the segmental recombination values y_1, y_2 and y_3. They constitute a theoretically satisfactory generalization of Kosambi's system. They enable the frequencies of the modes of gamete formation with as many as five linked loci to be expressed in terms of the segmental recombinations only.

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Digestion of Alpha-Cellulose by Larvæ of *Anobium punctatum* De Geer

Parkin[1] demonstrated that the larval gut of the common house borer *Anobium punctatum* De Geer contained an enzyme or enzymes which produced reducing sugars from isolated oak α-cellulose *in vitro*. Falck[2] and Müller[3] concluded from chemical analyses of sound and digested wood that some α-cellulose was digested by the larvæ. The present investigation was undertaken to determine the amount of α-cellulose digested and its significance in the total diet of *Anobium punctatum*.

Of the four methods[1] available for investigation of the nutrition of wood-destroying insects, only the comparison of chemical analyses of sound and digested wood is applicable to this investigation. This method shows whether changes have occurred in the proportions of the constituents following digestion but cannot show the amounts digested unless an assumption is made that one component is unaffected by the digestive enzymes of the larvæ. Most workers have assumed that lignin is inert during digestion. If this is so, the amounts of other components digested are readily calculated from the lignin ratio of sound and digested wood.

Table 1. Lignin Content of Wood and Frass Samples

	Lignin content* : per cent w/w on equivalent oven-dry basis		Lignin ratio‡
	Wood	Frass	
A	31·00	38·46	0·806
B	30·79	37·01	0·832
C	30·76	37·91	0·811
D	30·13	37·30	0·808
E	33·67†	38·83	0·867
F	29·49	36·40	0·810
X	29·84	38·33	0·779

* Mean of two determinations ; standard error of mean lignin value 0·14 per cent. † Mean of four determinations : 33·48, 33·80, 33·72, 33·68 per cent. ‡ Standard error of lignin ratio 0·005.

Six blocks (*A*, *B*, *C*, *D*, *E*, *F*) of sapwood kahikatea (*Podocarpus dacrydioides* A. Rich.) each from a different tree and infested with *A. punctatum* were used as a source of material for analyses. A single block (*X*) of sapwood matai (*P. spicatus* R. Br.) was also used. Blocks were split, frass removed from larval tunnels, and the frass-free splints passed through a grinding mill to obtain the wood samples. The frass from each block was collected and sieved on a 100-mesh screen to free the fæcal pellets from chewings[4] of undigested wood. Wood and frass samples were extracted first with ether and then with acetone before analyses. Results are reported on a basis of extracted wood or frass. Lignin was determined by the 72 per cent w/w sulphuric acid method outlined by Purves[5]. Alpha-cellulose contents of the samples were obtained by the methods of Wise, Murphy and D'Addieco[6] and Wise and Ratliff[7], first isolating holocellulose by action of acidified sodium chlorite at 75°–80° C., and then extracting the holocellulose with 25 per cent w/w potassium hydroxide at room temperature, for three hours, under nitrogen.

Lignin content of each wood and frass sample, and their lignin ratio $\frac{\text{lignin content of wood}}{\text{lignin content of frass}}$ is listed in Table 1.

Since some wood has been destroyed by digestion, the α-cellulose values obtained by analyses of frass cannot be simply subtracted from the α-cellulose values of the matched wood sample to obtain the amount of α-cellulose digested. However, if no

Table 2. Cellulose in Wood and Frass Samples and the Calculated Digestibilities of Wood and Cellulose

	Percentage* cellulose in wood	Corrected frass cellulose†	Difference equals cellulose digested	Cellulose digested as percentage of cellulose in wood	Apparent total digestibility of wood‡	Discrepancy§
A	46·2	30·8	15·4	33·3	19·4	4·0
B	48·1	33·6	14·5	30·1	16·8	2·3
C	48·9	30·8	18·1	37·0	18·9	0·8
D	45·1	31·2	13·9	30·8	19·2	5·3
E	42·6	30·9	11·7	27·5	13·3	1·6
F	48·6	32·4	16·2	33·3	19·0	2·8
X	47·1	28·4	18·7	39·7	22·1	3·4

* By analyses of wood samples. † Cellulose in frass X lignin ratio. ‡ Apparent total digestibility of wood : (1-lignin ratio). § Wood digested other than cellulose (apparent total digestibility minus cellulose digested).

lignin has been digested, the lignin ratios in Table 1 are numerically equal to the weight of frass derived from a gram of ingested wood. Therefore, to obtain α-cellulose values of frass samples as a percentage of the wood ingested, the α-cellulose values obtained by analyses of frass samples have been multiplied by the lignin ratios in Table 1. The α-cellulose values of wood and the corrected α-cellulose values of frass, together with relevant calculations of digestibility of wood and α-cellulose, are given in Table 2.

From Table 2 it is apparent that differences in α-cellulose content of matched wood and frass samples account for all but a few per cent of the calculated total digestion. The wood digested, other than α-cellulose, must include some protein and probably starch and free sugars since an amylase is known to be present in the gut extracts[1].

Since only about one-third of the α-cellulose present in the wood is digested, it is interesting to speculate whether the amount of some substance or substances present in wood determines the extent to which α-cellulose can be utilized. Such material is unlikely to be part of the carbohydrate complex but could well be protein and/or accessory growth-factors, the significance of which in the nutrition of *A. punctatum* is as yet unknown.

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Zinc Requirements of *Aspergillus niger*

Zinc is indispensable for the growth of all the higher plants, fungi, Actinomycetes and bacteria which have been examined, yet little is known of the role of zinc in metabolism[1,2]. Evidence has been presented recently, however, that phosphatase of *Penicillium chrysogenum* is a zinc-containing enzyme[3].

The zinc requirements of fungi have been determined largely from experiments in which glucose or sucrose has been used as the source of carbon. In the experiments described below the zinc requirements of *Aspergillus niger* were determined when the latter was grown on media involving a number of different carbon sources. The fungus was grown in surface culture in 100-ml. 'Hysil' or 'Pyrex' conical flasks in triplicate and harvested after 4 days incubation at 28° C. The basal medium contained ammonium nitrate, 0·3 per cent; dipotassium hydrogen phosphate, 0·05 per cent; magnesium sulphate, 0·05 per cent; iron, 0·5 p.p.m.; copper, 0·1 p.p.m.; and manganese, 0·05 p.p.m.

The media containing glucose, glycerol and peptone as carbon sources were purified free from zinc by extracting with chloroform solutions of diphenylthiocarbazone at pH 7·6[4], and those containing citric and gluconic acid by extracting with chloroform solutions of 8-hydroxyquinoline at pH 5·2[5]. Zinc was added as $ZnSO_4.7H_2O$ in graded amounts and growth response curves obtained.

Table 1 shows that for a given carbon source such as glucose there is a constant relationship between the amount of carbon used, the amount of growth made and the minimum amount of zinc required.

Table 1

Sole source of carbon (gm %)	Mycelial weight (gm.)	Minimum zinc requirement for optimum growth (p.p.m.)	Zinc requirement per gm. of mycelium (p.p.m.)
Glucose 0·25	0·018	0·015	0·83
Glucose 2·0	0·14	0·1	0·715
Glucose 5·0	0·38	0·3	0·79

Table 2 shows the relative zinc requirements for growth with different carbon sources.

Table 2

Sole source of carbon (gm. %)		Mycelial weight (gm.)	Minimum zinc requirement for optimum growth (p.p.m.)	Zinc requirement per gm. of mycelium (p.p.m.)
Glucose	2	0·14	0·1	0·715
Glycerol	5	0·069	0·05	0·725
Gluconic acid	5	0·15	0·015	0·10
Citric acid	5	0·074	<0·01	<0·18
Peptone	1	0·02	0·05	2·5

It will be seen that zinc is essential for growth on all the carbon sources; but considerably less is required for the metabolism of organic acids than for glucose or glycerol. It would appear, therefore, that zinc is chiefly required for some process involved in the metabolism of glucose or glycerol. It will also be seen that the zinc requirements for the utilization of glucose and glycerol, while being considerably greater than for the utilization of acids, are similar to each other. This may indicate that the utilization of glucose and glycerol involves the same metabolic pathway which would be expected if the Embden–Myerhof scheme exists in fungi, and that the zinc requirement occurs in that part of the metabolic path involved in the utilization of both substances; that is to say, after the formation of the triose phosphates in the Embden–Myerhof scheme.

The apparently high zinc requirement for the metabolism of peptone may be due largely to the formation of zinc complexes with the latter, thus diminishing the available concentration of zinc.

If the similar zinc requirements for the utilization of glucose and glycerol and for gluconic and citric acid do imply a similarity of metabolism, it may be that a study of minimum trace element requirements would be of value in determining whether two substances are metabolized by similar or different pathways.

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A Case of Disturbed Metabolism in *Daphnia magna*

IN the first half of January this year, a marked decrease in the rate of reproduction was noticed in ultures of *Daphnia magna* that are being kept on a ood of different algæ (mainly *Scenedesmus* sp.) at 8–20° C. The algæ cultures are kept in large aquaria with fountain water with occasional addition of mall quantities of nitrates and phosphates. These ultures are aerated artificially and illuminated with normal light bulb.

Nothing else could be observed in the mother nimals except the lack of active ovaria in many of hem and a rather unusual amount of fat droplets. At the end of the same month the rate of reproduction had fallen to practically zero; the mortality ad also increased, and moulting took place only xceptionally. Closer observation of the animals evealed the fact that they were completely filled with fat droplets of a pink colour. These fat roplets formed a massive cover around the intestinal ract, from the first third of it down to the anus, while a great number of them could even be found t the base of the abdominal end claws. The thoracic ppendixes were filled with droplets of the same olour, and they were even detected around the ephridia. Of the ovaries nothing could be seen. While well-fed *Daphnia magna* (with large fat reerves) can be starved for many days, during which hey use up the fat, these abnormal animals would not consume their fat reserves during starvation, but died within about two days.

This irreversible fat-storage led to the idea that he *Daphnia* might be deficient in some substance, which either the algæ or the animals could not produce under the conditions offered to them. To nd out whether there was really a kind of deficiency nvolved or not, the following experiments were made.

The animals were split into five groups of equal umbers: (1) and (2) the animals were kept as controls nd continued to feed upon the mixture of algæ as efore; (3) besides algal food, the animals received nely dispersed egg-yolk for twelve hours every ay; (4) instead of egg-yolk a suspension of baker's east was given for twelve hours every day; (5) the nimals received the same food as before, but they were put twice a day under the light of a mercury arc Original-Hanau Analysen-Quarzlampe) for five mintes at a time, at a distance of 20 cm. from the arc, sing a filter.

Results. After the first day of treatment the nimals of groups (3) and (4) already showed increased itality. After the second day of treatment first gns of resumed ovarian activity were observed in oth groups. The control animals and those of group 5) showed no change in behaviour. After the third ay all animals of group (3) had moulted and most them carried summer-eggs. In group (4) most nimals had moulted and showed active ovaria. The ther animals continued to die and no moulting was bserved. After the fourth day some animals of roup (3) released young, and all animals were now arrying summer-eggs. *Daphnia* of group (4) showed eggs of the same type. Groups (1), (2) and (5) still howed no [illegible] of improvement. After this, treatment as stopped [illegible]d all animals were put back on normal ood. While the animals of groups (1), (2) and (5) till showed the same pink colour as before, those of roups (3) and (4) looked pale; their fat reserves ere of yellowish colour and reduced to normal size.

In the following days, some of the control animals and some of group (5) also showed some improvement—moulting and a slight egg-production.

Situation after three weeks. The animals of groups (3) and (4) have a high reproduction-rate (about 20 young per moult per animal); colour, yellowish-brown; fat storage small; about two-thirds of the animals have died since the beginning of the treatment. The control animals and those of group (5) have a poor reproduction (2–3 young per moult per animal); low vitality; pink colour, with abnormal large fat accumulations; of forty-five animals at the beginning of the experiment only three are still living.

It should be mentioned that during this period of abnormal behaviour the production of males or of sexual eggs was never noticed; this is true for the treated animals as well as for the untreated ones. The oxygen consumption, as measured by the Warburg technique, showed the following figures in c.mm. oxygen per 15 min. per mgm. dry weight: before and after metabolic disturbance, $M = 2\cdot97$ c.mm./15 min./mgm., $\varepsilon = \pm\ 0\cdot10$; during period of disturbed metabolism, $M = 5\cdot50$ c.mm./15 min./mgm., $\varepsilon = \pm\ 0\cdot16$.

These results support the idea that the abnormal metabolism described above has its origin in some food deficiency. Of course, the complexity of the egg-yolk and of the yeast does not allow the type of deficiency to be specified.

EDITH FLÜCKIGER

Institute of Limnology,
Institute of Pharmacology,
University of Lund. March 15.

University College of Science
PHYSIOL Dept.
92, Upper Circular Rd, Calcutta

Heart-beat of the Hibernating Hedgehog

THE most characteristic feature of the physiology of hibernation is the changing of a homoiothermic mammal within certain limits into a poikilothermic animal. Thus, for example, the body temperature of the hedgehog may decrease during hibernation to about 2° C. When the animal wakes from hibernation, its body temperature rises in some hours from 2°–5° C. to 30°–35° C. again, and the animal returns to homoiothermy.

Owing to the low body temperature, the metabolism of the animal is greatly reduced during hibernation. This also has an effect on the heart function. The effect of hibernation on the physiology of the heart and the circulatory system has been but little investigated, however (cf., for example, Endres and collaborators[1], Ferdmann and Feinschmidt[2], and Suomalainen and Sarajas[3]).

With the aid of electrocardiograms we found that the mean normal heart-beat of the hedgehog (body-weight 420–920 gm.) is 188 per min. During hibernation (body-weight 420–770 gm., body temperature 6·2–7·7° C.) the mean heart-beat was 21 per min. The reason for this is primarily the lowering of the body temperature and strengthening of vagus tone, probably also increase in magnesium, decrease in potassium, and increase in carbon dioxide content of the blood during hibernation.

PAAVO SUOMALAINEN
SAMULI SARAJAS

Zoological Laboratory,
University of Helsinki. April 5.

[1] Endres, G., Matthews, B. H. C., Taylor, H., and Dale, Alison, *Proc. Roy. Soc.*, B, 107, 222 (1931).

[2] Ferdmann, D., and Feinschmidt, O., *Ergebn. Biol.*, 8, 1 (1932).

[3] Suomalainen, Paavo, and Sarajas, Samuli, *Ann. Zool. Soc. 'Vanamo'*, 14, 2, 1 (1951).

FORTHCOMING EVENTS

Wednesday, August 8—Wednesday, August 15

British Association for the Advancement of Science (at Edinburgh).—Annual Meeting.

Wednesday, August 8

At 8.15 p.m.—H.R.H. The Duke of Edinburgh, K.G., F.R.S.: "The British Contribution to Science and Technology in the Past Hundred Years" (Presidential Address).

Thursday, August 9

At 10 a.m.—Sir David Brunt, F.R.S.: "A Hundred Years of Meteorology (1851–1951)" (Presidential Address, Section A).

At 10 a.m.—Sir Cyril Hinshelwood, F.R.S.: "Chemistry at the Mid-Century" (Presidential Address, Section B).

At 10 a.m.—Dr. C. F. A. Pantin, F.R.S.: "Organic Design" (Presidential Address, Section D).

At 10 a.m.—Dr. O. J. R. Howarth: "The Centenary of Section E" (Presidential Address, Section E).

At 10 a.m.—Sir Henry Beresford-Peirse, Bart.: "British Forestry in the Last Century" (Chairman's Address, Section K*).

At 10 a.m.—Dr. E. M. Crowther: "Experimental Agriculture" (Presidential Address, Section M).

At 12 noon—Prof. C. A. Mace: "Psychology and the Laity" (Presidential Address, Section J).

At 12 noon—Prof. W. Brown, F.R.S.: "Mycology over a Century" (Presidential Address, Section K).

At 2.30 p.m.—Dr. D. A. Allan: "The Scottish Scene" (Presidential Address, Conference of Delegates of Corresponding Societies).

At 5.30 p.m.—Sir Edmund Whittaker, F.R.S.: "Eddington's Principle in the Philosophy of Science" (Eddington Memorial Lecture).

Friday, August 10

At 10 a.m.—Prof. R. G. Hawtrey: "The Nature of Profit" (Presidential Address, Section F)

At 10 a.m.—Sir Claude Gibb, F.R.S.: "Two Thousand Years of Engineering" (Presidential Address, Section G).

At 10 a.m.—Sir Cyril Fox: "The Study of Early Celtic Metalwork in Britain" (Presidential Address, Section H)

At 10 a.m.—Sir Hector Hetherington, K.B.E.: "Mid Century—Retrospect and Prospect" (Presidential Address, Section L)

At 5.30 p.m.—Prof. C. A. Coulson, F.R.S.: "The Place of Science in the Christian Faith" (arranged by the Research Scientists' Christian Fellowship).

At 8 p.m.—Prof. John Read, F.R.S.: "Alchemy and Alchemists".

Sunday, August 12

At 8 p.m.—The Very Rev. John Baillie: "Natural Science and the Spiritual Life."

Monday, August 13

At 10 a.m.—Prof. W. B. R. King, F.R.S.: "The Influence of Geology on Military Operations in North-West Europe" (Presidential Address, Section C).

At 10 a.m.—Prof. H. P. Gilding: "Physiology of the Capillaries" (Presidential Address, Section I).

At 7.30 p.m.—Session on "World Communications—The Impact of Speed" (Speakers will include Sir Edward Appleton, F.R.S., Sir Ben Lockspeiser, F.R.S., Dr. Edward Warner and Prof. P. Auger).

At 8 p.m.—Sir Edward Salisbury, F.R.S.: "The Contemplative Gardener."

APPOINTMENTS VACANT

Assistant (Scientific) in the Plant Protection Chemistry Section—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (August 11).

Head of the Engineering Department, and a Head of the Natural Science Department, of the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges of Arts, Science and Technology, 15 Victoria Street, London, S.W.1 (August 11).

Junior Cytogeneticist at the Commonwealth Potato Collection at Cambridge—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (August 11).

Physical Chemist on the Engineer's Staff—The Clerk to the Birmingham Tame and Rea District Drainage Board, 117 Colemore Row, Birmingham 3 (August 11).

Physicist to the Radiotherapy Department—The Secretary, Romford Group Hospital Management Committee, Oldchurch Hospital, Romford, Essex (August 11).

Assistant Lecturer or Lecturer in the Department of Botany, with a special interest in mycology—The Secretary, The University, Edmund Street, Birmingham 3 (August 13)

Lecturer in the Biochemistry Department, and an Assistant in Pathology in the Department of Animal Pathology, in the University Veterinary School—The Secretary of University Court, The University, Glasgow (August 15).

Lecturer (with a good honours degree in chemistry, research experience in physical chemistry, and prepared to teach the subject to B.Sc. Special standard) in Physical Chemistry, and an Assistant (with a degree in electrical engineering, or some equivalent qualification) in the Department of Electrical Engineering—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (August 15).

Professor and Head of the Department of Aircraft Design—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks, endorsed 'Professor of Aircraft Design' (August 15).

Engineer I at a Ministry of Supply establishment in Berkshire, for design and development work on schemes for production of useful power from atomic energy—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.68/51A (August 18)

Engineer I by the Ministry of Supply in London, for capacit, assessment in aircraft manufacture and repair, advice on jigging tooling, repair methods, etc.—The Ministry of Labour and Nationa Service, Technical and Scientific Register (K), York House, Kingswa London, W.C.2, quoting C.411/51A (August 18).

Engineer/Chemist I by the Ministry of Supply in London, t be responsible for planning and production of respirators and anti-ga stores—The Ministry of Labour and National Service, Technical an Scientific Register (K), York House, Kingsway, London, W.C. quoting C.412/51A (August 18).

Lecturer in Electrical Engineering—The Registrar, King' College, Newcastle-upon-Tyne (August 18).

Research Studentship in the Department of Physics (in th field of U.H.F. radio research)—The Registrar, University Colleg Hull (August 18).

Assistant Registrar (woman, graduate, preferably in Science)—The Principal, Royal Holloway College, Englefield Green, Surre (August 20).

Studentships in Biophysics and in Medical Physics—Th House Governor, Royal Cancer Hospital, Fulham Road, Londo S.W.3 (August 20).

Junior Technical Assistant (Electrical) in the Engineerin Branch of the Production Department at London Headquarter —The National Coal Board, Establishments (Personnel), Hobar House, Grosvenor Place, London, S.W.1, quoting TT/362 (August 21

Principal Scientific Officer in the Intelligence Division o the Department of Scientific and Industrial Research—Th Secretary, Civil Service Commission, Scientific Branch, Trinida House, Old Burlington Street, London, W.1, quoting S.4051/5 (August 23).

Lecturer in Electrical Engineering, and a Statisticia (temporary) in the Department of Social and Industrial Medicine—The Registrar, The University, Sheffield (August 25).

Research Microbiologist in the domestic preservation of frui and vegetables section at Long Ashton Research Station—Th Registrar and Secretary, The University, Bristol (August 25).

Head of the Department of Mathematics (with the status o Reader), Makerere College (University College of East Africa)—Th Secretary, Inter-University Council for Higher Education in th Colonies, 1 Gordon Square, London, W.C.1 (August 31).

Senior Lecturer in Geography at Auckland Universit College, New Zealand—The Secretary, Association of Universitie of the British Commonwealth, 5 Gordon Square, London, W.C. (September 8).

Chair of Civil Engineering at the University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Adelaide, September 30).

Agricultural Superintendent for extension work in Sierr Leone—The Director of Recruitment (Colonial Service), Coloni Office, Sanctuary Buildings, Great Smith Street, London, S.W.1 quoting 27059/220.

Assistant Forecaster (with a university degree, preferably i science and specialized in meteorology) for the Basrah Port Directorate—The Crown Agents for the Colonies, 4 Millbank, Londo S.W.1, quoting M.26338.B

Assistant Lecturer in Pharmacognosy—The Secretary, Roya Technical College, Glasgow.

Assistant Research Manager in the Research and Development Branch, Windscale Works, Sellafield, Cumberland, to lead a applied research group investigating a wide range of problems associated with atomic energy development—The Ministry of Supply Division of Atomic Energy (Production), Risley, Warrington, Lanc

Cerealist by the Government of Iraq for the Directorat General of Agriculture, to improve the field and quality of cere crops (mainly barley, wheat, rice and millet) by selection and breedin —The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 quoting M.18187.A.

Consultant Scientist (preferably with a degree in bacteriolog mycology or biochemistry) to advise the Ministry of Agriculture o the utilization and conservation of horticultural products grown i the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Consultant Scientist 401'.

Demonstrator in Pharmaceutical Subjects—The Registrar Municipal College, Portsmouth.

Departmental Assistant (university graduate) in Agricultur at the School of Agriculture, Sutton Bonington—The Registrar, Th University, Nottingham.

Graduate (with a science degree, with physics or mathematics) fo operational research in the wool industry—The Secretary, Wo Industries Research Association, Torridon, Headingley, Leeds 6.

Insecticide Chemist in the West African Cacao Researc Institute—The Director of Recruitment, Colonial Office, Great Smit Street, London, S.W.1, quoting 27106/39.

Lecturer in Dairy Husbandry at Massey Agricultural Colleg Palmerston North, New Zealand—The Secretary, Association Universities of the British Commonwealth, 5 Gordon Square, Londo W.C.1.

Lecturer in Mathematics, and an Assistant Lecturer (Grade in the Department of Chemistry—The Clerk to the Governin Body, Battersea Polytechnic, Battersea, London, S.W.11.

Lecturer in Pure Mathematics or Applied Mathematics—Prof. W. G. Guthrie, Magee University College, Londonderry.

Male Assistant (Scientific) in the Hydraulics Researc Organization (Department of Scientific and Industrial Research Wallingford, to assist in hydrographic surveying of beaches an estuaries and also to assist in research into the effect of waves an currents on beaches—The Ministry of Labour and National Servic Wallingford, Berks, quoting No. 141.

Public Health Engineer in the Public Works Departmen Sierra Leone, to undertake anti-malarial drainage and other urba works—The Director of Recruitment (Colonial Service), Coloni Office, Sanctuary Buildings, Great Smith Street, London, S.W.1 quoting 27322/201.

Senior Physicist to the Radiotherapy Department—Th Group Secretary, Wolverhampton Hospital Management Committe Royal Hospital, Wolverhampton.

NATURE

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SCIENCE AND THE LAYMAN

TWENTY years ago, at its centenary meeting in London in 1931, and again in returning to the scene of its first meeting in York in 1932, the British Association, both in the presidential addresses and in the proceedings of the meetings, looked back over the progress of science during the previous century, and in particular at the way it had assumed an increasingly important place in the life of the community. The annual meeting of the Association remains to-day, however, what it has been from its earliest years—the principal public forum in Great Britain for the review and general discussion of progress in all branches of science. The meeting in Edinburgh is thus appropriately regarded as part of the Festival of Britain, which aims at displaying the British contribution to civilization in the arts, in science, and in industrial design.

The Council of the Association decided at an early stage, accordingly, that it would be fitting for the programme of this 1951 meeting to include reviews of progress during the past century and, without substantial alteration to the normal character of the programme, some twenty reviews of progress in particular topics are being presented at this Edinburgh meeting. The presidential address of H.R.H. the Duke of Edinburgh, which is printed on p. 219 of this issue, reviews the British contribution to science and technology in the past hundred years, and what is worth noting here in the first place is that while the other addresses, like the presidential addresses at London and at York, are by men of science, the president disclaims any such title. At the outset he insists that he addresses the Association as a layman, and that his review is an endeavour to give an impression from outside of the march of science in the past hundred years and of the community's appreciation of the work of scientific men and women. But he is too modest in his estimate of his own claims to address the Association: his professional training in itself involves some elements of technology, if not of science; and it is manifest from this address that the President's appreciation and understanding of the outlook and achievements of science are in no way inferior to those of the Prince Consort, who occupied the presidential chair at Aberdeen in 1859. The Duke of Edinburgh in his address has ranged over a variety of subjects in science and technology, infinitely more complex than those displayed to his great-great-grandfather, and touched them with a discrimination and balance that few of the numerous addresses of a similar kind delivered during the present year have approached.

That may indeed be one justification for one who claims to be a layman addressing the Association from its presidential chair, and if, as the Duke of Edinburgh suggests, the very invitation demonstrated that science is not a magic circle, his address should help further to dispel the idea that science and technology are magic or mysterious activities apart from the ordinary activities of men and women and beyond their comprehension. In the modern world, such an impression is highly dangerous to the continuance of science, and, at a time when in Great Britain and in other countries the prosecution of scientific research depends more and more on public funds for support and less on private benefactions, it is of first-rate importance that the nature of scientific work should be clearly and widely understood.

The contribution of the Duke of Edinburgh's address to such a wider understanding is of real service to science. Besides this, in reviewing the implications of the British contribution to science in the past century and the lessons to be learnt from those achievements, he emphasizes some of the factors upon which continued advance depends, and indeed the economic prosperity of the British people. This part of his address is reminiscent of Sir Henry Tizard's presidential address at the Brighton meeting of the Association, from which indeed he quotes ; but even more than his review of the past, it bears the new President's distinctive imprint, and some of these warnings of the layman are not to be disregarded.

The Duke of Edinburgh recognizes to the full, for example, the value of co-operation and team-work in science and the way in which, with the growing complexity of research and the mounting cost of equipment, scientific and technical advance depends on such equipment. None the less, he points out that the basic discoveries which mark the great advances depend on the accident of individual genius, and it would be disastrous if no place were left for the individual investigator working in his own laboratory. Scientific discovery, in fact, only flourishes where it finds the right conditions, and of these the social climate is one of the most important. That is manifestly appreciated by the Duke of Edinburgh, though he obviously could not point to the risk of political climate discouraging initiative and enterprise. For example, it has been stated recently that the benefits of chemical industry, which has contributed so much to medical advances and the relief of suffering, might well cease to flow in the absence of competition and that new remedies might never be developed for the public benefit because of the disturbance involved to existing products. Only an alert and informed public opinion can prevent such dangers and ensure the social and political climate in which science and technology thrive.

The President is clearly aware of the vital importance of educating public opinion in all such matters, and if he spoke as a layman and amateur, it is well to be reminded that laymen and amateurs have still important contributions to make to science. Indeed, it may be questioned whether there can be any really wide understanding of what science is and how it works, save in so far as members of the community participate in some scientific activity at least in an amateur capacity. So long as they are based on a clear understanding of scientific principles and the method of science, the activities of the amateur photographer, the radio amateur, the bird watcher and many others all contribute to that end ; the great value of the field-work which is now receiving increasing attention is that it teaches students of a wide range of types how to pursue open-air activities which appeal to them in a scientific way.

Such work, quite apart from fresh observations to be added to the store of scientific knowledge, is of great value and is to be welcomed as assisting in turn the wider understanding of what science is. In its way such educational work is fully as important as the finding of a solution to the problem of higher technological education to which the Duke of Edinburgh specifically refers. Here, and elsewhere, his address indicates problems requiring urgent attention, and he need be in no doubt that the scientific men in Great Britain will find his address as stimulating as it is full of interest. But above all, it is to be welcomed as a fresh demonstration that the layman and amateur, using that word in its fine original sense, have a vital contribution to make in furthering mutual understanding between the man of science or technologist and the citizen ; an understanding which is essential both for the furtherance of the conditions in which creative scientific work can flourish and for the application of scientific knowledge for the benefit of mankind.

FIFTY YEARS OF PROGRESS IN SCIENCE

Scientific Thought in the Twentieth Century

An Authoritative Account of Fifty Years' Progress in Science. Edited by Prof. A. E. Heath. Pp. xv+387. (London : Watts and Co., Ltd., 1951.) 42s. net.

THIS book is a number of essays by thirteen authorities on their respective branches of science with an introduction by Prof. A. E. Heath, which is followed by a chapter on the philosophy of science by Prof. A. J. Ayer. The contributors are Prof. R. A. Fisher on statistics, Sir Harold Spencer Jones on astronomy, Prof. F. Llewellyn Jones on physics, Dr. Andrew Kent on chemistry, Prof. Duncan Leitch on geology, Prof. P. B. Medawar on zoology, Dr. E. B. Ford on genetics, Dr. J. C. Hawksley on general medicine, Dr. Alice Stewart on social medicine, Dr. Derek Richter on neurology, Sir Cyril Burt on psychology, Prof. Meyer Fortes on social anthropology and Donald G. Macrae on sociology. The editor and publishers are to be congratulated on bringing together the work of such a galaxy of men of science ; this in itself is indicative of the quality of the book.

Nevertheless, each author seems to have been restricted to a mere 7,000–9,000 words. Some of the writers have the gift of putting a quart, or often a gallon, into a pint pot, others clearly have felt themselves to be unduly hampered by lack of space ; but without exception an outline, albeit sketchy, of a half-century of progress in their respective subjects has been clearly and faithfully presented. It would appear unfair to single out a particular essay as outstanding, but Prof. R. A. Fisher's contribution seems to be particularly useful, in that he explains the nature of certain tools of research which he himself has helped to forge, and which have been so useful in the development of the biological and social sciences, described by some of the other contributors. Fisher sums up his position thus : "In the present century we have learnt (i) to conserve in its statistical reduction the scientific information latent in any body of observations, and (ii) to conduct experimental and observational inquiries so as to maximize the information obtained for a given expenditure".

It is strange that there is not a chapter on botany, especially as that on genetics only deals with the vegetable kingdom in the early paragraphs on Mendel. It is pleasing to find essays on social medicine, social anthropology and sociology in such a work as this; but as there is a separate chapter on neurology, why not one on bacteriology and another on physiology? Two only of the later chapters have bibliographies, though Sir Cyril Burt supplies useful footnotes instead. In view of the brevity of each essay, it would have been valuable had indications for further reading been supplied by every author.

The book jacket claims that the work is intended for the "general reader". The reviewer has some difficulty in picturing this general reader. Is he a reader with some scientific background or is he the intelligent 'man-in-the-street'? Have men of science yet been able to appreciate his mental processes? The problem arises when such splendid passages as the following occur in the work: "Other basic principles which have been suggested are Milne's *Principle of Impotence*, that one cannot tell where one is in the universe, and Bondi and Gold's *Perfect Principle*—that one cannot tell the cosmic time. Older principles, such as that of the conservation of energy, turn out to be trivial consequences of these principles"; or again, in another section, "T is a consistent estimate of a parameter θ if in large samples it converges in probability to the limit θ".

The painter Whistler said that his work was not to be valued at so much a square foot but in terms of the experience of a life-time. The same principle seems to apply to the present book, which costs two guineas. It is difficult not to recall the spacious days between the Wars when Mr. Gollancz was able to produce a larger and more comprehensive volume, with five or six times the amount of material of the present work, for the modest price of five shillings.

W. L. SUMNER

A PHILOSOPHER'S PHYSICS

Essays in Physics

By Viscount Samuel. Pp. vi+154. (Oxford: Basil Blackwell, 1951.) 7*s*. 6*d*. net.

AN 'event' has become a familiar word in philosophical literature, and for a variety of reasons. In the hands of the late Prof. A. N. Whitehead it achieved an almost æsthetic connotation among scholars. Now, the appearance of a set of essays by Lord Samuel is assuredly an event and, moreover, one to be pondered over and welcomed. Writing with the dignity and charm of an elder statesman, this slender volume of his resembles a subtle kind of tonic, to be taken with care, and perhaps not always without obtaining a prescription for it beforehand.

With justification, the author is scarcely enamoured of the tendency to confuse concepts of the mind with physical realities, and he complains that the present-day physics tends to blur the issue. The difficulty here is that Lord Samuel is an incorrigible optimist (a welcome enough quality these days), firm in his belief that there is in very truth a sharp boundary upon which to focus. It is conceivable, however, that, at any rate for some time to come, we may have to put up with a species of mental moratorium, not in a mood of despair, but as an honest facing of the facts. All of which suggests that some bold thinking along the lines of the late Edmund Husserl's "phenomenological bracketting" (or *epoché*) might provide a finger-post towards the solution of this particular dilemma, more especially in view of the radical *ding-an-sich* attitude inherent in it. Recollecting that Husserl started as a mathematician, and developed into an outstanding exponent of a presuppositionless philosophy, it seems by no means fantastic to propose a thorough search in that difficult terrain for some sort of a solution to this puzzle.

Lord Samuel lists three conclusions, two negative and one "more positive", which have an important bearing. First, the impossibility of measurement must not lead to the assumption of no causes. Secondly, the cause of any event cannot be a mental concept *per se*. (Incidentally, this seems but an echo down the centuries of what St. Thomas Aquinas thought of St. Anselm's views, or something very like it.) Thirdly, and indeed well said, is the need for speculation. Although it seems unlikely that any exception will be taken to these precepts, it is good to have them so aptly formulated.

Much of the remainder of the book is taken up with a discussion of certain lines of inquiry such as waves, particles, gravitation, and so on, followed by some observations upon quiescent energy. Lord Samuel will not expect to gather in a neat bundle of acceptances here; but his outlook is stimulating nevertheless. The collection ends with a letter from Prof. Albert Einstein, accompanied by an English translation; the German *verzicht* rendered as "resignation" is not very happy, but otherwise a sound piece of work. There is a slight misprint on p. 102 (7); but elsewhere the text is above reproach.

If two constructive hints are permissible, one is that Bohr's principle of complementarity might help to clarify some of the more obvious anomalies; the other is that in the concept of 'logical pressure' envisaged by the late Prof. E. A. Milne and exemplified in his epistemological approach to physics, probably lies the best hope of advance for which Lord Samuel so eloquently pleads.

F. I. G. RAWLINS

CHEMISTRY OF PHENOLIC RESINS

Chemie der Phenolharze

Von Dr. K. Hultzsch. (Organische Chemie in Einzeldarstellungen, Band 3.) Pp. vi+193. (Berlin, Göttingen und Heidelberg: Springer-Verlag, 1950.) 19.60 D. marks.

THE technical importance of phenolic resins and their industrial exploitation have not been reflected in corresponding fundamental advances. Until the late 1930's, investigations on the basic structure of the resins were comparatively few and their results were often inconclusive, chiefly because of the complexity and difficulty of the problem. The position was markedly altered by the work in Sweden, Germany and Austria carried out by the schools of Von Euler, Hultzsch and Zinke, so that at the present time a considerable amount of relevant information has been accumulated. Whereas earlier investigators largely used the analytical method—that is to say, they attempted to break down resins into identifiable crystalline compounds—the Continental work has been mainly of a synthetic type involving identification of materials produced during resinification of such active compounds as phenolic alcohols.

Dr. K. Hultzsch's book is the first real attempt to correlate the available information. It constitutes an effort to review critically and comprehensively the considerable literature and diverse views accumulated over many years. Dr. Hultzsch has included a historical survey, an account of the condensation of phenols with aldehydes and other compounds on the basis of modern electronic ideas, a critical review of existing chemical knowledge, and chapters on the technology of a wide range of phenolic resins and on their testing. The book includes author and subject indexes, as well as 376 separate references to papers published up to 1948. Comparatively little of significance has been omitted, although a few papers of perhaps minor importance appear to have been overlooked. If the chemist has been catered for more fully than the technologist, the fact must be accounted a good fault, in view of the practical trend of so many plastics books produced hitherto.

Controversy will still continue on the mechanism of the phenol–formaldehyde reaction despite Dr. Hultzsch's attempt at clarification, while few will agree with his contention that little more now remains to be done on the chemistry of the subject. There is likely to be still greater disagreement with his emphasis on the quinone methide structure as an essential feature of the heat-hardening of phenolic resins; most workers are likely to take the view that the evidence is as yet insufficient. Nevertheless, the author deserves gratitude for stimulating curiosity in a difficult field of work, and his monograph can be recommended unhesitatingly as essential to all workers on polymers, particularly at this time, when the organic approach tends to be neglected in favour of the more popular physico-chemical method of attack.

Students and advanced research workers will equally welcome this publication, so long as they can cope with the none too easy style of German writing adopted by the author. N. J. L. Megson

AN ORNITHOLOGICAL PIONEER

Studies in Bird Migration

Being the Collected Papers of H. Chr. C. Mortensen, 1856–1921. Edited by Poul Jespersen and A. Vedel Tåning. (Published by Dansk Ornithologisk Forening.) Pp. 272. (Copenhagen: Ejnar Munksgaard, 1950.) 18 kr.

THE method of studying the movements and life-histories of birds by marking them with light metal rings on the feet is now used in many parts of the world and in some of them on a substantial scale; it has yielded results of great value and its possibilities are very far from exhausted. Bird-ringing of a cruder sort had been tried in a small way before; but it was not until 1899 that rings of various sizes with serial numbers and adequate addresses were introduced. This development was due to a Danish schoolmaster, Hans Christian Cornelius Mortensen (1856–1921), whose collected papers on the subject are now republished in an English translation. This suitably marks the jubilee of his pioneer effort; and it also makes more accessible the results of his work, which are still of intrinsic scientific value.

Not many more than five thousand birds were ringed under Mortensen's own scheme (as compared with about one million in the British Isles alone during the past forty years); but he had either the foresight or the good fortune to concentrate largely on interesting species yielding a remunerative percentage of recovery records. Thus, after an initial disappointing experience with ringing starlings on an inadequate scale, he obtained excellent results with the white stork, the heron and various species of ducks, gulls and birds-of-prey.

With the white stork, Mortensen was able to show that those bred in Denmark usually migrate south-eastwards across Europe, around the Levant and through East Africa to the extreme south—but sometimes south-westwards to North Africa. The more numerous records from German and Hungarian ringing have amplified the picture.

More than three hundred pintail caught during autumn migration at a duck-decoy on the island of Fanö, off the west coast of Jutland, were purchased, ringed and released. The recovery records, about 20 per cent of the number of birds ringed, showed that ducks of this species passing through Denmark in autumn come from a summer area which extends to northern Russia as far as the White Sea and the Arctic Ocean; and that in winter they reach the British Isles, Holland, France, Spain, Italy and the eastern side of the Adriatic Sea. This finding still stands for comparison with results obtained from subsequent ringing elsewhere, and it forms an essential part of the general picture that is being built up of the seasonal movements of the pintail.

Reconciled as one is to recovery-rates as low as a fraction of one per cent for small passerine species, one may well be envious of such figures as 28 recoveries out of 65 ringed in the case of the common buzzard, and 10 out of 13 in the case of the goshawk. These spectacular rewards for a relatively small effort showed the value of the method, although with the less remunerative species similar information can be acquired only gradually by organized ringing on a scale of which the pioneer possibly did not even dream. A. Landsborough Thomson

THEORY OF FUNCTIONS

Funktionentheorie

Von Prof. Constantin Carathéodory. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften: Mathematische Reihe, Bande 8 und 9.) Band 1. Pp. 288. 36 Swiss francs. Band 2. Pp. 194. 24.50 Swiss francs. (Basel: Verlag Birkhäuser, 1950.)

THE title of this work is perhaps a little misleading, as suggesting a treatise on all the main aspects of the theory of functions; but it would be unreasonable to expect, even in two volumes, a full account of such an extensive subject, which can be approached in several different ways. Cauchy's method was based on integration around a contour, Riemann's on intuitive ideas derived from physics and geometry, and Weierstrass's on the power series.

All these dealt with the complex variable. Later came Cantor's theory of sets of points, leading to a great development of the theory of functions of a real variable. The name of Carathéodory is familiar to mathematicians as the author of a masterly treatise on the real variable. But the work under review is of quite a different nature; it can be described roughly as an introduction to a modern version of Riemann's geometrical ideas, freed from their original weaknesses, so that this approach can now be considered as firmly founded as the Weierstrassian. The main supports of this new version are Schwarz's theorems on conformal representation and Montel's concept of normal families of functions. These are used in conjunction with several modern developments, some due to the author himself, to give a clear and attractive exposition of fundamentals, though not including the general theory of Riemann's surfaces, of algebraic functions, or of uniformization. Although designed primarily as a text-book for students, some parts will be new and interesting even to the expert. The author died before it was published; but he had the satisfaction of seeing all the proofs, and his failing health would never have been suspected from the polished excellence of the work.

The division of the work into two volumes of unequal size, which is stated to be for the convenience of students, does not correspond to any real break in the continuity of the argument, and must have added to the cost of the work, which, at the present rate of exchange, is very high indeed in Great Britain. The first volume is divided into five parts, and the second volume into two more parts; each part is subdivided into three or four chapters. The first part begins with complex numbers, but takes an unexpected turn with the transition to spherical and non-Euclidean geometry. Emphasis is laid upon Ostrowski's *chordal difference* of two complex numbers, which is much used in the later pages, as it enables the point at infinity to be treated on the same footing as ordinary points. The second part gives a brief enunciation of such parts of the theory of sets of points as are needed in the later pages; for proofs the student is referred to the author's "Reelle Funktionen". The third part deals with analytic functions, including Cauchy's theorem, the maximum-modulus theorem, Schwarz's lemma, Poisson's integral, harmonic functions and meromorphic functions. The fourth part deals with the generation of analytic functions by limiting processes, using the somewhat unfamiliar ideas of *continuous convergence* and *limit-oscillation* to treat normal families of functions. These modern ideas precede the much older theorems of Taylor, Laurent, Mittag-Leffler, and a very brief treatment of the calculus of residues. The English-speaking reader may be puzzled why books in his own language contain so many examples, worked and unworked, on hese topics, while Carathéodory's book contains none. The fifth part deals with some special functions, namely, the exponential and trigonometrical functions, the logarithm and general power, the gamma function, and Bernoulli's numbers.

Turning to the second volume, the sixth part begins with a discussion of functions the moduli of which in a certain domain do not exceed unity, and in particular those of which the moduli are equal to unity at every point on the circumference of a circle of unit radius. After the important theorems of Pick, Jensen, Julia, Lindelöf, Fatou and Riesz, the way is clear for a rigorous treatment of conformal representation. The seventh and last part opens with analytic functions of two or more variables and some existence theorems on differential equations. It then applies the conformal transformation of a triangle, the sides of which are circular arcs, to deal with the hypergeometric function and its differential equation. Next come the Schwarzian triangle-functions and the modular function. Finally, there is a discussion of essential singularities and the theorems of Landau, Schottky, Picard and Montel.

The work is beautifully printed, as well as beautifully written, and may be warmly commended to those who can afford to buy it.

H. T. H. Piaggio

THEORY OF PROBABILITY AND STATISTICS

Introduction to the Theory of Probability and Statistics

By Prof. Niels Arley and Prof. K. Rander Buch. (Applied Mathematics Series.) Pp. xi+236. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 32s. net.

THIS work is a translation (with a few alterations and additions) of the third Danish edition of a book which has already proved very successful in the country of its origin. For the most part, the translation has been carried out very well.

The two authors are well known for their achievements in different branches of the subject: Niels Arley has made important advances in the theory of stochastic processes and in its application to the problems of cosmic radiation, and K. R. Buch is best known for his work on the range of values assumed by a measure-function on an abstract space. When a physicist and a pure mathematician join forces, the outcome is sure to be interesting; in this case it is a highly individual book which should do good work in familiarizing students of the natural sciences with the ideas, notations and techniques of the modern theory of probability. Its excellence as an introductory text-book for physicists may be illustrated by mentioning that Poisson's distribution makes its first appearance in connexion with the Poisson process (stochastic processes in general appear on p. 48, and the ergodic theorem four pages later). No attempt is made to burden the book with proofs of the central-limit and allied major theorems; but their substance is sufficiently indicated, and the reader is given an accurate and clear picture of what can be expected from the mathematical theory. He will, if serious in his intentions, find this a useful introduction to a detailed study of the more comprehensive work by Feller.

As a text-book on statistics as opposed to probability theory, I found the book much less satisfactory, and it is perhaps a pity that a third collaborator was not found to prepare the 'Fisherian' chapters. For example, there is no mention of the analysis of variance, of the χ^2-test for 'goodness of fit' or of two-by-two contingency tables. In a subsequent edition there is much that could be done to improve these sections of the book; the first half is so good that such an improvement would be well worth while.

David G. Kendall

Elsevier's Encyclopædia of Organic Chemistry

Edited by F. Radt. Series 3: Carboisocyclic Condensed Compounds. Vol. 12B: Naphthalene, A, Compounds containing One Naphthalene Nucleus; Oxo-Compounds (except Quinones). Pp. xxxv+2189–2716+Ind. 62. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1950.) £14 to subscribers to whole work.

This fourth part of Vol. 12B takes the naphthalene section of the "Encyclopædia" a stage further (see *Nature*, 167, 916; 1951). It is characterized by the customary excellence of production and freedom from error, and is concerned with aldehydes and ketones containing a naphthalene or hydronaphthalene nucleus. The various compounds are catalogued and their physical characteristics, methods of preparation and chemical reactions are discussed in the stereotyped way. Many of the compounds included in this part are in the nature of intermediates, without great intrinsic interest, and there is perhaps less to appeal to the reader generally interested in organic chemistry than in some of the preceding parts. There are, however, some interesting accounts of the sesquiterpene ketones, such as eremophilone and the cyperones, of the α- and β-tetralones, and of the stereoisomeric α- and β-decalones and their derivatives. The ketonic derivatives of the various hydronaphthalenes are rather scattered throughout the volume, and the tabulated summaries of these given at the beginning will facilitate rapid reference.

Apart from these ketohydronaphthalenes, most of the compounds treated in this part are, of course, compounds in which the carbonyl function is not an integral part of the naphthalene nucleus, but forms a separate attachment. There are, for example, the α- and β-naphthaldehydes and their derivatives, and the various groups of naphthyl ketones, including diketones in which the carbonyl groups are either present in a single side-chain or in two substituents. Included in this volume are the non-enolizable *gem.*-substituted derivatives of the ketonic forms of the naphthols, especially those formed from 1-substituted-2-naphthols. The production of such ketones is a warning against too sweeping generalizations in theories of aromatic substitution. J. W. Cook

The Solidifications of Castings

A Review of the Literature. By R. W. Ruddle. (Institute of Metals Monograph and Report Series, No. 7.) Pp. 116. (London: Institute of Metals, 1950.) 10*s*. 6*d*.

Imperfections present in castings or ingots persist, at any rate in large measure, despite any heat or mechanical treatment to which the metal may afterwards be subjected. It is therefore in the highest degree desirable that the factors which control the original solidification of the metal should be understood. Even to-day the production of castings is in large measure a matter of trial and error, combined with traditional experience.

In recent years, however, much attention has been paid to the scientific aspects of the problem, both on the empirical and fundamental sides, and the object of this monograph is to provide a critical review of the existing literature. Part 1 covers, in a general way, the work which has been done towards the practical application of scientific principles; the importance of directional solidification is discussed, and the means available to attain this end are considered. In Part 2 a review is given of the more fundamental work concerned with the rate of abstraction of heat and of solidification, and, although at the moment mathematical analysis has probably yielded results of less importance when applied to non-ferrous castings than to steel, possibly due to the longer freezing ranges, it can, in conjunction with experimental methods of studying the problem, be of undoubted value. The researches discussed in Part 2 and the conclusions drawn therefrom are briefly summarized in Part 3, and an appendix provides details regarding the thermal properties of metals and of the materials from which the moulds are made.

This review, prepared originally for the British Non-Ferrous Metals Research Association, fully upholds the high standard now expected from the Monographs of the Institute of Metals, and the author is to be congratulated on a most useful piece of work excellently carried out. F. C. Thompson

Scientific and Learned Societies of Great Britain

A Handbook compiled from Official Sources. 57th edition. Pp. 228. (London: George Allen and Unwin, Ltd., 1951.) 30*s*. net.

After a lapse of eleven years the compilation of "Scientific and Learned Societies of Great Britain" makes a welcome return to take its rightful place on the easily accessible shelf among other reference sources of British scholarship and learning. This handbook was previously known as the "Year-book of Scientific and Learned Societies", and under that name it has been published, almost continuously for more than fifty years, by Charles Griffin and Co., Ltd., the last issue appearing in 1939. After the end of the Second World War, the British Council acquired the rights of publication and is responsible for editing the present work. If praise be needed, it is sufficient to say that the book is every bit as good as its predecessors.

Part 1 is a new feature of this book and deals with the organization of scientific research in Great Britain. It gives the names and addresses of the main research organizations administered by the Department of Scientific and Industrial Research, Medical Research Council, Agricultural Research Council and the research associations. An interesting chart has been constructed outlining schematically the relationship of the various bodies in Great Britain engaged in scientific research.

Part 2 of the book, which forms about five-sixths of the two hundred-odd pages, is on the lines of the previous issues. It is divided into fifteen sections as follows: general science; mathematics and physics chemistry; biology and microscopy; medicine agriculture, horticulture, forestry and veterinary science; engineering and architecture; geography geology and mineralogy; archæology and history anthropology and sociology; law; economics statistics and political science; literature and fine arts; town and country planning and public amenities; other societies. The sections are divided into the regions of London, counties, Scotland, and (where applicable) Wales and Northern Ireland Within these regional sub-divisions more than six hundred societies are listed alphabetically, giving the objects of the society, principal officers, membership subscription, meeting times and publications.

An index of subjects and names of societies completes the volume.

THE BRITISH CONTRIBUTION TO SCIENCE AND TECHNOLOGY IN THE PAST HUNDRED YEARS*

By H.R.H. THE DUKE OF EDINBURGH, K.G., F.R.S.
President of the British Association

To mark the opening of this year's meeting, His Majesty The King has been graciously pleased to send the following message:

> I shall be glad if you will express to the members of the British Association for the Advancement of Science my appreciation of their having once more honoured a member of my family by inviting him to be their President.
>
> I trust that this year's meeting of the Association will further the development of Science for the benefit of mankind throughout the world, and prove an encouragement to all those men and women who are so devotedly working for that end.

On your behalf I propose to reply in these words:

> The Members of the British Association for the Advancement of Science assembled at Edinburgh send Your Majesty their humble duty and their loyal thanks for Your Majesty's Patronage of the Association and your gracious message of encouragement.
>
> I am to assure Your Majesty that the development of Science for the well-being of Your Majesty's Realm and for the general welfare of mankind is the constant object of the Association.
>
> We will strive with all humility and with the grace of God to apply the blessings of scientific and technological improvement to the problems which face us all to-day.

In Aberdeen in 1859 my great-great-grandfather started his address to the British Association with these words:

"Your kind invitation to me to undertake the Office of your President for the ensuing year could not but startle me on its first announcement. The high position which Science occupies, the vast number of distinguished men who labour in her sacred cause, and whose achievements, while spreading innumerable benefits, justly attract the admiration of mankind, contrasted strongly in my mind with the consciousness of my own insignificance in this respect."

I cannot improve on this to express my own feelings; but, like him, I reflected upon your invitation and came to the conclusion that it is just as an outsider, a layman so to speak, that I can be useful to you and to science. This very invitation seems to me to demonstrate that science is not a magic circle and that you wish us to enter your confidence. In return the least I can do is to show our appreciation of the work of scientists and to give you a layman's impression of the march of science in the past hundred years. I crave your indulgence if I have drawn any false conclusions and I hope that during the meetings which will follow this one, the experts will take the opportunity to make any corrections.

The Prince Consort had very much less reason to be modest about addressing you than I have, because this year we celebrate the anniversary of the Exhibition which was his greatest achievement, and an event which had an untold value to science. Let us hope that this year's Festival will be judged a worthy successor and an inspiration for the future. I am proud to pay tribute to this man who saw so clearly the part science was destined to play in the future of this country, and my address is largely the story of the fulfilment of his hopes.

The Starting Point

In a review of British science and technology, 1851 is a convenient starting point for two reasons. First, the Exhibition of that year can be regarded as a gigantic stocktaking of the national resources and technical skill; secondly, because it marked the end of the Industrial Revolution and the conversion of Victorian England to the policy of industrial expansion on which our future still depends. The period as a whole saw the climax of our industrial supremacy and its inevitable decline when countries with greater resources and population learned from us the lessons of the mechanization of industry. It also covers the birth and growth of the new concepts of modern science.

Social conditions of a hundred years ago were, generally speaking, the outcome of the Industrial Revolution, but with all the traditions of the England of agriculture, cottage industry and small market towns. The population of 20 millions was growing fast but still small compared to our 50 millions of to-day. Education was limited to a minority and was almost entirely classical, so the new profession of engineering had to draw its recruits from a different sphere—that of self-educated men. A new wealthy class was growing up in the commercial world to rival the old aristocracy. There was unbounded optimism about the future and ample scope in commerce and industry to attract all intelligent and enterprising men. The number of poor was on the increase and their conditions were deteriorating because, as yet, no social conscience had grown up to replace the patriarchal responsibility of the landowners and master craftsmen.

In the domestic field, lighting was by candle and oil lamps, cooking and heating by coal or wood in ranges or open fires with the consequent enormous waste of energy. Food had to be fresh or crudely preserved, and thus needed to be produced locally. In health and hygiene the figures speak for themselves. In 1851 the infant death-rate was 150 per 1,000 live births compared with 25 per 1,000 to-day. Anaesthetics, antiseptic surgery, biochemistry, tropical medicine, were all virtually unknown or in their infancy. Psychology had not yet achieved independence from philosophy on one hand and physiology on the other.

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* Presidential address delivered at Edinburgh on August 8.

This was the age of the practical engineer and of processes arrived at by intuition born of experience and by trial and error. Technology was concerned with the application of steam-power, with metallurgy and the working of metals for various purposes, and with the production of machine tools and precision machinery. Men were already turning their minds to other types of engines, and the internal combustion engine was in the process of development.

Scientists, while continuing their search for the secrets of Nature, were beginning to turn their attention to exploring the empirical developments of industry. Their numbers as yet were small, the endowments for research were negligible and much of their work was carried out in the watertight compartments of the different sciences. But the seed had been sown, and it was not long before scientists and engineers were preparing the way for the great technological harvest of the twentieth century.

The Conditions

The changes brought about in the lives of men and women in the last hundred years have been greater and more rapid than during any other period in history, and these changes have been almost entirely due to the work of scientists and technologists all over the world. They have not only affected the way of living of all civilized peoples but have also vastly increased our knowledge about ourselves, the earth we live on and the universe around us. I cannot emphasize too much that the sum total of scientific knowledge and technological progress is an international achievement to which every civilized country has made some contribution.

Now before considering the contribution of the British Commonwealth, I should like to sketch what appears to a layman like myself to have been the main influences on the course of scientific and technical achievements since 1851 and their relation to one another.

The great stimulus of the 1851 Exhibition created a growing interest in technical education and research, followed by a widening of the scientific horizon which was soon to find expression in borderline subjects. For the next fifty years science advanced rapidly; but in most fields there was a wide gap between science and industry. Electricity was an exception, and the groundwork was already being laid for the electrical revolution of the Victorian age. Medicine was on the verge of breaking away from medieval practice and taking the first steps towards its modern pattern, while British colonial development stimulated the study of tropical disease.

Between 1851 and 1870, practice, in many industries, was ahead of science, and in that period the large number of inventions of the Industrial Revolution were progressively improved and widely applied. These inventions, which added so much to our industrial production, were mainly the work of British genius. They were of great economic advantage to this country and were quickly exploited commercially. New factories and plants were built to include the very latest ideas, and with the expansion of industry came the demand for more and more new ideas and greater efficiency. This demand was a direct stimulus to technological invention as well as an indirect stimulus to science. We are still struggling with the social results of this vast expansion.

From 1870 to 1890 the highwater mark of British industrial expansion, as compared with other countries, had been reached and the competition of the United States and Europe was just beginning to be felt. But the lack of serious competition hitherto had bred a feeling of over-confidence and satisfaction in the methods and processes employed. The result was a conservative attitude towards technical change and, particularly in the older industries, neglect of scientific research. Accumulation of wealth and the income from foreign investments in any event made the country as a whole less dependent on the efficiency of her industries. Concurrently a subtle change occurred in the type of British exports. So far the products of our machinery, such as rails and rolling stock, had been shipped abroad for immediate use; but now machines themselves were exported to do their work in the factories of Europe and America instead of in Britain. The result of this was to intensify foreign industrial competition between 1890 and 1914; but with the increasing demands from the Colonies the volume of British exports was not greatly affected.

Then came the critical years of the First World War, bringing a realization of the part science must play in the industrial and military strength of the nation. For the first time in history a real attempt was made to enlist the services of science in the war effort, and the Department of Scientific and Industrial Research was founded to further the application of science in industry through Government laboratories and through research associations.

The effects of these measures appeared clearly in the inter-war years, when there was a marked swing of education from classics towards science. Coupled with this, the War had directed the attention of many research scientists to practical objectives, so that after the War there was a rapid expansion of industrial research. Scientific progress was no longer confined to the work of a few brilliant individuals, but came also from teams of research scientists each working on different parts of the same problem. It was during this period that many new commercial research laboratories grew up, employing scientists to discover new processes and materials connected with their industry as a direct weapon of competition.

The War had also shown a great weakness in our dependence on foreign production for many vital articles, such as dyestuffs, scientific instruments and optical glass, in the manufacture of which scientific research played an essential part. This weakness was remedied with the help of the Key Industry Import duties, which gave the necessary support and encouragement to the establishment of these industries at home.

It is true that manufacturers in some of the older industries still clung to traditional methods in spite of the pressure of competition from America and other countries. In this connexion it is significant that the history of production engineering after 1890 is almost entirely confined to the United States.

It was, however, a period of rapid development in Britain. The invention of the internal combustion engine and the pneumatic tyre had opened new branches of industrial engineering, and the demand for fuel for motor-cars and aircraft gave birth to the new technology of oil. In the electrical, chemical and aircraft industries, science was fully enlisted in the fields of electronics, synthetic fibres, plastics, aerodynamics and light alloys. Consequently the outbreak of war in 1939 found us in a much stronger position to meet the immense demands it made on all branches of technology for new gadgets, machines and weapons. From the outset science in all its forms and branches was harnessed and completely co-ordinated with the war effort. It was only the intimate partnership of science and engineering with the staffs of the Fighting Services that enabled us to meet swiftly and effectively the ever-changing menace of total war.

The tremendous demands on our industries had some good after-effects. Once again these demands revealed weaknesses where our industrial capacity was out of date. The realization of this has initiated comprehensive reconstruction on most modern lines. The almost complete absence of income from our foreign investments has forced us to rely once more on our capacity to make the goods the world requires. Our industry and productivity have shown a wonderful improvement; but there is still a lot more that can be done. The rate at which scientific knowledge is being applied in many industries is too small and too slow. Our physical resources have dwindled; but the intellectual capacity of our scientists and engineers is as great as ever, and it is upon their ingenuity that our future prosperity largely depends.

The Contribution

I would now like to make a brief survey of the British contribution to natural knowledge and technology and pay a tribute to some of the great men of science of the past hundred years.

In some branches almost the whole story can be told, since one problem after another has been solved by British scientists. In others there are many blanks and gaps where the vital links in the chain were forged abroad. But looking at the whole vast field of abstract and practical science there can be no doubt that during this period the contribution of the British Commonwealth has been of outstanding importance.

Our knowledge of the stars, the heavens, and our place in the universe has increased steadily through the centuries; but since 1851 some of the most important links were supplied by such men as Eddington, Jeans and Milne in their work on mass, luminosity and stellar evolution. Huggins made a great contribution with his application of spectrum analysis to astronomy, and Lockyer's discovery of helium in the sun had a significance far beyond the realms of astrophysics.

Coming nearer to the earth, the work of Abercromby and Shaw on the behaviour of the earth's atmosphere in the troposphere started the scientific study of weather and weather prediction, and Appleton's research into the ionosphere extended this to the upper air.

Chemistry has fascinated man from the earliest times, and vast progress has been made in the past hundred years both in knowledge and theory. Much fresh ground was broken by Crookes by his work on spectra, his discovery of thallium and of 'radiant matter' known later as cathode rays. Long after everyone was quite sure of the composition of the air, Rayleigh found another ingredient which he called argon and so started the hunt for other inert gases. In organic chemistry both Perkin and Robinson have added enormously to our knowledge of the structure of carbon compounds, and to our power to copy natural products synthetically. The development of X-ray analysis by the two Braggs, father and son, has given us a means of finding the actual arrangement of the atoms in the molecule and has revealed the accuracy of the chemists' conclusions about the architecture of molecules based on their reactions with one another. This is a most striking example of the power of the theoretical and practical scientist to penetrate Nature's secrets.

Going beyond the chemist and his molecules, we come to the physicist and the study of even smaller particles. Thomson's discovery of the nature of the electron was the first attack upon the integrity of the atom. Next, thanks to Rutherford's brilliant research and keen intuition, came the nuclear theory which revolutionized our ideas of matter. To prove it, he was the first man to succeed in the transmutation of an element. It is appropriate to mention Moseley's work on the X-ray spectra of the elements, as it already showed such great promise, before he was killed at Gallipoli.

Parallel with this activity in the physical sciences there occurred a technological revolution of even greater scope and variety. The Darbys of Coalbrookdale were the lineal ancestors of Bessemer, Thomas and Siemens, and the whole technology of metals. First, cheap cast iron followed by cheap steel, then steel from phosphatic ores, completely changed the materials available to engineers, shipbuilders and architects. Scientific metallurgy can be said to have started when Sorby first applied a microscope to the surface of metals. The way was opened for the investigation of the metallic alloys which came in quick succession from developments in which Hadfield and Rosenhain made outstanding contributions.

It was not long before the possibilities of these new materials were recognized, and the great majority of the mechanical developments of the period were due to new alloys which could withstand higher stresses. But before these materials could be fully used, Maudsley and Whitworth had to lay the foundations of production engineering, and Mushet had to do pioneer work in developing tungsten steel as the first high-speed cutting tool.

The reciprocating steam engine of the Industrial Revolution was the main source of power until Parsons invented the steam turbine, which revolutionized large-scale power production on land and sea. But that was not the only source of power to rival the push-and-pull engine. The internal combustion engine, in which Dugald Clerk and Akroyd Stuart were among the early pioneers, has proved to be a formidable challenger in many fields. In marine engineering, Froude's work on hull forms and propellers enabled the full benefit of the new prime movers to be reaped at sea.

Here I wish I could mention early British pioneers of motor-vehicles; but, as is well known, restrictive legislation drove the development of the motor-car abroad, until the repeal of the speed limit in 1903 gave scope to the genius of Royce, Lanchester and Ricardo. In place of the motor-car, however, we have Lawson to thank for the invention of the safety bicycle; and all wheeled vehicles except those running on rails owe their rapid development to Dunlop's invention of the pneumatic tyre. The material required for this started the vast natural and synthetic rubber industry, and has made famous the name of Wickham for a brilliant feat of smuggling, when he brought the rubber seeds from Brazil to Kew, from which sprang the rubber plantation industry of the East.

In flying, the names of the pioneers and their feats are legion, and more than in any other mechanical science the development of aerodynamics has been shared by many nations; but Lanchester's vortex theory was one of the stepping stones to powered flight, and the achievement of Alcock and Brown in making the first Atlantic flight in 1919 speaks highly for the tremendous scientific and technological background of flying in Great Britain. Of outstanding importance and consequence was the genius which Mitchell brought to aircraft design, and, more recently, Whittle's pioneer work has given us the lead in jet engine production both for civil and military use.

Following on the immense progress in metallurgy and mechanical engineering, the most far-reaching development of the period has been that of electricity and electronics. Although the key discovery belongs to Faraday in an earlier period, the second founder of the science is undoubtedly Clerk Maxwell, with his classic treatise on electro-magnetism. The use of electricity for domestic and industrial purposes was helped by Wilde's development of the dynamo and then by Swan's incandescent lamps. Wheatstone and Kelvin pioneered the use of electricity for communication by their work on line and cable telegraphy. Wireless telegraphy soon followed, and the work on tuned circuits by Lodge, and Marconi's many brilliant developments made in Britain with the General Post Office and the Navy, soon made radio a practical proposition. Heaviside and Appleton made further contributions on the propagation of radio waves. It is interesting to see that the technique used by Appleton in his pulse-ranging on the ionosphere and upper layers was later developed by Watson-Watt into radar, which is now almost indispensable to airmen and seamen all over the world. Here Randall's development of the magnetron for high-frequency radar was one of the major contributions to the Allies' equipment for war.

Television has a wide parentage, but Baird's name will always be linked with the first successful pictures.

Another great innovation of this hundred years was the discovery and development of plastic and synthetic materials. The story starts with Parke's discovery of celluloid and Cross and Bevan's manufacture of viscose which gave birth to the rayon industry and the many later types of synthetic fibre. Perkin's mauve, first of the aniline dyes, and Kipping's new silicon compounds were, however, disregarded by industry in Great Britain. But we see to-day a change of heart in the development in our industrial laboratories of two new plastics, 'Perspex' and polythene, with almost an unlimited range of applications in the air, on the ground, and at sea.

The effect all this has had upon the citizen varies naturally with where and how he lives; but basically it has given him reliable light and heat in his home, push-button communication with almost any part of the world and home entertainment of a high quality. His transport on land, at sea, and in the air is quick, comfortable and clean. In addition, he has a vast range of materials with which to clothe himself and to furnish and embellish his home. Almost more important, these developments have brought about a complete change in his conditions of work.

But if the citizen has benefited, so too has science from the great array of new techniques that have been invented and the new tools with which the scientist and technologist can burrow, hack and worry at the growing mountain of problems to be solved.

So far I have dealt with the physical sciences. Now I would like to turn briefly to the biological and psychological sides, which after a slow beginning in Great Britain have made increasingly rapid progress.

The whole field of biological science in this period is overshadowed by the works of Darwin presented in his "Origin of Species" and "The Descent of Man". Nothing has done so much to widen man's thoughts as his conception of evolution as the great law controlling living things, "that progress comes from unceasing competition, through increasing selection and rejection".

In the basic study of living things some of the most important contributions from Britain were the pioneer work of Francis Galton and William Bateson in the field of heredity, Sherrington's work on the integrative action of the nervous system, and Dale's and Adrian's contributions to our knowledge of the transmission of nervous impulses.

The science of biochemistry is relatively new and Gowland Hopkins was its founder in Britain. His discovery of the significance of accessory food factors, leading up to the recognition of vitamins, started the modern science of nutrition. Other landmarks were Bayliss and Starling's recognition of the part played by hormones in the blood stream, followed by Banting and Best's isolation of insulin, and Harington's synthesis of thyroxin in Edinburgh.

Fleming, working on mould cultures, discovered the antibacterial properties of penicillin, and later Florey and Chain, at Oxford, found that penicillin could be extracted in a highly purified form, and used it to treat human disease.

Modern surgery can be said to have been born in Scotland, with Simpson's discovery of the use of chloroform as an anaesthetic and Lister's antiseptic technique based on Pasteur's bacteriological discoveries. A further advance of the greatest value to surgery as a science was Macewen's aseptic technique, which made surgery clean and safe, followed by his classic work on the brain and spinal cord.

If Lister was the father of modern surgery, then Manson was the father of tropical medicine, and it is particularly in this field that the British contribution has led the world. The discovery by Ross that malaria is carried by the anopheles mosquito and, much later, the work of Fairley in Australia on its prevention and cure, have been of the greatest benefit to mankind. Bruce will always be remembered for his discovery of the part played by the deadly tsetse fly in the transmission of sleeping sickness and his work on Malta fever. Finlay, Adrian Stokes and Hindle stand high among the names linked with the study and prevention of yellow fever.

These were all vital efforts towards the prevention of sickness; but there is another aspect of medical practice in which the Commonwealth has taken a leading part—the promotion of health. It was Sir John Simon, the first medical officer appointed to a central authority, who made a careful statistical study of the causes of sickness, with the view of taking effective measures for the health of the community at large. Through his leadership, health services have been provided in regular stages throughout the country. At first these were largely aimed at providing pure water, effective sanitation, and the abolition of slums; but since the beginning of the present century the *personal* health services, especially in the case of mothers, babies, and school children, have become national in scope and lead the world.

There are two other fields in which the biological sciences play a major part. The first is in the preservation of food and in nutrition, which has had the most profound economic and social effects. The ability through freezing, drying and canning to import large quantities of food has enabled a rapidly increasing population to maintain and increase its standards of living, which would have been impossible had it been dependent on British agriculture alone. The scientific study of nutrition has made it possible to improve the health of the population and in war to feed the people with the minimum of waste.

Mort had the first freezing works in the world at Sydney, and was a pioneer in refrigeration; but success in transporting meat to Britain had to wait for the development of more reliable refrigerating plant. Since 1918 the Food Investigation Laboratories of the Department of Scientific and Industrial Research, of which Sir William Hardy was the first director, have established the basic biological knowledge on which the storage and transport of meat, fish and fruit are now largely based.

The second field is in agriculture, where in order to compete with cheap foreign foods the most successful farmer is one who enlists the full assistance of science. Lawes, who discovered how to make and use superphosphate, and started the great fertilizer industry, was quick to realize this. He founded Rothamsted, now the oldest agricultural research station in the world, and there he and Gilbert carried out the first scientifically controlled field experiments which laid the foundation of agricultural science. Later, Biffen's pioneer work in plant breeding at Cambridge became one of the greatest contributions to the problem of feeding the world's growing population. He showed how it was possible to breed strains of wheat combining resistance to disease with high yields and good milling properties. In the field of animal breeding, the foundation of the most important aspect of British agriculture to-day, I will mention among the many investigators only Cossar Ewart and Crew, who did so much to advance its scientific study here in Edinburgh. The mechanization which was to revolutionize farming in all parts of the world was also under way and Britain was playing a leading part. The reaping machine, for example, was invented by Patrick Bell in 1826 although it was not manufactured until 1853.

There is no need to point out the effect which all these improvements, discoveries and inventions have had on society. It is this group of biological sciences which have had the most far-reaching social results, and it is particularly during and since the Second World War that it has been possible to exploit them.

There is one science which I have not yet mentioned. It is both the youngest science and the oldest problem. The study of man's mind was the province of the philosopher until the middle of the nineteenth century, when it separated from him and began its independent existence as the science of psychology. The foundations were not laid in Great Britain; but important contributions were made, both from the biological and the philosophical sides, by men like Ferrier, Bain and Ward. Sully's work on child psychology was the first of its kind. But probably the most outstanding figure in this country was Galton, whose teaching is widely respected in all psychological laboratories, and who was the first to develop an interest in the mental differences between individuals—a field in which British psychology has made some of its greatest contributions. Again, it is only recently that full practical advantage is being taken of the progress made in this branch of science; but the results of that application may be as important as the many more easily understood developments in the purely physical world.

The Implications

The story of the British contribution to science in the past century is indeed impressive, and I am very pleased to have this opportunity of paying tribute to the men whose achievements I have been discussing. But this story would not be complete without studying the wider implications of their work and examining some of the lessons to be learnt from it.

The concrete measurement and indirect effect of all scientific effort is the general improvement in the conditions in which people live and work; it is in the improvement in health, in the expectation of life and standards of living; the latter including not only food and clothing, but also housing, home comforts, medical care, education, books and newspapers, recreations and travel facilities. In every one of these directions the progress that has been made has amounted to a revolution.

Not all this springs directly from science and invention. Much has been due to the politicians and administrators, and behind them to religion, morals, education, art and the complex influences which we call culture. But even there science has stood beside the authors of progress to advise, to help and sometimes to guide.

Now as science and technology are so vital to the future strength and prosperity of the British Commonwealth, the great problem is to discover the conditions under which they are most likely to flourish. The records show that both depend very much on co-operation, and upon the linking up of a long chain of discoveries, one with another; so that it is quite exceptional for the credit of a great advance to belong to one man or even to one country, although it will always require the flash of inspiration to weld the links into the chain. To-day the development of team-work in laboratories has made this truer than ever. For many reasons, but principally because of the increasing complexity of research and its cost, such team-work is becoming more and more the rule. We need not repine at this; but it would be a disaster if the individual inquirer working in his own laboratory were discouraged out of existence.

While the quality of scientific work is determined by the quality of the scientist, the quantity of scientific output is determined by the money available. The rapid progress of science in Britain has owed much to the growing support and sympathy of government and individual benefactors and to the endowment of research by industrial corporations. However, the basic discoveries that mark the great advances depend on the accident of individual genius and are not at our command.

The scope and intensity of the progress of applied science and technology, on the other hand, bear a close relationship to the circumstances of the time. Technology, as the combination of scientific knowledge with the practical ability of the inventor to apply that knowledge to the solution of particular problems, comes into play with any new discovery of scientific fact. The latest particle of truth is then developed, according to the circumstances of the time, for military, commercial or medico-social purposes. It is a sad reflexion that the urgent demands of modern war can produce advances that might otherwise take many years to develop, especially in the costly and uncertain experimental stages.

The rivalry between large commercial undertakings, using science to improve their products or processes as a direct means of competition, has produced a steady flow of improvements and developments. However, the fruits of this form of scientific work are sometimes open to considerable misuse. The discoveries of these commercial laboratories may be kept secret, and in some cases a number of teams may be working on the same problem, which may have already been solved elsewhere. The buying up and suppression of patents and discoveries to protect equipment from becoming obsolete has also been known to happen. I am glad to see, however, a change of outlook in the growing quantity of publication of the results of industrial research.

It would seem that science has become so well established that nothing can stand in the way of its natural growth. This is far from the truth. Since the earliest times the natural conservatism of laymen has acted as a powerful brake to the adoption of new ideas which do not rigidly conform to his notion of the correct order of things. In its most violent form it will produce unreasoning anger, utter disbelief in face of the clearest evidence or provoke plain ordinary laughter. The storm raised by Darwin's "Origin of Species" is an excellent example where even scientists failed to keep an open mind.

The position seems better to-day, and I am sure that Sir Harold Hartley, our immediate past president, spoke for all scientists when he said: "To-day, with our greater understanding, there is humility in the minds of all scientists. The further we penetrate into Nature's secrets the more clearly we see the ever-receding frontiers of knowledge."

The resistance towards anything new or unexpected is balanced, on the other hand, by bursts of enthusiasm that some particular discovery or invention will see the end of all our troubles. The belief in the philosopher's stone seems to be just as great as ever.

As the front of pure science has advanced, so its lines of communication to practical exploitation have got longer and longer. The time was when the whole process of discovery, application and exploitation could be achieved by one man. In our time a great army of scientists, technicians, inventors, designers and production engineers is required to keep the lines of communication open. Quite how important some of the members of this follow-up team have become is not always appreciated. In his presidential address in 1948 Sir Henry Tizard emphasized this point when he said: "All depends on good design and production. Our weakness in the war was not to be found in what was best to do, nor in the scientific work of how to do it. It was when the stage of design and production was reached that we fell short of the best standards."

This was true already when Whitworth invented the screw micrometer, which was afterwards put into production in Germany and the United States, and up to the First World War all micrometers had to be imported into Britain.

To Prof. Kipping of Nottingham goes the credit for the basic work which led to the development of silicones in Russia and the United States, and yet until this year we have been dependent on imports from the latter of marketable silicone products.

There are many cases in the Navy where a piece of apparatus has been used operationally exactly as the inventor put it together, with all the resulting disadvantages in maintenance and efficient operation. The limitation in performance, except in some cases, is practical as opposed to scientific. Where the basic scientific principles are known by all nations the advantage lies in the good design of equipment for practical use.

A more general and far-reaching matter for concern, and possibly the most vital factor affecting the industrial application of scientific research, is the lack of a co-ordinated system of scientific and technological education in Britain. Excellent as they are, the existing institutions, which have grown up to meet particular circumstances, do not produce anything like enough trained technologists to meet the urgent needs of scientific development in industry and to provide leaders for the future. It is to be hoped that the new and rather uncertain science of education will develop sufficiently quickly to point the way to a speedy solution of this problem.

The shortage in Britain of "personnel trained and eager to apply scientific knowledge and scientific methods to practical ends"—as Sir Ewart Smith said last year—is only one of the many shortages which the world is now facing. Among them are food, non-ferrous metals, steel alloy metals and sulphur. These very shortages are due to the scientific complexity of present-day life, and it is only by science that they can be overcome. Naturally, there are many ways of tackling this problem; but the most obvious are: first, by improved design to secure economy in production and the minimum use of scarce materials; secondly, by the development of substitutes made from raw materials which are still abundant; thirdly, by the reclamation of scrap and improved methods of using low grade ores; finally, the development of renewable raw materials such as timber to satisfy the world demand for cellulose. Some of these shortages are partly due to the huge inevitable waste of war and its consequences, and partly to the lack of any comprehensive survey of the world's resources and requirements. It is only by an accurate knowledge of the world's resources that we can foresee the scope and magnitude of the future problems which science and technology have to meet and which only they can solve.

It is, therefore, good news that the Economic and Social Council of the United Nations has resolved "to promote the systematic survey and inventory" of those resources which are not already covered by the Food and Agriculture Organization.

We have evolved a civilization based on the material benefits which science and technology can provide. The present shortages are a timely reminder of the slender material foundation on which our civilization rests, and of our dependence upon science and technology.

The Conclusion

The pursuit of truth in itself cannot produce anything evil. It is in the later stage when the facts dug up enter the process of application that the choice between the beneficent and destructive development has to be made. It is quite certain that it is an exception if any particular discovery cannot be used equally well for good and evil purposes. Happily the beneficent exploitation of scientific knowledge has kept pace with its destructive application.

In a mid-century article *The Times* put it this way: ". . . It has been an age of great achievement. The lines of progress in which the Victorians trusted have been pursued farther and faster than they foresaw. Scientific discovery, from which above all their doctrines of progress derived, has swept forward on an enormous front. The conquest of the air has made possible an intercourse and understanding between distant peoples such as our ancestors could not imagine—and it has been diverted to the vast destruction of men and cities. The invention of wireless telephony has opened a channel through which liberating truths might be proclaimed to all the listening earth—and every would-be despot has used it to suborn the blind masses into the worship of false gods. The medical art has performed miracles; the cures of immemorial pestilences have been found, infancy has been safeguarded and old age tended, so that the normal expectation of life has been extended by years—aside from the new and universal apprehension of sudden death."

To my mind it is vital that the two sides of scientific development are fully and clearly understood, not only by the research scientist, inventor, designer and the whole scientific team, but also by all laymen. The instrument of scientific knowledge in our hands is growing more powerful every day; indeed, it has reached a point when we can either set the world free from drudgery, fear, hunger and pestilence or obliterate life itself.

Progress in almost every form of human activity depends upon the continued efforts of scientists. The nation's wealth and prosperity are governed by the rapid application of science to its industries and commerce. The nation's workers depend upon science for the maintenance and improvement in their standards of health, housing and food. Finally, superiority or even our ability to survive in war is a direct measure of the excellence and capacity of the scientific team.

This team of research workers and engineers has a dual responsibility, one for its work and the other as informed citizens, and it can only fulfil its proper functions if its members have a sound general education as well as a thorough training in science. It is no less important that the people who control the scientific machine, both laymen and scientists, should have a proper understanding and appreciation of what science has grown into and its place among the great forces of the world.

It is clearly our duty as citizens to see that science is used for the benefit of mankind. For, of what use is science if man does not survive?

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

A HUNDRED YEARS OF METEOROLOGY

In his presidential address to Section A (Mathematics and Physics) Sir David Brunt outlines the development of meteorology during the past hundred years. Before dealing with his main theme, he points out that the Greek philosophers Aristotle and Theophrastus had developed meteorology in the fourth century B.C. so far that their ideas dominated the meteorological thought of Europe for nearly two thousand years, while Pindar set up a standard of forecasting which even to-day is difficult of attainment, except on rare occasions.

The re-awakening of independent thought took place about the time of the foundation of the Royal Society in 1660, and the influence of that Society remained very great up to the time when control of official meteorology in Great Britain passed into the hands of the Air Ministry in 1920.

Many workers with creative minds have, of course, been indispensable on the research side of meteorology, and the names which Sir David mentions include those of astronomers such as Halley and Laplace, and physicists such as Lavoisier, Wheatstone and Glazebrook. Of particular importance was Sir Napier Shaw, the more so because Shaw was instrumental in adding the names of those most prominent in Great Britain during the past sixty years, for example, W. H. Dines, C. J. P. Cave, E. Gold and G. I. Taylor. Shaw's services should be judged against the background of the Meteorological Office, to which he went as director in 1905. Shaw found a 'Slough of Despond', into which he contrived to instil some of his own enthusiasm. Shaw made the greatest written contribution to meteorology of the century when he published, in 1906, the memoir entitled "The Life History of Surface Air Currents", a work in which he was assisted by R. G. K. Lempfert. This anticipated the paper entitled "Life Cycle of Cyclones and the Polar Front Theory of Atmospheric Circulation", by J. Bjerknes and H. Solberg, which has laid the foundations of the method of forecasting weather which has been developed during and since the Second World War.

Turning then to the research work now being done in Great Britain as part of a revived scheme of international co-operation, Sir David points out that the problems receiving increased attention include: (a) the nature of the depression of middle latitudes; (b) effects of atmospheric radiation and absorption on the heat balance of the atmosphere; and (c) formation of cloud, rain, ice-crystals and snow. Items (b) and (c) have given the most positive results; as regards (a) we cannot predict where the next depression will form, or even explain the precise conditions which led to the formation of yesterday's depression. In the case of (b) the approximate balance of radiation and absorption in the atmosphere can now be evaluated by graphical methods due to Elsasser in the United States and Robinson in Britain. In the case of (c) we now nearly understand the condensation of ice, and also the artificial production of precipitation. Another new matter which is being investigated has come to the fore as a result of further advances in aircraft design, making flights possible at very high altitudes. These have revealed a new phenomenon called the 'jet stream'. This is a stream of air, at levels between 15,000 ft. and 40,000 ft., moving roughly eastwards at speeds of 130 knots or more, and traceable for great distances downwind, but sharply restricted vertically and transversely.

CHEMISTRY AT THE MID-CENTURY

In his presidential address to Section B (Chemistry), Sir Cyril Hinshelwood points out that a century ago there was a great wave of intellectual optimism, more recently succeeded by disillusion and pessimism from which recovery is to-day far from complete. At this moment there may be profit in taking stock of the realities of the situation and in examining against the general background some particular themes of interest to the science of chemistry.

The great chemical events of the past century have been the evolution of views about the basic substratum of things, the perfection of the arts of synthetic chemistry, and the growth of knowledge about the laws of energy and of the intimate mechanism of chemical changes. Now after a long and eventful approach the chemist stands face to face with the problem of life itself.

Early ideas about atoms and the manner of their union were naive. They have gradually become more sophisticated and more abstract, and now chemical valency must be interpreted in terms of electrons with properties quite unlike anything known to ordinary observation. Behind this there seems to lie some deep mystery relating the possibility of detection with the very existence of the entities postulated in physical theories, and in a glass darkly one seems to see here some connexion with the mind–matter problem itself. The present situation is unsatisfying to many; but it should not be concluded too readily that the limit of knowledge, or taking long views, even of the power of human understanding is yet reached.

Much of chemistry is of a more workaday character and unconcerned with these deep questions. Structural chemistry, now in the early stages of becoming a mathematical science, has not only revealed the underlying atomic patterns of things but also enabled the chemist to weave designs of his own choosing. The deeper understanding of mechanisms has not only led to understanding but also to control.

It has often been questioned whether the powers of chemistry are used for good or evil ends. To this an emphatic answer may be given: chemistry has in fact, conferred vastly more benefit than harm on mankind; and men of science are in no way responsible for the abuse of their discoveries by others. The desire to inhibit scientific discovery rests, moreover, upon an utter lack of faith in human destiny.

The detailed understanding of what happens in chemical changes has revealed a picture surpassing in wonder that conceived by the poetic imagination of Lucretius. It is now being extended to the events occurring in living cells. The selective influencing of cell processes opens the door to the great field of chemotherapy, though generations may pass before all the promise of this is fulfilled.

As the cell discloses its secrets there will emerge the possibility of deep-seated intervention of man into the fashioning of his own biological future, and those of little faith may raise more vigorous cries than ever.

Men of science at the mid-century are faced with difficult problems, both scientific and human. If in face of hopes and fears they seek a policy, they will do well simply to follow the advice of Candide: "Il faut cultiver son jardin". If they do this unconcernedly, their own garden will not fail to go on producing its fruits.

GEOLOGY AND MILITARY STRATEGY

The relation between geology and the movements of armies forms the theme of the presidential address to Section C (Geology) by Prof. W. B. R. King. Military operations in north-west Europe during the past two hundred and fifty years have illustrated as well as in any part of the world that the ability of a commander to move, feed and supply a large army at will is one of the prime necessities of a campaign, for this leads up to the successful deployment for the actual battle. The first of these necessities clearly depends on the general topographical lay-out of the country viewed in a broad way, while the details of the battle are often influenced by local geological controls.

Belgium, between the Meuse-Sambre and the rivers draining towards the Scheldt, has often been a 'corridor of invasion' between east and west, and many of the great battles from the time of Marlborough onwards have been for the control of this 'corridor'. The early battles of 1914 and 1940 were clearly influenced by the presence of this natural east–west throughway. The line taken up by the Allies in May 1940, based on the Scheldt estuary–River Dyle–Meuse valley above Namur, left only a short stretch of line without a natural defensive river position. That the Germans were able to turn this line by advancing through the difficult Ardennes country does not say that the line chosen was not a good one. Other defensive lines in northern France are essentially river lines, like that of the Somme running across what is, on the whole, open country.

When the general geological pattern of north-west Europe is considered, it is clear that the oft-repeated pattern of military operations can be co-ordinated with the physical geography of the area and this is clearly controlled by its geological history.

North-west Europe can be divided into five main areas: (1) the low-lying area of the north with wide sluggish rivers and large areas actually below sea-level; (2) the Chalk and high-standing Tertiary areas of Belgium and northern France with relatively few natural barriers; (3) the Palæozoic and igneous rocks of the Ardennes and surrounding Bunter Sandstone outcrops, a wooded area of high relief with deeply incised valleys; (4) the Paris Basin consisting of an outer zone of marked dip and scarp topography, a middle zone, that of the Chalk, an area of open country of well-drained flat surfaces and an inner zone of dissected wooded hills; (5) the Palæozoic area of Brittany and west Normandy with its strong east–west 'grain'.

Clearly, of these divisions, (2) and the centre zone of (4) are those most suited to easy movement of large armies, and historically it is in these areas that the main military operations have taken place. But besides the controls due to the solid geology, the area as a whole was in the periglacial zone during the Pleistocene Ice Age. This has had great influence on the physical features. The effect of a lowered sea-level due to abstraction of oceanic waters to form the ice-caps has been to cause a temporary rejuvenation of all the valley systems, particularly in their seaward portions. These overdeepened valleys were drowned on the recovery of sea-level to near its former position. This resulted in either large estuaries or, as occurred in most cases, valleys filled with recent unconsolidated sediments including peats. It is these deposits which make so many of the river lines such strong defensive positions, for the whole valley floor, not merely the river, is the barrier. The other important result of the periglacial climate is that it leads to the formation of vast sheets of loess spread over the country as a blanket. On the slopes this has been largely removed, but on the plateau areas it still exists. Its effects are numerous. On the loess soil the type of agriculture is plough lands with large open fields without hedges. The silty nature of the soil renders it firm and quick-drying during summer but highly treacherous in winter and spring. It is on such plateau lands during the summer months that airstrips for servicing fighter aircraft could be prepared with least work and where the open country was particularly well suited for rapidly moving armies.

The effects in the coastal regions of movements of the strand line were important. Along all the Channel coasts it was known that peats and clays of the 'Submerged Forest' existed in patches. The location of patches of these under the sands of the Normandy beaches necessitated extremely intensive study, for unless covered by a sufficient thickness of sand, vehicles were liable to become bogged. The work done by Prof. F. W. Shotton and others on this problem was well justified by the results.

It is seen, therefore, that the solid geology of the area controls the broader problems of strategy, while the features resulting from the periglacial position during the Ice Age has had two effects which have been of the greatest importance in controlling details. These are the infilling of the overdeepened valleys with unconsolidated alluvium, rendering them effective barriers, and the presence of the loess-covered plateaux which form large areas suitable for 'open' warfare and give rise to numerous tracts which can be turned rapidly into temporary airstrips for the landing and servicing of fighter aircraft, a feature of the greatest importance for modern armies.

ORGANIC DESIGN

In his presidential address to Section D (Zoology), Dr. C. F. A. Pantin remarks that by the beginning of the nineteenth century two principles had emerged from the study of comparative anatomy: first, that structures are adapted to the function which they serve; secondly, that some plan underlies the architecture of whole groups of animals. Purposive adaptation was used as an argument for Divine design. So also was the existence of an underlying anatomical plan. This plan showed two features. First, animals exhibited grades of organization which we term 'higher' and 'lower'. This was partly the old anthropomorphic over-simplification that placed man at the head of a *Scala Naturæ*. The error still persists because it contains an element of truth. 'Higher' animals show functional differentiation which leads to increased independence of the environment. The price of this independence is centralized control, particularly by a brain.

The second feature is that animal organization is found to be based on one or other of a series of architectural types, such as the vertebrate, the molluscan and so on. One hundred years ago, Richard Owen gave precise definition to this idea in his conception of the archetype, which he considered as the expression of an underlying abstract plan—in much the same way as to-day we may consider the groups of the elements of the Periodic Table give expression to such a plan.

The "Origin of Species" gave a totally new interpretation of these things. The type and its structural homologies were consequences of evolution from a common ancestor. Purposive adaptation was the negative image of natural selection.

By 1918 abstract comparative anatomy, even in evolutionary guise, had lost much of its power to inspire research. Many new lines of work opened, particularly in the physiology of animals and their tissues. Almost all these lines have led back to morphology, though from a very different point of view from that of the older comparative anatomists. New relationships emerged at the molecular level of structure. Biochemical similarities appeared between organisms which were utterly sundered in their evolution, as in the carbohydrate metabolism of fermenting yeast and of contracting muscle in vertebrates. Such similarities arise independently because the materials available for the construction of organisms are of few kinds and of unique properties. Consequently the same materials, and these alone, are available again and again for the construction of functional systems independently in different sorts of organism.

Once these limitations are introduced at the molecular level, they affect all higher levels of structure. One of the most remarkable features of comparative physiology is the repeated and independent utilization of the same kind of machinery for muscular movement in quite different animals.

As in the structures erected by engineers, so in the organism, there are three factors governing design: first, any functional problem can only be solved in a limited number of ways; secondly, for any solution only materials of limited kinds and properties are available; thirdly, the engineer selects a solution which he can execute with the materials available. In the same way we may say of living organisms that natural selection gives reality to one or other of a series of possible structural solutions limited by the properties of matter and energy.

As a result of these limitations, we repeatedly find the same structural solution of a functional problem achieved by quite unrelated organisms. The most striking example of this is the independent development of similar nervous machines by which organisms execute their behaviour.

THE CENTENARY OF SECTION E (GEOGRAPHY)

The year 1951 marks the centenary of Section E (Geography) in the British Association, and its president, Dr. O. J. R. Howarth, surveys its history and achievements. The subject was previously subordinated to geology, and for some years was confined to physical geography. The establishment of the new section, in which ethnography was at first included, was due to Sir Roderick Murchison. He helped to found the British Association and also the Royal Geographical Society: he was to become a general secretary and afterwards president of the Association, and he maintained an intimate interest in the new Section, assuming its annual presidency no less than seven times. His first conception of its main function was that it should deal with travel, and should attract the interest of lay members of the Association by bringing before them eminent explorers in person: "A noble procession of explorers passed across the stage of the Section"—Burton and Speke, Livingstone and Stanley, Wallace, Sturt, Palgrave, Scoresby, Ommaney, and many more.

The standing of geography as a true science was viewed with doubt by scientific purists. As a result, geographers and others disputed the question 'What is geography ?' at greater length than was justified. The Section never actually debated this question; but a succession of addresses and papers attempted to answer it in various terms: those who in the earlier years of the Section saw the answer most clearly were Strachey and Clements Markham. The present address tries to show that "what Geography has achieved in the century we are reviewing, and what Section E has very effectively aided in achieving, is to demonstrate an outlook wider in horizon than those of the other departments of science with which it is associated, and to help to bring them into a harmonious focus".

By means of examples from the sectional transactions, the developments in British geography in various directions are traced—survey and cartography, geomorphology and the introduction of natural regions by Herbertson, human geography, and geography as an educational subject. Occasion is taken to refer to the work of many of the leaders in the development of geography—Keltie, Mackinder, Mill, Chisholm, Dickson, Geddes, Roxby and others. Dr. Howarth had personal contacts with some of these; but has not ventured into the fields of the work of those who have come after them and still are active. He suggests, however, "that in the century which is past British geographers have enunciated their principles and begun to apply them; have indeed applied them so far that the time is ripe to express them, not only in terms of individual researches (as is done) but in terms of a new geographical encyclopædia"—a suggestion easy to make, but less easily carried out "against the barrier of present-day costs".

Following upon the remarks on geography in education, it is suggested that to foster the instinct for admiring and preserving natural beauty is a function of geographical teaching alongside the organizations and individual activities which work to that end. "In this connexion we owe constant attention to the literary side of our subject, for much can be achieved by well chosen words, whether with or without opportunity for visual guidance." Geographical works are not the only sources of inspiration: by way of example, an illustration is quoted from the work of Robert Louis Stevenson.

There is an appendix to the printed version of the address, in which very brief biographical notes are provided of some seventy geographers and supporters of geography mentioned in the text.

NATURE OF PROFIT

To the questions what profit is and by what causes it is shaped and determined, economic science has not yet supplied answers which command general agreement. In his presidential address to Section F (Economics), Prof. R. G. Hawtrey points out that the classical economists, Adam Smith, Ricardo and Mill, recognized that profit must be distinguished from interest. Profit is the remuneration of the active head of an enterprise, whereas interest is paid, for the use of money, to a capitalist who takes no active part. The profit remaining after providing for interest is, therefore, remuneration for services rendered. But it differs from a wage or salary in that it is proportional to the magnitude of the trader's business, so that an expansion of the business may mean an indefinite multiplication of his income.

Marx accepted the classical view of profit and went so far as to describe the profit-making capitalist as a 'wage labourer', but with the qualification that the wages which he claims "do not depend on the degree of his exertions".

Marshall's treatment of profit had an apologetic flavour. He approached the subject from the point of view of a representative firm, one not exceptional either in efficiency, size or luck. The profit of such a firm would not be more than fair remuneration for services rendered. The rate of profit would vary widely. But an essential part of the cost of using capital is risk of loss, and uncertainty means inequality. However, it was the concentration of industry in big units that Marx had attacked, and Marshall's representative firm did not pretend to offer a defence against that attack.

Marx had in mind the concentration of industry that mechanization makes possible. But there had been from time immemorial another kind of concentration, that of the large-scale merchant's business.

The purpose of production is to meet needs, and the function of the merchant is to marry the product to the needs which it is to meet. It is a skilled service remunerated by the difference between buying price and selling price—in fact, by profit; and the merchant's income has the special characteristic of profit, that it can be multiplied in proportion to his transactions. The merchant's profit is the remuneration of selling power. It is paid for his skill in selecting goods to suit the needs of consumers and users. The industrialist is no less a seller than the merchant, and his profit is likewise the remuneration of selling power. He has also other responsibilities, but can delegate them to a salaried staff. The responsibility for selling attaches inseparably to the *owner* of the product to be sold.

How then are profits determined under competitive conditions ? The profit margin in any trade must be such as to secure a reasonable income to a newcomer. It will be regulated by the *magnitude* of the business that the newcomer with his command of capital and business connexion can expect. Even the passive shareholder, being part-owner of the product to be sold, gets more than bare interest on his money. That is his reward for making a wise selection among profit-makers to whom to tie his fortune.

Concentration of selling-power is more productive of near monopolies than concentration of industry, but is not always so serious an abuse as appears. The big concern can afford to be content with a narrower profit margin than the small; and the accusation is usually not that its prices are extortionate, but that it treats its competitors harshly.

Profit-making is attacked nowadays from within the capitalist system. The advance of democracy has given an equalitarian bias to taxation. Here the danger is a destruction of saving at its most fruitful source.

2,000 YEARS OF ENGINEERING

SIR CLAUDE GIBB's presidential address to Section G (Engineering) traces the development of engineering from prehistoric times up to the present day and concludes with a prediction of future developments.

Engineering was born of the requirements of man, who, during his gradual development from a barbaric savage, fashioned tools and weapons to obtain food and to protect himself from the beasts of the forests. With the growth of civilization, man required irrigation schemes, canals, docks and harbours, good roads, palaces and temples, and the engineer had to use much ingenuity to provide these wants.

Ancient Greece furnished us with a number of eminent engineers, including Alexandrinus, Hero of Alexandria and Archimedes, and their work formed the basis for our knowledge of many subjects. The Romans also did much to further the art of engineering, the building of roads being one of their greatest achievements.

As the mining industry in Great Britain developed, some form of pumping engine and raising gear became necessary. Engineers turned their attention to this problem, which resulted in the introduction of the reciprocating engine. Engines of this type were also used for driving the paddle-wheels of sea-going vessels, and this eventually led to the introduction of screw propulsion, and the general use of steam engines at sea.

Some cheap and quick method of transporting coal from inland collieries to the river shipping points led to the construction of steam locomotives for coal haulage, and later the steam locomotive was adapted to passenger-train service.

Tribute is paid to the work of the engineers and physicists who gave us the laws of thermodynamics. Watt, Count Rumford, Carnot, Joule, Sir William Thomson, Rankine and Clausius all played their part, and it was the work of these physicists that made possible the rapid advances in steam engineering.

Due to the activities of many inventors, the beginning of the nineteenth century was an important period in the history of electricity. Electric generators came into being, and the electric telegraph services were introduced. Later the trans-Atlantic telegraph services, the telephone and electric lighting all made their appearance. Sir Joseph Wilson Swan and T. A. Edison gave us the incandescent electric light; then came the public lighting companies, followed by Ferranti and his work at the Deptford Power Station.

Equally important developments took place in the prime movers for driving the electric generators. Starting with the semi-portable agricultural type of engine, the Peter Brotherhood high-speed direct-coupled engine was introduced, followed by the Parsons epicycloidal engine, the Willans engine, the Bellis engine and finally, in 1884, the Parsons turbine. After the success of the turbine for the driving of electric generators, Parsons attacked the problem of adapting the turbine to marine propulsion and, after many initial disappointments, was equally successful. It was Sir Charles Parsons's work which made possible the large turbo-alternators used in central power stations and the large liners, cargo vessels and naval ships of to-day.

The advent of coal gas at the beginning of the nineteenth century saw the introduction of the gas engine and its development by Otto and Clerk. While these developments were taking place, the discovery of petroleum led to the use of oil instead of gas as fuel, the earliest oil engine to achieve success being the Priestman engine introduced in 1885. The Daimler engine followed; this was the beginning of the modern petrol engine, and its dramatic use for nearly all modern self-propelled vehicles.

The success of the petrol engine on land was followed by its use in the air. During the First World War, rapid advances were made in the design of aeroplanes, and in 1919 the Atlantic was crossed by aeroplane. Research work undertaken by Sir Frank Whittle gave us the jet-propelled aeroplane, and the development work during the Second World War produced the large aircraft used for the present-day long-distance passenger services.

Although efforts had been made at the beginning of the century to introduce gas turbines, it was not until about 1935 that serious attention was again given to the subject. While the War slowed up these developments, work still proceeded. On the Continent, gas turbines for outputs up to 27,000 kW. are in operation and in Great Britain machines of 10,000 kW. and 15,000 kW. are nearing completion.

In recent years considerable attention has been given to the work of the scientific men investigating nuclear energy, and to the possibilities of adapting this source of energy to commercial work. The first atomic pile was put into operation in the United States in 1942, and during the War considerable progress was made. Since 1945 atomic energy establishments have been put into operation in Great Britain at Harwell and at Sellafield.

In predicting the developments of the future, Sir Claude considers large-scale railway electrification is possible, following the production of electrical energy from the use of fissile material. To justify the high initial cost of an atomic energy plant, the production of electrical energy by fission must be carried out on a large scale, and so electrification of railways using electrical energy on a large scale will automatically result. He considers the jet or gas turbine cum jet will be used to the exclusion of all other means of propulsion for all types of aircraft. This type of prime mover meets the requirements so admirably that it is difficult to see how any other form of prime mover can compete. On land, the gas turbine will be used possibly to supplant the Diesel engine; but for very large powers the steam turbine will still be used. He sees no difficulty in making gas turbine units of 100 h.p. which could be fitted to motor-cars within the space now occupied by petrol or Diesel engines, the only problems requiring solution being a low cost and highly efficient regenerative heat exchanger.

Large-scale use of electricity for pump-produced rain and for soil heating will help to solve our ever-growing food shortages, and supersonic frequency electronically produced vibrations will become an everyday thing in our industrial, domestic and medical life.

EARLY CELTIC METAL-WORK IN BRITAIN

THE presidential address to Section H (Anthropology), by Sir Cyril Fox, opens with a reference to the great collection of Celtic metal-work from Llyn Cerrig, in Anglesey, of the period 150 B.C.–A.D. 50, spread out on a workroom bench in a museum in war-time. For a study of parallels to individual pieces, museum collections were not then available; Sir Cyril was dependent on the literature, and found it very inadequate. That sense of inadequacy was the reason for choosing the subject for his address.

The character of this Celtic metal-work is discussed, specially fine examples referred to, and the absence of good monographs deplored. Some large hoards discovered fifty to a hundred years ago, it is pointed out, are not yet completely published or assessed. Reasons for the lack of enterprise thus indicated are suggested, and remedies for the lack of interest in this first flowering of British art outlined.

After referring to Dr. Jacobsthal's important researches, which promise, in time, a comprehensive survey, Sir Cyril outlines his own investigations: in brief, he has been concerned with the life-history of a particular artistic idea—or the art-history of a particular motif or group of motifs—in the last hundred and fifty years of Celtic freedom in southern Britain. The antecedents of the Llyn Cerrig plaque, the piece first chosen for investigation, its development as a three-dimensional work and transformation into a two-dimensional pattern, and the variations that flowed from it, are aspects that find a place in the series of published papers on the subject.

None of the more elaborate of the British Celtic patterns had hitherto been intensively studied; it is now seen that some at least are not so individual as to be at this distance of time inexplicable, but form closely related groups which can be placed in evolutionary series. The dependence of the Celtic craftsman on traditional patterns and the slow *tempo* of change despite his originality of mind and advanced technique are factors which make such elucidations possible. The backs of many Celtic mirrors, for example, are decorated, and this decoration is regarded as springing from one source, namely, the triskele, present on the Llyn Cerrig plaque. It culminates in the well-recognized high achievement of the Desborough mirror, wherein the graceful design of the mirror-back is matched by the beauty of form of the handle, both being fused, by art and artifice, into a unified structure.

The fold-over symmetry of many mirror designs, dating as these do in the period A.D. 1–50, has been recognized as due to the influence of Roman art; an attempt is now made to tie the achievement more closely to that source, since in its barbaric fashion it reflects something of the delicacy of perception and execution, the serenity of mood, which characterizes that art in the Augustan age.

It is held to be probable that the popularity of the triskelar pattern in British art was due to its magical significance, and a neglected stone aniconic object carved with triskeles, found near Gloucester fifteen years ago, is regarded as important in this connexion.

The difficulty met with by students in working out the history of early Celtic patterns, and the regional distributions of such—which require us to neglect no decorated piece of Celtic metal-work of the period in the country—arises from the lack of any organized centre for such study. Each individual repeats the laborious task of his predecessors: search through the scattered literature, and visits to museums to see described but unillustrated examples in the hope that they may be relevant to his needs. The creation of a card index of early Celtic metal-work in Britain, then, is urged, accessible to all accredited workers, and preferably linked to some institution, so that when completed to date, it will be kept up to date. It is hoped that an English school of research on early Celtic art may grow up in connexion with the development of such an index; it is gratifying to record that such a school for Scottish Celtic art may be held to be already in being in Edinburgh.

PHYSIOLOGY OF THE CAPILLARIES

THE presidential address to Section I (Physiology), by Prof. H. P. Gilding, forms the preface to a whole day's discussion on "Body Water". A brief outline of capillary structure serves as introduction. The complex patterns of capillary networks differ from organ to organ. That seen in simple structures such as the mesentery, so widely portrayed, can be very misleading if this picture is taken as a model for the rest of the body. In most structures the arterioles and venules run together until their final ramification, when they separate; this is best seen in skeletal muscle. Here the arterioles and venules lie transverse to the longitudinal axis of the muscle fibres, and ultimately the arteriole separates from the venule in such a manner that the latter is draining blood from arterioles on either side of it, with longitudinal capillaries of between 0·43 and 1·35 mm. in length joining them. Thus, between two transverse arterioles or venules a distance of more than 2 mm. is commonly found.

These facts were sufficiently well known a hundred years ago to be described and depicted in standard text-books of that time; it is not a little surprising that factual knowledge so important in consideration of capillary function should have been neglected and forgotten. It will be obvious that in skeletal muscle the lengths of the longitudinal capillaries are several hundred times their breadth. If we consider the maintenance of muscle fibres, another significant point emerges; along a given muscle fibre, alternating areas approximately 2 mm. apart are richly supplied by arterial blood, while the portion of fibre between is served by increasingly venous blood. These facts must be borne in mind when dealing with capillary tissue exchanges.

The evidence for the view that there is a gradient of capillary permeability is briefly discussed and reasons advanced for the necessity of such a gradient.

Consideration of known capillary and venous pressures throws doubt on the popular view of arteriolar-capillary filtration and venular-capillary absorption. Venous pressures measured in the dorsum of the human foot in quiet standing give readings of about 90 mm. mercury; this high pressure must be reflected in the capillaries, and therefore prevailing hydrostatic pressures in the foot during standing are such that filtration should, theoretically, continuously predominate and result in œdema. Common experience shows that this is not so. Similar considerations hold for the condition of affairs in the abdominal cavity. The portal capillary pressures in the supine animal are known to be higher than elsewhere, and furthermore these vessels are more permeable to protein. In the erect human being, gravity will increase the venous and capillary pressures over and above that in the horizontal position. We can calculate, therefore, that the prevailing colloid osmotic pressures are differentially too low physically to re-absorb the fluid, which is usually assumed to be filtered at the arteriolar end of the vessels.

The concept of capillary permeability being dependent on pores of varying sizes is discussed and repudiated.

Modern work using radioactive isotopes to measure capillary permeability is reviewed and reasons advanced for considering endothelial permeability as being comparable to cell membranes in general.

PSYCHOLOGY AND THE LAITY

THE century between the two great Exhibitions has seen the emergence not only of the science but also of the profession of psychology, and this is the keynote of the presidential address of Prof. C. A. Mace to Section J (Psychology). A 'ministry of the mind' has been created which is in many respects parallel and co-ordinate with the 'ministry of the soul' and the 'ministry of the body'. The acceptance of responsibilities by the psychologist in education, in industry and in the personal lives of men might seem to constitute a challenge to the vested interests of sagacity and experience, and to threaten yet further restrictions on individual liberty.

The surest defence against the danger, if danger there be, lies in the education of an understanding but critical laity. It is, indeed, upon the existence of such a laity that the success of the new profession must depend. The psychologist works indirectly, since when principles of psychology need to be applied it is almost always the layman who has to apply them. If reassurance be needed, it may be found in some measure in the history of the science in Great Britain. It has its roots in British natural history. The story of its growth could almost be told through the lives of three generations of the Darwin family. Erasmus Darwin was the first of the moderns to conceive the science of psychology as an integral part of biology. His grandson Charles applied the methods of the experimental naturalist to psychological problems. The other distinguished grandson of Erasmus, Francis Galton, could fairly be described as the founder of modern experimental psychology, since in his work, more than elsewhere, may be found the beginnings of so many of the most vital contemporary lines of research. He was the first of the experimental human naturalists—a psychologist of the field as well as of the laboratory. Among our near contemporaries, Charles Myers belongs to the same intellectual lineage.

In this tradition two features are outstanding. Erasmus Darwin, Galton and Myers did much to bridge the chasms that divide the arts, the sciences and the technologies. All were men of science who worked in close association with the scientific laity. The future of psychology, perhaps more than that of any other science, depends upon the preservation of this British tradition—since it is both *by* the layman and *to* the layman that psychology is in the main applied.

There is, accordingly, a distinctive approach in psychological research. The need for 'multidisciplined operational research'—the combined attempt of many specialists to solve practical problems in a scientific way—is now widely recognized. But in psychological research the layman who possesses special and relevant experience is an essential member of the research team. In many such cases this relevant experience may be in the field of the arts or the technologies. This approach is important in so many of the problems of technological education. It is important, too, for the solution of the problems of 'consumer assimilation' of the results of scientific research in every field. The piling up of the unapplied findings of scientific research is due in the main to the lack of machinery for co-operation between those who make discoveries and those who can apply them. The problem is especially acute in the field of the human and social sciences. We need a new conception of the function of a psychological laboratory or institute for psychological research. Such an institute needs to combine the features of a laboratory with those of a field station—to which intelligent amateurs will come, not for ready-made solutions to their problems, but for working hypotheses to test in their lives and daily work.

The need for co-operation between professionals and the laity gives additional significance to the current demands that scientific findings should be expressed in the common language of all educated men. The psychologist most of all needs to be bilingual—using whatever technical terminology he prefers in his purely professional circles, but speaking also in the language of the common educated man. The demand is not exacting; because although psychology is a very difficult subject, it has nothing in it which cannot be expressed in language which an intelligent fifth-form schoolboy can readily understand. Psychologists do not write cryptic prescriptions. They have no secret remedies. All they know they can and must tell. The function of the professional psychologist is not to cultivate a mystery but to communicate understanding, first of all to parents, then to teachers, and then to all who in any way are concerned with the supervision and management of men. So to report the facts of science is in the British tradition. It is in virtue of this tradition that the British Association is a British association—an association of professionals and laymen.

MYCOLOGY OVER A CENTURY

A REVIEW of the advance of mycology over the past hundred years, which constitutes Prof. W. Brown's presidential address to Section K (Botany), must be to all intents and purposes a review of the whole subject as a branch of science. Taxonomic mycology had taken shape in the early part of the nineteenth century, at least as regards the larger fungi; but any scientific treatment of the much larger number of microfungi (including bacteria) was impossible so long as it was held that such small organisms arose by spontaneous generation. A little less than a hundred years ago Pasteur established the biological theory of fermentation and disease, and the parallel work of de Bary and the Tulasne brothers laid the foundations of modern mycology.

The earliest researches took the form of mapping out the life-cycles of fungi, with the ultimate object of fitting the group into the scheme of Hofmeister, which had already been shown to apply to all groups of plants from the Bryophytes upwards. The task was difficult, on account of the reduction and even elimination of sex organs in the higher members of the fungal series, and it was only towards the beginning of the twentieth century that advances in cytological technique made the complete elucidation of certain life-cycles possible. These studies form the basis of the modern classification of fungi and of views regarding their evolutionary descent.

Much work has arisen from the discovery of heterothallism in fungi. Many of them exist in two forms (which may roughly be called male and female) and in general the life-cycle cannot be completed unless these two forms come together with resultant nuclear fusion. It has been possible, on this account, to adapt the Mendelian method of study to fungi (including yeasts), so that there is now a flourishing line of fungal genetics. Fungal species in general consist of a cluster of strains, and it is possible to produce new ones by suitable mating. In this way new strains with enhanced value for industrial purposes—for example, yeasts for brewing, strains of *Penicillium notatum* for penicillin manufacture—have been developed.

The smaller fungi, especially moulds and yeasts, offer many conveniences for research on cell metabolism and on respiration in particular. The process of alcoholic fermentation by yeast has the special interest that it is closely related to anaerobic respiration, which is known to precede the normal aerobic respiration characteristic of all animals and most plants. Hence the wide biological significance of yeast biochemistry. Biochemical studies of fungi and bacteria, important from the fundamental point of view apart from their industrial interest (as in the preparation of citric acid, acetone, glycerol, certain vitamins, etc.) have become very active in recent years in connexion with the search for antibiotic substances, such as penicillin and streptomycin.

Two lines of physiological research on fungi have interesting parallels elsewhere. One of these concerns the response of fungi to minimal traces of certain metallic elements (zinc, copper, manganese and others), a response which is comparable to that of many higher plants; the other concerns the requirement by fungi of small quantities of special organic substances (biotin, aneurin, etc.), some of which are related to vitamin B. This behaviour is comparable with the dependence of animals on a vitamin-containing diet.

The interrelations of fungi and other plants are many and varied. Mutualistic effects between micro-organisms largely determine their localization in Nature and the frequency of their occurrence, and have been much studied in relation to the biology of soils. Beneficial effects (symbiosis) between micro-organisms and higher plants are shown in the fungus roots (mycorrhiza) of many plants such as grow in soils of high humus content (heath plants, orchids, many forest trees). Nodulation of the roots of leguminous plants is another example, and this is of the greatest importance in connexion with soil fertility. Harmful effects, which are not always sharply distinguished from symbiosis, are seen in the wide range of plant diseases caused by fungi. The development of plant pathological research on a nation-wide scale is one of the major mycological advances of the period under review.

MID-CENTURY—RETROSPECT AND PROSPECT IN EDUCATION

IN his presidential address to Section L (Education), Sir Hector Hetherington points out that the development of public education in Great Britain over the past hundred years reflects the same impulses or ideas which have expressed themselves in the changing pattern of social, political and economic institutions and policies. The two dominating elements in that movement have been the coming to full maturity of the natural and applied sciences, and of the technological civilization founded thereon: and on the other hand, the wider operation of a principle best described by Dr. Gilbert Murray's word 'liberality'. The essential social history of the period is that of the effort to overcome the class divisions produced by the first impact of the Industrial Revolution, to diminish differences in economic status and in political responsibility, and therefore also in educational and social opportunity. The process has been gradual, undoctrinaire, experimental, controversial as to method but not as to broad objectives, and in the course of a hundred years has been carried a very long way.

The corresponding development in public education was influenced no doubt by the need of an expanding industry for more skilful, and therefore for better educated, workers, just as the movement fifty years ago towards wider secondary and technical education was influenced by the technical outpacing of Great Britain by Germany and the United States. But the main impulse undoubtedly was the force of the moral demand, and the main struggle was over the assertion of the State's direct responsibility. The State's concern for elementary education had been asserted in 1833. The State's full responsibility for it was not established until 1870. Its legalized and explicit participation in secondary education was not established until 1902, and its responsibility for the provision of a full educational experience—'compulsory secondary education for all'—dates only from 1944.

Just as the century's changes in economic and political institutions and practice have left some obstinate problems still unsolved, so also in the field of education. Great progress has been made, beyond doubt; but it has been progress in the creation of opportunity rather than in its assured and effective use. Large material problems remain—a shortage of teachers and a scarcity of well-equipped schools. Perhaps even more urgent is the definition of the use to be made, especially for the non-academic pupil, of the longer school-life. At that stage vocational and technical education is of high personal and national importance. But the essence of the matter is to discover how best to use these instruments as an introduction to a free and intelligent participation in the interests and responsibilities of a civilized society. To that end, the linkage with voluntary adult education is of great significance.

The favourable elements in the situation are the gradual emergence not of a single organic structure of national education, but of closer and more co-operative relations between many different elements, old and new, government and voluntary, formal and informal, and the reinforcement of the State provision by youth services of all kinds. But it is important to recognize that under modern technological conditions there are strong influences making for mass emotion and mass action, and that the educational system has it in trust to preserve the values of a free society.

EXPERIMENTAL AGRICULTURE

DR. E. M. CROWTHER, president of Section M (Agriculture), points out that the first critica review of the difficulties in obtaining reliable in formation in experimental agriculture was publishe a century ago by J. F. W. Johnston, who held the post of chemist to the Agricultural Chemistry Association of Scotland. Johnston realized the

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necessity for having at least two plots for each treatment and the advantages of comparing manures "both singly and in combination". Field experiments with single plots per treatment were still being made in Britain until well on into the present century, though replicated plots in systematic arrangements were employed on the Continent from 1880 onwards. The whole subject of agricultural experimentation was transformed around 1925 by R. A. Fisher, who established the necessity for a measure of randomization in assigning treatments to plots and showed how the precision of the experimental results could be estimated. The factorial design of experiment, developed by R. A. Fisher and F. Yates, provided one of the most generally useful patterns of field experiment. There is an urgent need for series of these experiments for settling practical problems and providing basic facts for laboratory investigations.

Scientific concepts are often used somewhat loosely in interpreting agricultural observations, although no means have yet been found for testing their relevance. The contrast between the deductive and the inductive approaches to soil fertility problems was well illustrated in the famous controversy a century ago between Liebig and Lawes. The difficulty of relating laboratory research to practical agriculture still remains. Many laboratory techniques are too elaborate to be applied to the large numbers of samples needed in modern field experiments and soil surveys. Agricultural research has its own version of a principle of indeterminacy—the more exacting the technique, the less adequate the conditions under which it can be employed. Sometimes the difficulty arises in the opposite direction. Physical and biochemical investigations on soil structure are held up through lack of soil samples in which contrasted structures have been produced under experimental control in rotation experiments with different kinds and length of ley. So far, the field experiments required have proved too difficult.

It is essential that field experimental work should not be wasted on matters of purely local and temporary concern, but should be planned to make the fullest use of, and to provide the best raw material for investigations in, other branches of agricultural science.

The problem of balancing the various lines of approach may be simplified, in research and in teaching, if it is realized that agricultural science does not seek to establish general principles from which agricultural practices may be deduced, but has a more modest aim. Agricultural science may be regarded as a search for patterns of performance to be fitted to suitable landscapes. Its starting-point is current practice in the region concerned or in a similar one. The features of many environments and the effects of most agricultural operations can be classified sufficiently well for forecasting the effects of moderate changes in practice, but it is unwise to make drastic innovations without pilot schemes and detailed experiments.

The final paragraph from the introduction to Johnston's "Experimental Agriculture", published in 1849, is still relevant to-day. "It is only by means of conjoined experiments in the field, the feeding-house and the laboratory—all made with equal care, conscientiousness and precision—that scientific agriculture can hereafter be with certainty advanced. If we have been long in getting upon the right road, we ought to advance the more heartily now we have found it."

THE SCOTTISH SCENE

IN his presidential address to the Conference of Delegates of Corresponding Societies, Dr. Douglas A. Allan points out that the systematic survey of any scene should begin with its rock foundations. The Scottish scene is composed of the Pre-Cambrian area of the Highlands, the older Palæozoics of the Southern Uplands, the Old Red Sandstone and Carboniferous of the Midland Valley, and the Tertiary volcanics of the Hebrides. These determine the distribution of basic economic minerals, and to a large extent the pattern of the scenery; but the final touches are due to the recent glaciation, from which the modern river-drainage system and the spread of soil layers derived. With amelioration of climate, belts of vegetation advanced across the country, to be followed by a variety of animals and, finally, man. Man the food-gatherer was succeeded by man the settler, with his specialists of priests and warriors. All can be traced through Scotland by arrowheads, beakers, brochs, vitrified forts, and a multitude of remains.

Roman police occupation south of the Forth and Clyde for roughly a hundred years is marked by roads and forts. Christianity came north-east from Ireland and north-west from the Continent, as evidenced by ruined chapels and treasured shrines, while the Vikings, at first pagan and later Christian, for fully four hundred years raided and settled on coasts and islands, leaving customs and language as well as boats and buildings as their contribution to the making of the land and its people. The Wars of Independence barred the way to English culture but developed links with the Baltic, the Low Countries and France, all of which left their mark on Scottish arts and crafts, industry and learning. The four Scottish Universities came into being between 1412 and 1582. The union of the Crowns in 1603 and of the Parliaments in 1707 led to peaceful development, save for the Wars of the Church and the two Jacobite risings. Then came the Industrial Revolution, and the exploitation of the mineral wealth of the Midland Valley, the tough man-power bred of a warlike tradition, and an ingenuity stimulated by a wealth of contacts overseas.

The characteristic devotion to learning, once peace and a modest economic stability were secured, was reflected in schools and colleges, scientific and learned societies, and private and corporate collecting of antiquarian and natural history specimens. There are some seventy museums stretching from Stranraer to the Shetlands, each of which in some degree houses and explains examples of the geology, botany, zoology and human history of their districts; and eight regimental ones telling their special story, inevitably extending far overseas. The societies and museums of Scotland thus collect and preserve not only material individually interesting and important, but also as a team present for to-day and to-morrow a facsimile and a synthesis of the land, its inhabitants, and its history. To their aid have come such official bodies as the Ministry of Works with its Inspectorate of Ancient Monuments, and such unofficial ones as the National Trust for Scotland for Places of Historic Interest or Natural Beauty, both of which, in one form or another, have instituted site museums in special areas. In 1947 it was recommended that a National Parks Commission for Scotland be established, with the aim of preserving stretches of country carefully chosen as typical examples of wild scenery.

The Forestry Commission, to which has been entrusted the task of restocking vast areas despoiled in the course of the two World Wars, has extended its service by providing national forest parks in those high-level parts of its estates where planting would be unprofitable. The preservation of scenes and woodlands calls for similar action to save their wild life, that is to say, precariously balanced assemblages of plants and animals. To attempt this there has come on the Scottish scene the new Nature Conservancy; but to achieve it will call for prolonged and conscientious observing, collecting and recording by a field force of amateurs. This is a clear call to action which the Corresponding Societies must not ignore.

NEWS and VIEWS

Genetics at Adelaide: Dr. D. G. Catcheside, F.R.S.

The Executive Committee of the Commonwealth Scientific and Industrial Research Organization has recently made arrangements for the strengthening of animal genetics in the School of Zoology of the University of Sydney, and has guaranteed to the University of Adelaide, for the first ten years, a chair of genetics which will be held at the Waite Agricultural Research Institute of that University, where a programme of plant breeding has been in existence for some years, and where a postgraduate school in plant genetics has been recently developing. Dr. D. G. Catcheside, reader in plant cytogenetics in the University of Cambridge, has accepted the new chair and will take up his duties in 1952. Dr. Catcheside graduated at King's College, London, in 1928 under Prof. R. Ruggles Gates. His first post was as assistant in botany in the University of Glasgow. He returned to King's College as assistant lecturer in 1931 and later became lecturer. R. P. Gregory had started the teaching of cytology and genetics at Cambridge before the First World War. After Gregory's death at the end of 1918, Prof. F. T. Brooks, then lecturer in mycology, carried on the work until Dr. Catcheside arrived to relieve him. Under Dr. Catcheside's leadership the subject rapidly developed at Cambridge and became a prominent part in the training of students in botany for the Natural Sciences Tripos. Dr. Catcheside's growing reputation attracted an increasing number of research students to Cambridge. In 1944 he was elected to a fellowship at Trinity College, Cambridge, and in 1950 he was made reader in plant cytogenetics. In 1951 he was elected to fellowship of the Royal Society. His interests are wide and include the cytology and genetics of *Oenothera*, the cytological and genetical effects of ionizing radiation, and the biochemical genetics of *Neurospora*. His work is well known in the United States, where he spent the year 1936–37 as a Rockefeller Foundation Fellow at the California Institute of Technology under Prof. T. H. Morgan and his sabbatical leave at Stanford University in 1947. Dr. Catcheside's promotion to the chair at Adelaide will be a serious loss to the Botany School at Cambridge.

Astronomy in the University of Manchester: Prof. Z. Kopal

Dr. Zdeněk Kopal has been appointed to a newly created chair of astronomy in the University of Manchester. Dr. Kopal was born in Czechoslovakia in 1914 and graduated as a doctor of science of the Charles University, Prague, in June 1937. He held the Ernest Denis Fellowship of the Czechoslovak Government during January–June 1938 at Cambridge, working under the late Sir Arthur Eddington. From September 1938 he held a research fellowship at the Harvard College Observatory, Cambridge, Massachusetts, becoming a research associate in Harvard University in 1940. During August 1942–June 1946 Dr. Kopal was on leave of absence, undertaking war work at the Massachusetts Institute of Technology, where he became in 1946 a research associate; in 1947 an associate professor of applied mathematics; and in July 1949 head of the Institute's Computation Laboratory. Since 1949 he has also been an honorary lecturer at Harvard University. The majority of the large number of scientific papers published by Dr. Kopal have dealt with the theory and observation of variable stars. His monograph, "An Introduction to the Study of Eclipsing Variables", is the standard work on the subject. He has also studied the oscillations of various stellar models. He became a naturalized citizen of the United States in 1948, since when he has been chairman of the Commission on Close Binary Systems of the International Astronomical Union and a member of the Commissions on Meteors and on Variable Stars, as well as of the sub-committee on the upper atmosphere of the National Advisory Committee on Aeronautics of the United States. Since 1950 he has been consulting editor of the *Journal of Mathematics and Physics*.

Imperial College of Tropical Agriculture: Mr. A. B. Killick, C.M.G.

Mr. A. B. Killick, at present director of agriculture in Uganda, has been appointed professor of agriculture and director of studies at the Imperial College of Tropical Agriculture, Trinidad, British West Indies, and is expected to take up his duties early in 1952. Mr. Killick graduated from Wye College (University of London) and is also a past student of the Imperial College of Tropical Agriculture. He spent the early part of his career in Uganda, where he served as an agricultural officer from 1924 until 1936. He was then appointed deputy director of agriculture in Trinidad, leaving there in 1939 to take up a similar appointment in Tanganyika; in 1947 he was appointed to his present post in Uganda.

Lorenz Oken (1779–1851)

Despite his remarkable learning, Lorenz Oken, who died a century ago, on August 11, 1851, is remembered chiefly as the exponent of doctrines long since abandoned. He was born at Bohlsbach in Swabia on August 1, 1779. When a medical student of two years standing, he published his "Grundriss der Naturphilosophie" (1802)—an attempt to construct a biology which reflected the action of the mind. Regarding man as the summit and crown of Nature, his exaltation of the male led him to declare that "Ideally every child should be a boy". Though he was groping toward something which he understood but imperfectly, he showed some conception of protoplasm and cells in his essay "Über das Universum" (1808), describing the first transition "from the Inorganic into the Organic" as "the transformation into a cell".

Oken advanced the science of embryology and founded the biological journal *Isis* (1816–48), an organ of wide scope responsible for an "encyclopædic diffusion of knowledge". By prompting the first German Congress of Naturalists and Physicians in 1822, he initiated the annual meetings of men of science which now have their counterparts all over the world. He originated the vertebral theory of the skull, later expounded by Goethe and finally exploded by Huxley in 1858. He never knew financial security, and his candour earned him political enemies who were responsible for his dismissal from Jena and Munich. Given a professorship in the newly founded University of Zurich in 1833, he produced his thirteen-volume "Allgemeine Naturgeschichte". Though frequently in the wrong, Oken was an original thinker and teacher who stimulated others to scientific endeavour. His real name was 'Ockenfuss'.

Science and Religion

THE controversy between truth as revealed by 'religious insight' and the scientific attitude is clearly brought out in two recent articles in *The Fortnightly* (No. 1,015; July 1951). In a review of Prof. Barbara Wootton's book, "The Testament of Social Science", J. B. Coates declares that knowledge of a scientific kind is on an inferior level of being to the existential world of the creative spirit, the world of value and of communion between persons, and should be recognized as being instrumental to it. Coates implies that the tendency to make science supreme over religion and philosophy is usually an evidence of spiritual debasement as it is frequently marked by intellectual arrogance. In her reply to Mr. Coates, Prof. Barbara Wootton argues much more tolerantly that Mr. Coates has attacked a windmill of his own making and that both unique personal experience and facts collected by scientific probing are essential if man's behaviour and values are to be understood. On a subject of such importance it is hoped that these articles will lead to comments by others.

East African Industrial Research Board

THE eighth annual report of the East African Industrial Research Board, covering the year ended December 31, 1950, indicates that no new major investigations have been initiated, the technical staff having been fully occupied on investigations already in hand. Much analytical work has also been undertaken and many mineral ores again assayed on behalf of the Geological Survey of Uganda. Kyanite is now being calcined locally to give the more valuable product, mullite, from which a substantial production of high-grade refractories is expected to develop. The production of fired clay building materials on a much larger scale in the Nairobi area is imminent. Further work has been done on the manufacture of Broseley tiles from Kiambu sub-soil and finely ground quarry debris, and a small pilot plant is producing decorated domestic pottery using brushwork on a raw glaze, although the only large pottery operating in Kenya has closed down its plant. Production of soda-phosphate fertilizer is now established commercially, but further work is being carried out to eliminate a tendency of the briquettes to collapse on warming when the reagents are fired in a brick kiln, with consequent difficulty in obtaining even firing conditions. Further research has been carried out on the so-called 'fermentation' of fresh pyrethrum flowers to ascertain whether a special treatment could be applied to the freshly picked flower heads which would substantially increase their pyrethrin content. It appears, however, that unless the action is closely controlled, no marked increase in pyrethrin content can be expected, and such control could not easily be applied on a large scale.

Commonwealth Index of Scientific Translations

FOLLOWING resolutions passed at the British Commonwealth Scientific Official Conference in 1946 and the Royal Society Scientific Information Conference in 1948, the British Commonwealth of Nations Scientific Liaison Offices in London have started a Commonwealth index of scientific translations. Each of the Commonwealth countries has or will have an agency which is to maintain a central index of translations into English of published scientific papers, reports and journal articles which have been made by various organizations within the Commonwealth. Each agency collects details of translations made by the organizations in its own country which are co-operating in the scheme; the information is then passed to British Commonwealth of Nations Scientific Liaison Offices, London, where index cards are prepared and sent out to the agencies within the Commonwealth. Persons wishing to know if a certain translation is available should apply to the agency in their own country. So far the following agencies have been established: *United Kingdom*, ASLIB, 4 Palace Gate, London, W.8; *Canada*, Information Division, National Research Council, Ottawa; *Australia*, Information Service, Commonwealth Scientific and Industrial Research Organization, 314 Albert Street, East Melbourne; *New Zealand*, Information Bureau, Department of Scientific and Industrial Research, Wellington; *India*, Deputy Secretary, Ministry of Natural Resources and Scientific Research, Secretariat, New Delhi.

Preservation of Glass from Corrosion

A SHORT note by Max Unwin on the preservation of glass from the effects of weathering is contained in the April issue of the *Museums Journal*. In many instances, iridescence in glass is caused by carbon dioxide in the air or soil forming carbonic acid. This combines with the alkaline constituents of glass and causes decomposition of the surface which may ultimately lead to complete disintegration. The iridescent appearance is the result of an optical effect, and the lamination of the decayed surface may be eliminated by impregnating the surface with a medium optically continuous with the glass itself. The resin now used for this purpose is a polyvinyl acetate dissolved in toluol, prepared by Messrs. Hopkin and Williams, Ltd. Impregnation is effected by dipping the object for a short time in the resin solution.

Oil and Colour Chemists' Association

THE membership of the Oil and Colour Chemists' Association has increased so rapidly, and its *Journal*, published monthly, has so increased in size, that it has become necessary to establish a permanent office. Mr. R. H. Hamblin has been appointed general secretary, both to look after the general affairs of the Association and to deal with the editorial side of the *Journal*. All business inquiries and communications should therefore be addressed to him at the Association's new offices, Memorial Hall, Farringdon Street, London, E.C.4. The 1951 Conference of the

Association was held at Scarborough during May 29–June 2, and the technical side took the form of a symposium on pigment/vehicle relationships. The following honorary officers were appointed for the current year: *President*, Mr. L. O. Kekwick; *Hon. Secretary*, Mr. R. S. Law; *Hon. Treasurer*, Mr. N. A. Bennett; *Hon. Editor of the Journal*, Dr. R. F. Bowles.

Summer School on the Technology of Synthetic Resin Adhesives

A SUMMER SCHOOL on the technology of synthetic resin adhesives, organized by Aero Research, Ltd., Duxford, Cambridge, will be held during September 23–29 at Cambridge. There will be a choice of two courses: synthetic resin adhesives for the wood-working industries; and synthetic resin adhesives for the engineering, electrical manufacturing and allied industries. Lectures will be given in the University Engineering Department Lecture Theatre in the mornings, and most afternoons will be devoted to practical work and demonstrations at the factory at Duxford. Accommodation has been arranged at St. Catharine's College, Cambridge, and the inclusive fee for the school is 10 guineas. Further details can be obtained from Aero Research, Ltd., Duxford, Cambridge.

Conference of the International Association of University Professors and Lecturers

THE sixth conference of university teachers, organized by the International Association of University Professors and Lecturers, will be held in Nice during September 20–24 and will be open to members of the Association and to all others interested. The conference will meet under the chairmanship of Prof. A. Portmann, of the University of Basle, and the vice-chairmanship of Prof. F. Vito, of the Catholic University of Milan. The general aim, as of all the activities of the Association, is to foster the development of an academic fraternity, across the boundary lines of faculties, among the university teachers of all countries. In particular, three topics will be considered at the conference: academic freedom; relation between research in industry and in the universities; and the status of the university teacher. The address of the conference will be Centre Universitaire Méditerranéen, 65 Promenade des Anglais, Nice. The registration fee is 10*s*. Further details can be obtained from Mrs. Cecil, Secretary, I.A.U.P.L., 13 Old Square, Lincoln's Inn, London, W.C.2.

University of London

THE title of professor in the University of London has been conferred on the following in respect of the posts held by them at the Royal Veterinary College, London: Prof. H. Burrow, professor of veterinary medicine; and Prof. N. J. Scorgie, professor of veterinary hygiene. The title of reader in inorganic chemistry in the University has been conferred on Dr. A. J. E. Welch, in respect of the post held by him at the Imperial College of Science and Technology, London.

Clayton Awards for 1951 of the Institution of Mechanical Engineers

UNDER the Clayton Bequest, the Institution of Mechanical Engineers has recently made the following awards for 1951, amounting in all to about £3,800, for postgraduate training or research in mechanical engineering: *Clayton Fellowships*: B. E. L. Deckker (Birmingham), F. Ellis (London), J. Halling (Mitcham, Surrey), J. Houghton (Coventry), D. Howe (Bletchley, Bucks), G. Moss (London), H. Naylor (Baildon, Yorks) and M. Ruddick (Grays, Essex). *Clayton Grants*: J. Huddart (London), D. R. S. Rabley (Plymouth) and N. D. Thomson (Sheffield).

Announcements

WE regret to announce the death of Prof. A. J. Allmand, F.R.S., lately professor of chemistry in King's College, University of London, which occurred on August 4, aged sixty-six.

PROF. C. A. COULSON, professor of theoretical physics in King's College, University of London, has been elected Rouse Ball professor of mathematics in the University of Oxford as from January 1, 1952. Prof. Coulson went to his present post in 1947 (see *Nature*, May 10, 1947, p. 632).

DR. ANDREW WILSON, reader in applied pharmacology in University College, London, has been appointed professor of pharmacology in the University of Liverpool.

A SUMMER SCHOOL on relaxation methods will be held in the Imperial College of Science and Technology, London, S.W.7, during September 3–21. The school will be on similar lines to that held last year and will cover the numerical solution of linear algebraic equations, framework problems, Laplace's and Poisson's equations, the biharmonic equation, eigenvalue problems, the heat-conduction equation, etc. The fee for the course will be £10. Further details can be obtained from D. N. de G. Allen, at the Imperial College.

A CONFERENCE organized by the Food, Agriculture and Fine Chemicals Groups of the Society of Chemical Industry on "Problems Arising from the Use of Chemicals in Food" will be held at the Wellcome Research Institution, 183–193 Euston Road, London, N.W.1, during September 27–28. Forms of registration for the conference can be obtained from the Assistant Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1; the registration fee is 10*s*. for members of the Society of Chemical Industry and £2 for non-members.

A COLLOQUIUM on recent advances in the study of cosmic radiation will be held in the School of Cosmic Physics, Dublin Institute for Advanced Studies, during September 25–27. Formal lectures will be given in the mornings by Dr. G. D. Rochester, Dr. C. Ó Ceallaigh and Dr. E. P. George. In the afternoons there will be specialized discussions to which contributions will be made by the visiting lecturers and members of the School. Further particulars can be obtained from the Registrar of the Institute.

IMPERIAL Smelting Corporation, Ltd., are now producing fluorine gas compressed into steel cylinders at 400 lb./sq. in. pressure at their Avonmouth works. Inquiries should be directed to the Company at 37 Dover Street, London, W.1.

IN connexion with the review of Oliver Heaviside's "Electromagnetic Theory" published in *Nature* of July 28, p. 136, Messrs. E. and F. N. Spon, Ltd., state that this publication is now issued only by them, and they have the complete copyright in it.

SCIENCE IN BERLIN

During the seven days beginning May 24, a scientific conference was held in Berlin and was attended by delegates from many parts of the world. It was held under the patronage of the Burgomaster of Berlin, Prof. Ernst Reuter; the Senate of the City of Berlin; and the Plenipotentiary of the German Federal Republic, Dr. Heinrich Vockel. The Conference was organized with the support of the Gesellschaft Deutscher Chemiker, and its president, Prof. K. Ziegler, paid tribute to Prof. J. D'Ans who, as president of the Berlin branch of the Gesellschaft, had been largely responsible for the idea of holding the Conference and for its organization. The bodies which acted as hosts were: the Freie Universität Berlin, the Technische Universität Berlin, the Deutsche Forschungshochschule Berlin-Dahlem, the Ortsverband der Gesellschaft Deutscher Chemiker and the Berliner Physikalische Gesellschaft.

The Conference demonstrated very clearly that Berlin again has an important part to play in academic and scientific affairs, and it provided a valuable occasion for Berlin scientific workers to meet their colleagues from other parts of Germany and to discuss their scientific problems. It was the first major scientific conference to have been held in Berlin after the War, since most of the recent conferences have been held in the Federal Republic of Western Germany. It was attended by students of the Berlin Universities, including the Humboldt University in the Eastern Sector. Nearly 2,500 tickets were sold to participants, about 800 of these to residents of the Eastern Zone of Germany or the Eastern Sector of Berlin.

The scientific papers were formally divided into two main groups: the first on chemical problems in living processes; the second on problems of atomic physics, molecular physics and cosmogony. The large number of papers contributed at the Conference (some sixty or so in number) covered a wide range of chemistry, physics and physical techniques; eight of the papers were from the Eastern Zone of Germany and four from the Eastern Sector of Berlin.

The visiting foreign men of science, many of whom read papers, were: Prof. H. J. Hildebrand, University of California; Dr. J. R. Johnson, Cornell University; Dr. Miller, Minnesota Mining and Metallurgical Corporation; Prof. P. Niggli, Technische Hochschule, Zurich; Prof. J. A. Hedvall, Göteborg; Prof. R. Domenjoz, Saarbrucken; H. Nitschmann, Bern; Prof. H. S. W. Massey, London; Dr. F. P. Bowden, Cambridge; Prof. Chrétien, Paris.

The Conference was held in the premises of the Technical University (Berlin-Charlottenburg), and at the ceremonial gathering the rector, Prof. W. Pflaum, laid stress on the important part that the fundamental and exact sciences play in technology. Dr. Vockel said that he envied the natural scientists their comparatively simple task of discovering the natural laws which govern the physical world. He appealed for their understanding of, and sympathy for, the politician who is attempting the difficult and urgent task of discovering the laws which govern the social order. Dr. Tiburtius, as Senator for Education in the City of Berlin, spoke of the attitude of the State towards science, which should not be to harness it for political ends, but to co-operate with scientific workers and to assist them in the free pursuit of their researches. The other speakers were Prof. M. von Laue, president of the Kaiser-Wilhelm-Institut, Berlin-Dahlem; Prof. Ziegler; Prof. Hans von Kress, rector of the Free University. Prof. C. Ramsauer, president of the Berlin Physical Society, gave an account of the part which Berlin scientific men have played, particularly in modern physics and chemistry. Measured by any yardstick this is impressive, and it was interesting to note that of the total of thirty-four Nobel Prizes which have been awarded to German physicists and chemists, eleven were gained by Berlin scientific workers. Prof. P. Niggli (Switzerland) spoke on behalf of the foreign men of science and paid tribute to Berlin's record in the natural sciences.

The first session began with a paper on photosynthesis by Prof. O. Warburg, and the physics session on radioactivity, which was under the chairmanship of Prof. J. D'Ans and Prof. M. von Laue, was opened with a paper from Prof. O. Hahn. This opening session was attended by Major-General G. K. Bourne, General Officer Commanding Berlin (British Sector), by Dr. Vockel, and by representatives of the British, American and French Scientific Research Divisions.

Those attending the Conference worked hard during the day, and in the evenings were entertained at various social functions, both official and private. These included a reception given by Dr. Vockel; an evening at the ballet "Abraxas", followed by a reception given by the Senator for Education, the Rector of the Technical University and the Rector of the Free University. At this reception a presentation was made to Herr Werner Egk, composer of the ballet. A reception was also given by the Mayor and Senate of Berlin. In addition to this, there were student gatherings and entertainments. Visits were paid to various research laboratories, many of which are admirably equipped and which are carrying out work of a high standard.

The Conference was held in an atmosphere of lively interest and enthusiasm, and it was impressive to see how science can transcend all political difficulties. The attendance was very large; in the physics session, for example, it was well over a thousand, a big proportion being students. The whole Conference was admirably organized, and it reflects great credit on Prof. D'Ans and the organizing committees. It is clear that science in Berlin is very much alive, and tribute must be paid to the devotion and courage of those who have built it up under such difficult conditions.

F. P. Bowden

A CENTURY OF DEVELOPMENTS IN ENGINEERING

A "Joint Engineering Conference, 1951", organized by the Institutions of Civil, Mechanical, and Electrical Engineers, was held in London during June 4–15. A large number of papers reviewing the development of different branches of engineering during the past hundred years were read.

One group of papers dealt with mechanical engineering developments in the mercantile marine, on the railways, in the gas industry, in electricity power stations, in road transport vehicles and in the iron and steel industry. Mr. R. A. Crowe outlined the development of ship propulsion from the day when the naval "Seamanship Manual" stated categorically that "there is no greater fallacy than to suppose that ships can be navigated on long voyages without masts and sails", to the most recent developments in the application of gas turbines to marine propulsion. He believes that for many years to come the steam turbine is likely to remain unchallenged for the propulsion of large passenger liners. Mr. R. A. Riddles reviewed progress in railway mechanical engineering from the early pioneering days of the Stockton and Darlington Railway, the first public railway to employ locomotive traction, to the many attempts to improve the thermal efficiency of steam traction which have been made during the first half of the present century. Mr. F. M. Birks dealt with technical advances in the gas industry. He explained the advances from manually charged retorts to the successfully developed Glover–West and Woodall–Duckham systems of continuous vertical retorts, which are now responsible for about one-half of the gas output of the industry. A ton of Durham coal now yields 74 therms of gas, 20 therms of tar and 165 therms of saleable coke, the total products for sale having 86 per cent of the thermal value of the coal. Mr. Birks thinks that, economically, the gas industry has a promising future, as it is able to convert thermal energy for cooking purposes at a capital cost considerably less than half that required by any other system of distributed energy. Mr. Bask, in discussing mechanical plant for electricity power stations, said that fifty-three new power stations have been designed in Great Britain to come into operation during the period 1946–56. Anxiety about the rate of extraction of coal, oil and natural gases is giving a special impetus to the use of water-power resources and the more efficient use of other sources of power. Economic studies appear to justify the use of heat from atomic piles for base-load stations, and it seems that atomic piles in association with steam plant may become practicable in the near future.

Another group of papers dealt with hydro-electric power schemes and power station design and construction, the generation, transmission and distribution of electricity, applications of electricity to sea transport, the development and use of gas-pressure cables for high-voltage systems in Great Britain, electric traction and signalling, telecommunications, air radio, electrical measuring instruments, the British television service, radio masts and towers and progress in electric lighting.

Sir John Hacking, in his paper on the generation, transmission and distribution of electricity, said he believes that during the next twenty years there will be more development in the use of water power than in the use of any other kind of energy for electrical generation. Tidal power schemes such as the Severn Barrage have been investigated, but they suffer from the disadvantage that it is not possible to obtain a reliable output during peak-load hours without some system of energy storage. On the other hand, the use of gas turbines would have the advantage that they can be started up rapidly for use during peak hours; they are not likely to become competitive in Great Britain until pulverized coal can be used as a fuel in the place of oil. Experiments are also being carried out at the present time to make use of wind power.

Mr. J. E. Goodall and Mr. D. B. Irving described the development of gas-pressure cables for high-voltage systems. The first experimental installation using high gas-pressure to suppress ionization, or the reaction involving re-combination of ions, passed its tests in November 1931, and the first commercial installation of this type of cable in the world was carried out in the following year in London. The main mechanical difficulties were encountered in sealing the ends; but these have now been largely overcome, and different manufacturers are standardizing the details of these cables.

Sir Stanley Angwin traced the development of telecommunications during the past hundred years, Air Commodore Cadell and Dr. O'Kane discussed the use of radio aids in flying, and Sir Archibald Gill described the ever-increasing use made of electrical devices on board ship. Sir Stanley Angwin pointed out that the electric telegraph handled 48,600 messages during the year 1851, whereas in 1948 that number had increased by more than a thousand times. The comparable figures for the telephone service show that the first exchange with eight subscribers was opened in 1879, the total number of subscribers increasing to 3,300,000 in 1939 and 5,200,000 at the present time. Dr. S. Whitehead reviewed the development of electrical measuring instruments. He pointed out that the early history of electrical measurements is virtually the history of physical science. Electrical measurements made many of the discoveries possible, which in turn led to better instruments. With the development of the electrical industry came a further great demand for reliable electrical measurements, until to-day there are very few measurements in which electricity does not or could not play a part. Sir Noel Ashbridge described the developments that led to the establishment of the British television service. He recalled that, in 1908, A. A. Campbell Swinton, in a letter in *Nature*, outlined a proposed method of television strikingly similar to that now in use. Sir Noel discussed the difficulties in the siting of television transmitters, and, turning to the future, thought that the reasons which militated against stereoscopic cinematography operate even more strongly against stereoscopic television. Colour transmission, on the other hand, presents an attractive field for development. It is now possible to transmit a satisfying picture of adequate detail in colour within the same spectrum space as a picture of apparently similar detail in monochrome.

Mr. R. D. Ackerley outlined the development of electric lighting from the discovery of the electric arc by Sir Humphry Davy to the construction of the largest light source in the world, a 4,000-amp. 600-kW. arc lamp for anti-aircraft use in the Second World War. The greatly improved efficiencies of modern lamps were mentioned, and Mr. Ackerley foresees developments in high-pressure mercury vapour lamps for better street lighting, and an increase in efficiency and a fall in the cost of fluorescent lamps. Mr. C. O. Boyse, in his paper on radio masts and towers, described the co-operation between the radio engineer and the structural engineer which is necessary in the design of these structures. He considers that the installation at Rugby, which was built in 1923 and consists of a dozen 820-ft. high masts, is still one of the outstanding achievements in this field.

Yet another group of papers dealt with permanent-way developments, underground-railway planning and railway bridges, ports, harbours and dry docks, road planning and safety, a number of public-health topics and the development and design of aircraft structures, and planning and construction of airfields. Mr. Everard, Mr. Anderson and Mr. Sutherland Campbell, the authors of the first of these papers, pointed out that underground railways provide a second plane of traffic with the highest known capacity for handling large crowds. They can handle more than 100,000 people per rush hour in two directions of traffic at an average speed of 20–25 m.p.h. The figures of journeys by public transport per year per head of population were given as: Paris 400, New York 462, London 500. No large-span railway bridge has been built in Great Britain since the Forth Bridge (1890). The greatest problem in connexion with railway bridges in Britain is their maintenance, the railway executive being responsible for a total of more than sixty-two thousand bridges. Mr. Leighton and Mr. Guthrie Brown discussed the port facilities of Britain and the great contribution engineers have also made to the handling of bulk cargoes like grain, seeds, coal and petroleum. There are now thirty-two major dry docks in the world, ten of which are within the British Commonwealth. Any forecast of future dry docks is linked with the average increase in the size of commercial vessels, particularly if the tendency of an increasing ratio of beam to length continues. Mr. G. T. Bennett, in his paper on road safety and planning, quoted an estimate that the total cost to Great Britain of road accidents was £100 millions in 1946, without accounting for losses due to delay on the roads. He pointed out that Great Britain depends for prosperity largely upon the exploitation of its geographical position, the short distances between ports and centres of industry favouring entrepot trade and exports. He advocated strongly the investment of capital in road improvement to cheapen production costs.

Mr. H. J. B. Manzoni, Mr. H. F. Cronin and Mr. D. M. Watson read three papers on the related topics of public-health engineering, water supplies and sewage disposal. Mr. Manzoni reviewed the insanitary state of most towns and cities in the early part of the last century and the great advances which have been made since then. He gave an indication of the magnitude of the problem of refuse disposal by quoting the figure of 14 million tons as the annual quantity of refuse collected by local authorities in England and Wales just before the Second World War. He also referred to the problem of district heating. This is the most economical method for a large estate of houses in which the whole of each house is heated; the cost is greater, however, than the cost of coal fires to heat only one, or at most two, of the rooms in each house.

Papers on engineering education and training which were read at the Conference have already been reviewed separately in *Nature* of July 7, p. 14.

E. K. Frankl

THE MUSEUMS ASSOCIATION

ANNUAL CONFERENCE

The fifty-seventh annual conference of the Museums Association was held in Belfast during June 18–22 under the presidency of Mr. S. D. Cleveland, deputy director, City Art Gallery, Manchester. The theme of the Conference in this Festival Year was "The Museum as Mirror of British Achievement in Art and Science". About three hundred delegates attended, including representatives of the French museum movement, and others from Unesco, and from Australia, Canada, Mauritius, Egypt and the United States.

The presidential address, on "Association Reflections", was a survey of the activities of the Association since 1939. Mr. Cleveland reviewed in some detail the work carried out by museums and art galleries during the difficult war years, and felt that, despite the handicaps, the period was a stimulating one in the museum movement. With regard to the future, Mr. Cleveland considered that, in adopting a constitution more in keeping with the present policy of the Association as primarily a professional organization, the present standards of curatorship necessary for a public service would be maintained and indeed improved.

Mr. J. A. S. Stendall, director of the Museum and Art Gallery, Belfast, after outlining the history of museums in Northern Ireland, described the modern display methods adopted at Belfast during the past few years. The material has been re-arranged so as to tell a story, colour effects have been used lavishly, and fluorescent lighting is combined with the earlier tungsten lamps. Reference was made to the projected museum of Ulster life and tradition which is to be established in the grounds of Belfast Castle.

Dr. D. Dilwyn John, director of the National Museum of Wales, recalling the theme of the Conference, reminded the audience that "a mirror reflects things outside itself and thus museums do mirror British achievements which are not in themselves museum achievements". As an example he took a specimen of *Glossopteris*, a fossil fern from the Antarctic, collected at the side of the Beardmore Glacier by Wilson when returning with Scott from the South Pole. Eventually the specimens were found and shown in the British Museum (Natural History). The fern proved the existence in former times of a great southern continent. But the fossil has another value, for it reflects and mirrors a great British achievement.

Dividing the work of museums into display, curatorial activity and study, Dr. John showed how present display methods consist of starting with the familiar and gradually passing step by step to the less well-known. The safety and preservation of rare specimens are among the most important of curatorial activities, while from the study of great natural history collections springs new knowledge and understanding. Dr. John stressed that a museum man, working in a natural history museum, may be led on from his fundamental work to considerations of the widest interest and to problems which are world wide.

Dr. F. Sherwood Taylor, director of the Science Museum, London, considered that local museums should show illustrations of the physical sciences even if only as temporary displays. He considered that experiments are preferable to static apparatus and stressed that museums should not attempt what has already been demonstrated in schools. He also felt it more desirable to illustrate local industries rather than the simple laws of physical sciences.

The Conference was of particular importance in that it not only reflected the continued progress of museums in their recovery from war damage and reorganization, but also demonstrated the new aims and ideas, techniques and activities which are now evident, and which have greatly stimulated popular interest in, and change of outlook towards, the function of public museums and art galleries.

INSTITUTE OF PHYSICS

ANNUAL GENERAL MEETING

AT the thirty-first annual general meeting of the Institute of Physics, held on May 16 at the Institute's House, 47 Belgrave Square, London, S.W.1, the following were elected to take office on October 1: *President*, Prof. W. E. Curtis; *Vice-President*, Dr. J. Topping; *Honorary Treasurer*, Mr. E. R. Davies; *Honorary Secretary*, Dr. B. P. Dudding; *New Ordinary Members of the Board*, Mr. O. W. Humphreys and Prof. S. H. Piper. Dr. A. B. Wood and Mr. C. G. Wynne join the Board as the new representatives of the Physical Society.

The thirty-first annual report of the Board, covering the work of the Institute during 1950, was adopted at the meeting. It records continued progress. The Board met six times and its various standing committees twenty-one times during the year. The total membership increased by 201 to 3,858, though there was a considerable—and from a financial point of view an undesirable—decrease in the number of subscribers. Slightly fewer applications for election or transfer to the various grades of membership of the Institute were received during 1950 than in the previous year. From the detailed analysis of membership given in the report, the effect of the changes made in the regulations in 1949 can clearly be seen. These changes allowed for the creation of the grade of graduate and the raising of the minimum ages of entry and the lengthening of the periods of experience required for grades of fellow and associate. It has recently been decided to establish a graduateship examination, and the regulations and syllabus, which have been drawn up by the Institute's Education Committee, will shortly be issued.

Details of the activities of the eight branches and the seven specialist subject groups of the Institute are listed in the report. The Australian Branch, which consists of five divisions, held thirty-three meetings for lectures and discussions, and, in addition, a four-day conference in Sydney during November on photometry and its applications. The Manchester and District Branch, in collaboration with the British Society of Rheology, held a summer conference on the physics of lubrication, and the Midland Branch held a two-day conference in Birmingham on vacuum physics at which several firms exhibited various types of vacuum equipment. Under the auspices of the Scottish Branch, well-attended courses of lectures on atomic and nuclear physics, and on industrial and medical applications of atomic physics, were given at the University of Glasgow and University College, Dundee, respectively.

Most of the groups, in addition to holding lecture meetings, organized or participated in conferences lasting over several days. The Education Group discussed physics in schools; the Electronics Group, gas discharge tubes; the Stress Analysis Group, electric strain-gauge techniques; and the X-Ray Analysis Group, both the production and application of high-intensity X-ray beams, and the development and application of Fourier methods in crystal structure analysis. The Industrial Radiology Group held a five-day summer meeting and exhibition in London in association with the Sixth International Congress of Radiology. This group has also been responsible for the production of memoranda on the training of industrial radiographers and on radiological units, in addition to the publication of a second edition of the "Handbook of Industrial Radiology".

At the suggestion of the British Iron and Steel Research Association, the Institute organized a conference on some aspects of fluid flow. This was held at the British Iron and Steel Federation's house, Ashorne Hill, near Leamington Spa, during October 25–28 and was attended by about a hundred and fifty, of whom one-third were members of the Institute. The papers presented and a summary of the proceedings are being published in book form by Messrs. Edward Arnold and Co.

The report mentions that thirty-three technical colleges have now received official recognition, after inspection by the Institute, as institutions suitable for the training of physicists. During 1950, for the first time candidates were presented for the Higher National Certificate in Applied Physics issued jointly by the Ministry of Education and the Institute, and four of the six candidates were successful. For the Ordinary National Certificate there were sixty-four candidates from England and Wales; thirty-eight were successful. Seven candidates entered for the first examination to be held in Scotland, and six were successful.

The Institute has continued to take an active part in the discussions by various bodies on the training of technicians and on higher technological education. The Board has decided to discontinue the Institute's Certificate in Laboratory Arts, and no further examinations will be held after December 1951. The proposals put forward by the City and Guilds of London Institute's Advisory Committee on the education and training of laboratory technicians for an appropriate examination under the auspices of that Institute are regarded by the Board as very satisfactory and suitable for replacing the Certificate examination.

The report states that the new monthly periodical, *British Journal of Applied Physics*, which began publication in January 1950, has been well received. Both in this journal and in the *Journal of Scientific Instruments*, a high standard has been maintained. Other publications during 1950 include a monthly *Bulletin* circulated to members; "Acceleration of Particles to High Energies", in the "Physics in Industry" series, containing the papers delivered at the symposium held in 1949 by the Electronics Group; and a revised and enlarged edition of "Notes on the Preparation of Contributions to the Institute's Journals and Other Publications".

The Institute has kept in close and constant touch with the American Institute of Physics, and is represented on many joint committees and bodies, including committees of the Royal Society and the British Standards Institution.

A growing number of inquiries from members and others about salaries, conditions of service, consulting fees, insurance and radiation hazards, and other professional matters were received and dealt with by the executive officers of the Institute. At the annual conference of the Branch and Group officers, the Board was requested to develop further the Institute's already extensive professional activities and to include a greater interest in the economic status of physicists, particularly those who are teachers in schools. A new survey, similar to that of 1948, of salaries and emoluments paid to Fellows and Associates is to be undertaken, and a new set of notes on terms of engagement suitable for physicists is being prepared. The appointments register has been discontinued, but notices of vacancies for physicists have been included in the monthly *Bulletin*, and from the steadily increasing demand from employers for such space it would appear that this new procedure is satisfactory.

FIRST NATIONAL POLISH SCIENCE CONGRESS

THE First National Polish Science Congress was held at Warsaw during June 29–July 2, in the magnificent hall of the reconstructed Polytechnic Institute. The Congress was called together to deal chiefly with the reorganization of science in Poland, and the discussions, therefore, concerned administrative problems rather than the details of scientific researches as such. Nevertheless, it was of great importance for Polish science, which lost some 40 per cent of its personnel, and suffered widespread destruction of buildings and equipment in the Second World War. Re-organization was required by the great expansion of facilities and numbers of newly trained scientific workers. It had come to be felt on all hands that a unified National Academy of Sciences was a necessity.

The principal formal business of the Congress consisted, therefore, in the incorporation of the former leading scientific organizations, such as the Cracow Academy of Sciences (Polskie Akademie Umietnosci) and the Scientific Society of Warsaw (Warszawska Towarzystwo Naukowe), both dating from the early years of the nineteenth century, into the new National Academy. The Cracow Academy had always been an honorific and essentially publishing body, while the Warsaw Society, though partly concerned with popularization of science (like the British Association), had come to possess a number of research institutes of its own. The new National Academy, modelled on those of the U.S.S.R., China and other countries, will now possess a network of research institutes, and the academicians will be mainly directors of institutes or departments of institutes.

Preparations for the Congress had involved more than a hundred conferences and meetings covering all branches of science and technology. At these meetings there had been discussion of the best arrangements for the organization of the new institutes. At the Congress itself it was emphasized, in the speech of the president (Dr. Jan Dembowski, zoologist), that during the period of re-organization there would be the minimum interruption of research projects currently under way. But besides these problems, the preliminary meetings had evidently also devoted much time to discussion of theoretical problems in the various sciences—a process no doubt stimulated by the desire of the younger generation of Polish men of science to incorporate the philosophy of dialectical materialism into the background of their thought. The interesting speeches of Dr. Dembowski and of Dr. K. Petruszewicz at the opening plenary sessions were made available to foreign representatives in languages of Western Europe, and it would seem very desirable that they should be published in some way in Great Britain.

Foreign countries were represented by small groups of up to about half a dozen members. The Soviet delegation, headed by Prof. Oparin, the biochemist, was naturally the largest; but there were also delegations from France, Germany, China, Hungary, Sweden, Rumania, etc. From the United Kingdom, Dr. J. Needham brought a message of greetings to the new National Academy from Prof. E. D. Adrian, president of the Royal Society. The foreign representatives were able to listen to the speeches in simultaneous translation, and had the opportunity of meeting a very large number of Polish scientific workers of all generations and all specialities. There can be no doubt that the Congress, and the Academy which it was called upon to found, represent an important step forward in the organization of science in Poland.

J. NEEDHAM

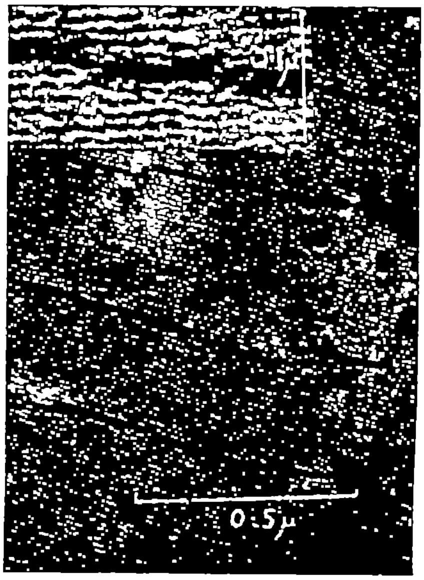
CRYSTAL STRUCTURE OF A LOW MOLECULAR WEIGHT PROTEIN

Electron Microscopy of β-Lactoglobulin Crystals

ELECTRON microscopy of protein crystals has in the past been concerned solely with proteins or nucleoproteins of high molecular weight[1-3]. In this investigation the electron microscope reveals structure in crystals of a protein of a much lower molecular weight, namely, β-lactoglobulin, molecular weight 36,000, which has already been examined by X-ray diffraction methods[4].

Preparations for the electron microscope were made according to the pseudo-replica technique of Wyckoff[5], the specimens being shadow-cast with palladium before stripping from the glass surface. The bulk of lactoglobulin was dissolved out in water before examination of the replica.

The accompanying micrograph is typical of the results. It shows the (100) face. The striations on the crystal face are parallel to the *b*-axis of the crystal. The periodicity is 105 ± 5 A. Molecular steps similar to those shown in earlier published pictures of *n*-hexatriacontane[5,6] occur on the crystal



face. From measurement of shadow-length these steps are found to 50 ± 10 A. in height. The micrograph therefore resolves structure in two crystallographic directions, namely, along *a* and along *c* on the crystal face. It is further evident from the micrograph that the molecules in the crystal are arranged in successive columns parallel to the *b*-axial direction, and this is confirmed by the fact that cross-shadowing does not improve resolution along *b*. It can be seen that the individual columns are in some instances incomplete; the inset enlargement gives two examples of this type of edge dislocation in the crystal lattice.

A direct comparison of the data from X-ray analysis and from electron microscope examination is now possible for the first time for this protein. Since the crystals of β-lactoglobulin were of necessity dried before examination, the results from them can be compared only with the X-ray diffraction results[7] from air-dried preparations. Such results are now given again in the following communication from Dr. D. P. Riley. The periodicity agrees well with previously recorded values for the *c*-axial length[7,8], as does the height of the molecular steps with the *a*-axial value. The concept of molecular packing in columns is supported by the (100) Patterson section given in the accompanying letter.

I wish to thank Prof. J. M. Robertson for his interest and encouragement in this work, the Rockefeller Foundation for an equipment grant to the Department, and Imperial Chemical Industries, Ltd., for a research fellowship. I am grateful to Mrs. D. Hodgkin for the specimen of β-lactoglobulin and for making available to me the X-ray data published in thesis form.

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May 28.

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Structure of Dry β-Lactoglobulin Crystals

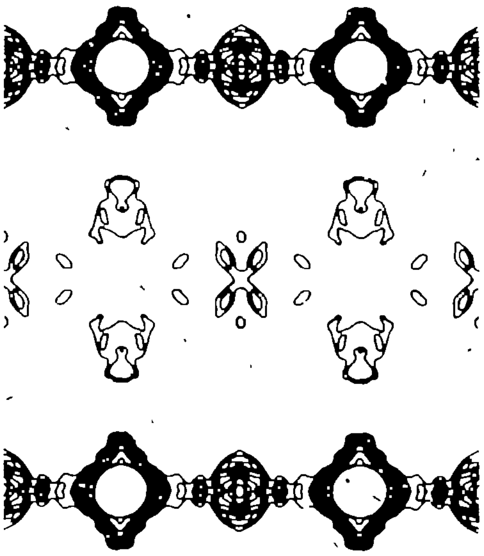
I AM encouraged by Dr. Dawson's most interesting communication to present some crystallographic results on β-lactoglobulin which have hitherto only been available in a thesis[1] or in articles[2] mainly of a review character. Attention will be confined to the dry orthorhombic crystals, often described as 'tabular'.

Although I have not examined the actual batch used by Dawson, the habit of his crystals is essentially the same as that of crystals which I have investigated from several other sources and may be written as: tabular $\{100\}$ elongated along $[010]$; strongly developed $\{100\}$ with subsidiary $\{001\}$ and indefinite $\{0kl\}$. The crystals show a pseudo-uniaxial interference figure and appear isotropic when viewed along *c* parallel to α.

The unit-cell dimensions of the air-dry crystals are $a = 60$ A., $b = 63$ A., $c = 110$ A. (N.B. The values given in an earlier note[7] are incorrect.) Values in good agreement with these have been reported since by other workers: Fankuchen[4], $a = 60$ A., $b = 62$ A., $c = 111$ A.; Senti and Warner[5], $a = 60{\cdot}7$ A., $b = 61{\cdot}0$ A., $c = 112{\cdot}4$ A. Perfect agreement would not be expected owing to the differences in residual water-content from crystal to crystal.

The relative intensities of 142 *hkl* reflexions have been estimated visually and used to calculate the principal Patterson projections and Patterson–Harker sections. That the structure of the air-dry crystals is not very disordered is demonstrated by the fact that X-ray reflexions occur out to a spacing limit of about 4·5 A. The space group is $P\,2_1\,2_1\,2_1$. The density of the air-dry crystals was measured as $1{\cdot}27 \pm 0{\cdot}01$, but the later figure of McMeekin and Warner[6], $1{\cdot}260 \pm 0{\cdot}003$, is more precise.

Dawson's unit-cell dimensions are $a = 50 \pm 10$ A., *b* undetermined, $c = 105 \pm 5$ A. It is to be expected that these values would be somewhat lower than those given by X-ray measurements on air-dry crystals, as the electron-microscope shadowing technique probably involves further drying in a vacuum chamber. The air-dry crystals still contain[6] 9·78 per cent of water by weight.



Patterson section at $x = 0$, $P\,(0, y, z)$, for air-dry lactoglobulin crystals. $b = 63$ A., horizontal; $c = 110$ A., vertical. Higher contours around origin not drawn

The agreement between the electron micrograph and X-ray diffraction evidence is not confined to this near coincidence of unit-cell dimensions. The accompanying figure reproduces the Patterson section at $x = 0$, $P\,(0, y, z)$, in which only the higher contours have been drawn, the lowest contour line shown having a value of 10 arbitrary units. For clarity, the very dense region around the origin has been omitted as the contours there rise to a value of 49. This map represents the summation of interatomic vectors lying in the (100) plane and is therefore directly comparable with the electron micrograph. Its main features are the pronounced band of vector density parallel to *b* at $z = 0$ and, conversely, the absence of any very high peaks in the middle of the pattern. This is exactly the Patterson vector-map corresponding to the arrangement of molecules shown in the micrograph, wherein the molecules lie in columns parallel to b, the columns being separated, centre-to-centre, by the whole c cell-dimension. The Patterson section, however, reflects further structure in the (100) layers which the electron micrograph is unable to resolve. There is, first, the fundamental b-lattice translation. Second, the relatively high peak at $y = \frac{1}{2}$, $z = 0$ shows that the molecules which constitute the columns parallel to b are probably placed with their centres $b/2 = 31 \cdot 5$ A. apart, that is, there is a pseudo-halving of this cell dimension. Third, the two distinctly resolved peaks on the $z = 0$ line, at 10 A. and at $b/2 - 10$ A., indicate the presence of marked intramolecular vectors parallel to b of length 10 A.

On the basis of eight molecules in the unit cell, the anhydrous molecular weight is 35,800, the errors arising particularly from imprecise knowledge of the water-content. Senti and Warner[5] arrive at the more accurate value of 35,400 from consideration of the wet crystals. The volume of the anhydrous molecule, subject to the same errors, is 44,400 A.^{3}, and it can be shown that 85 per cent of the available free volume in the air-dry crystal is occupied by water.

Reliable knowledge of the shape of the molecule with its actual linear dimensions is now clearly very near and should result from a re-examination of the X-ray data in conjunction with further electron micrographs.

D. P. Riley

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July 3.

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SMITHSONIAN INSTITUTION

ANNUAL REPORT FOR 1949–50

THE report of the Secretary of the Smithsonian Institution for the year ended June 30, 1950*, points out that increasing pressures on all sides and definite trends in certain countries towards the regimentation of science enhance the importance of the freedom of inquiry which the Institution has always sought to further, and it records that government support of the ten branches of the Institution has not kept pace with modern exigencies, particularly in physical plant and facilities.

Reference is again made to congestion at the National Museum and at the Natural History and the Arts and Industries Building. The task of modernizing exhibits in the museums, which were visited by more than 2,600,000 persons during the year, is now proceeding as rapidly as funds become available for the purpose. The collections at the National Museum were increased by about 793,300 specimens during the year, while, in the field, investigations of the bird life of northern Colombia and of eastern Panama continued. Natural history collections were made on Prince Patrick Island in the Canadian Arctic archipelago, and other work has included a short field study of molluscs inhabiting the salt marshes on the eastern shore of Maryland, botanical field studies on Big Pine Key, Florida, extensive collections of lichens under the auspices of the Arctic Institute of North America, and a study of the origin and occurrence of rare sulphate minerals at the Geysers and Island Mountain, California; four field parties studied problems in invertebrate palæontology.

The Director of the Bureau of American Ethnology continued his studies of archæological collections made in Panama, and the survey work of the Bureau for the year has covered twenty-six reservoirs situated in eight States and five river basins. At the end of the year, excavations were completed or under way in thirteen reservoir areas in nine States, and, since the start of this River Basin Survey in July 1946, 120 reports have been issued, the investigations being conducted in co-operation with the National Park Service, the Bureau of Reclamation of the Department of the Interior, the Corps of Engineers and other non-government institutions. Archæological investigations conducted on Cornwallis Island in the Canadian Arctic have yielded a large collection of artefacts which have thrown considerable light on the prehistoric inhabitants of the region; further studies were made of the Iroquois, especially at the Tonawanda and Alleghany Seneca reservations in western New York, and Dr. J. P. Harrington continued his study of the grammar of the Abnaki language at Old Town, Maine. The Institute of Social Anthropology continued its anthropological teaching and research programmes in Brazil, Colombia, Mexico and Peru, and issued during the year Vol. 5 of the "Handbook of South American Indians".

The International Exchange Service handled 1,009,675 packages of government, literary and scientific publications, an increase of about twenty per cent, and the majority of the publications now being transmitted are current issues. Consignments are now made to all countries except Rumania and China, and ninety-nine sets of United States official publications are now sent abroad in exchange for similar publications of other countries, fifty-nine of these being full sets. A list of depositories of the sets is given in the report. The value of the National Zoological Park has been enhanced by addition of a number of animals never before exhibited there, and research has continued to be an important feature of its operations. At the Astrophysical Observatory the Division of Radiation and Organisms completed its reorganization and reconstruction of its laboratories; and the Division of Astrophysical Research, besides constructing three silver-disk pyrheliometers for institutions in New Zealand, Venezuela and Rumania, and two modified Angström pyrheliometers and a special water-vapour spectroscope for a meteorological institute in Belgium, has calculated that there has been an increase of 0·25 per cent in the radiation emitted by the sun in the two decades 1925–44 from solar-constant determinations at the Chilean station.

Twenty-one scientific workers visited Barro Colorado Island in the Canal Zone Biological Area during the year and worked at various research projects. The Smithsonian Library received 53,035 publications during the year and currently enters 16,961 periodicals, mostly in exchange for its own publications. With the Secretary's report is included the financial report of the executive committee of the Board of Regents.

* Report of the Secretary of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1950. (Publication 4020.) Pp. ix+161. (Washington, D.C.: Govt. Printing Office, 1950.) 50 cents.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Origin of the Word 'Protein'

In an address to the Swedish Royal Academy of Sciences on "The Place of Berzelius in the History of Chemistry" and in the Berzelius Memorial Lecture to the Royal Society, I claimed for Berzelius the authorship of the word 'protein'. This claim was based on the following passages in a letter to Mulder, the Dutch chemist, dated July 10, 1838:

"Or je présume que l'oxyde organique, qui est la base de la fibrine et de l'albumine (et auquel il faut donner un nom particulier p. ex. protéine) est composé d'un radical ternaire, combiné avec de l'oxygène dans quelqu'un de ses rapports simples que la nature inorganique nous présente."

And later in the same letter:

"Le nom protéine que je vous propose pour l'oxyde organique de la fibrine et de l'albumine, je voulais le dériver de πρωτειος parce qu'il paraît être la substance primitive ou principale de la nutrition animale que les plantes préparent pour les herbivores et que ceux-ci fournissent ensuite aux carnassiers."

Prof. A. C. Chibnall then pointed out to me that the credit for coining the word 'protein' was generally given to Mulder, and that the "Oxford English Dictionary" gives a reference to the first use of the word in his paper "Sur la composition des quelques substance animales" in the monthly issue of the *Bulletin des Sciences physiques et naturelles en Néerlande* dated July 30, 1838. The word 'protein' first occurs in print in this paper in the following sentence:

"La matière organique, étant un principe général de toutes les parties constituantes du corps animal, et se trouvant comme nous verrons tantôt, dans le règne végétal, pourrait se nommer Protéine de πρωτειος primarius."

The parallelism between these passages seemed to me too close to be an accidental coincidence; but a study of the Berzelius–Mulder correspondence edited by the late Dr. Söderbaum and published by the Swedish Royal Academy of Sciences brought to light no previous mention of the word 'protein' by either of them. Dr. Arne Holmberg, librarian of the Academy, then very kindly examined the post-marks on the Berzelius letter of July 10, 1838, which showed that it reached Greifswald on July 14, and although the post-mark at Rotterdam is illegible, the evidence of the transit time of another letter makes it probable that it reached Mulder by July 20. Mulder's paper opens with a generous acknowledgment of his debt to Berzelius, and there seems to me little doubt that he adopted Berzelius's suggestion without making any specific acknowledgment to him.

Prof. H. B. Vickery, in a paper on "The Origin of the Word Protein" in the *Yale Journal of Biology and Medicine* (22, No. 5; May 1950), examines the evidence in great detail and agrees with this view.

Thus, we owe to Berzelius in his later years not only the generalizations which he crystallized in the words 'isomerism', 'polymerism' and 'catalysis', but also the word 'protein' which he coined to express the fundamental significance of certain substances in nutrition, the sense in which we still use it to-day.

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Observations of the Golgi Substance with the Electron Microscope

Observations by several investigators during the past few years lend support to the view that the Golgi substance is present in living cells in the form of droplets stainable supra-vitally with certain vital dyes[1-4]. The classical form of the Golgi substance has been considered to be a gross artefact induced by the development of myelin figures from droplets of phospholipid[3,4]. This view has been accepted by some[5-7] and questioned by others[8,9]. It was felt that observations with the electron microscope might aid in the elucidation of this complex problem. With this possibility in mind, liver and intestinal epithelium were fixed by perfusion in two different fixatives, one the Kolatchev–Nassonov modification of Champy's fluid[10] and the other a mixture of equal parts of 2 per cent osmic acid, 3 per cent potassium dichromate and 2 per cent lanthanum nitrate. The *p*H of the former fixative is 2·0 and that of the latter is 3·4. After fixation, slices of tissue were transferred to the same fixative for varying lengths of time. Both tissues were examined during the period of fixation with oil immersion at a thousand diameters by crushing the tissues under a coverslip in water or glycerine. Neither myelin figures nor the Golgi substance could be identified during the first twenty-four hours with the osmic acid, potassium dichromate, lanthanum nitrate mixture, nor during the first forty-eight hours fixation with modified Champy's fluid. Further treatment with 2 per cent osmic acid for three days at 37° C. resulted in the appearance of the Golgi substance with its typical form and distribution throughout both tissues after fixation in modified Champy's fluid but not after fixation in the osmic, dichromate, lanthanum mixture. Secondary treatment of the tissues preserved in the latter fixative with a mixture of equal parts of 3 per cent potassium dichromate and 1 per cent chromic acid followed by treatment with 2 per cent osmic acid for four days at 37° C. resulted in the development of faint positive images of the Golgi substance, whereas secondary treatment with modified Champy's fluid for twenty-four hours followed by treatment with 2 per cent osmic acid at 37° C. for four days resulted in the development of typical, well-blackened Golgi figures in both tissues.

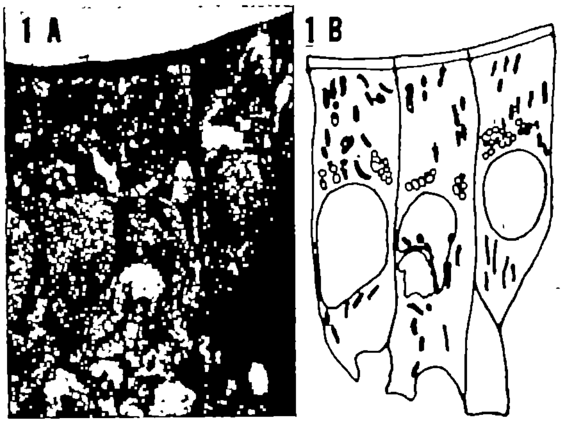

Fig. 1A. Electron micrograph of a principal cell of the duodenum fixed for twenty-four hours in modified Champy's fluid, showing empty vacuoles, arrow (osmiophobic component of the Golgi substance), in the Golgi zone (× 2,000 approx.). *B*. Tracing of the cell in Fig. 1A, to emphasize the vacuoles: mitochondria black

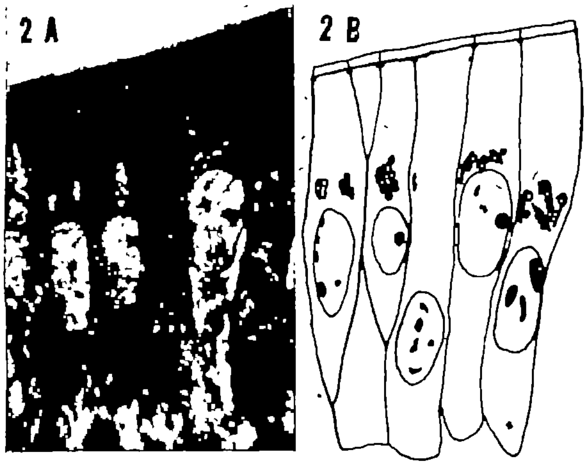

Fig. 2*A*. Electron micrograph of a principal cell of the duodenum fixed for twenty-four hours in modified Champy's fluid followed by treatment with 2 per cent osmic acid at 37° C. for three days, showing vacuoles comparable to those seen in Fig. 1 associated with osmiophilic material, arrow (osmiophilic component), in the surrounding cytoplasm (× 2,000 approx.). *B*. Tracing of the cell in Fig. 2*A* to emphasize the vacuoles and osmiophilic material

Examination of these tissues under the electron microscope disclosed the presence of negative images of the Golgi substance in principal cells of the intestine (Fig. 1) but not in hepatic cells after preliminary fixation in both fixatives. These negative images consisted of rows and groups of vacuoles, some showing slight darkening with osmic acid, others being completely empty. After treatment with osmic acid, positive images were found to consist of areas of blackened cytoplasm in juxtaposition to the vacuoles (Fig. 2). Few vacuoles were found in association with the Golgi substance in hepatic cells (Fig. 3).

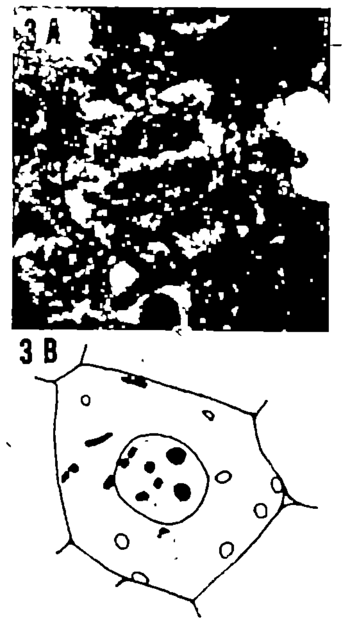

Fig. 3*A*. Electron micrograph of a hepatic cell fixed in modified Champy's fluid followed with treatment with 2 per cent osmic acid at 37° C. for three days, showing the osmiophilic component of the Golgi substance only, arrow (× 2,000 approx.). *B*. Tracing of the cell in Fig. 3*A* to emphasize the osmiophilic component of the Golgi substance. Osmiophilic spheroids (lipoid ?) in cytoplasm in outline form

Thus the Golgi substance is considered to consist of an osmiophilic and an osmiophobic component in principal cells of the intestine of the mouse, but frequently of an osmiophilic component only in hepatic cells. The osmiophilic component is believed to consist of a substance in the cytoplasm of the Golgi zone which reduces osmic acid only after treatment with a combination of strong oxidizing agents such as chromic acid, potassium dichromate and osmic acid. This characteristic distinguishes it from other substances in the cytoplasm which react directly and more readily with osmic acid.

These results suggest that the 'flexuose tubules' described by Gatenby in the hepatic cell of the rat[8] are not present in the hepatic cell of the mouse and that the osmiophilic component of the Golgi substance is not involved in myelin figure formation in the sense of Palade and Claude[3,4]. They also indicate that Baker's suggestion[5] of substituting the term 'lipochondria' for the term 'Golgi apparatus' because of the undesirability of continuing "to apply the name of the great Italian neurologist to an artefact" was possibly premature.

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Superconductivity of Lead Isotopes

Before the discovery of the isotope effect in the superconductivity of mercury[1,2], it was generally assumed that the variation in the atomic weight (M) of a substance would not influence its transition temperature (T_c). This assumption was based on measurements by Onnes and Tuyn[3], and Justi[4], who had compared the transition temperatures of uranium lead and ordinary lead, and had found them to be identical. Observations of isotope shifts in the transition temperature of tin[5-7], and their agreement with the general theory of Fröhlich[8], make it probable that such an effect should also exist in lead. Assuming the validity of Frohlich's formula $T_c \propto 1/M^{1/2}$, the isotope shift in lead would be of the order of 0·025° K. This difference will have just escaped notice with the resolution used by Onnes and Tuyn, but could have been observed by Justi, who claimed an accuracy of temperature measurements to within several 1/1,000° K.

Measurements of the transition temperature have now been carried out on two lead samples with mean atomic weight of 206·15 and 207·72. The method[9] used was identical with that previously employed in this Laboratory, except that the gas thermometer readings were supplemented by a resistance thermometer. The disappearance of the electrical resistance of the two samples was found to be sharp to within 0·002° K., indicating good chemical purity of the metal. The transition temperature of lead-206·15 was found to be $0{\cdot}038_6 \pm 0{\cdot}002$° K.

higher than that of lead-207·72. No attempt has as yet been made to determine with great accuracy the absolute value of the transition points, which are slightly above 7·2° K. The resulting power of M(0·73 ± 0·05) thus appears to be somewhat higher in our experiments than that predicted by Fröhlich (0·5).

Lead-207·72 (extracted from Ceylon thorite)[10] was kindly lent to us by Prof. F. Soddy, and spectrographically analysed by Mr. G. H. Palmer, of the Atomic Energy Research Establishment, Harwell.

We are grateful to Mr. C. H. Collie for lending us the uranium lead sample (lead-206·15) which was obtained from the Eldorado Mining Company of Canada. I wish to thank Dr. K. Mendelssohn for his interest and advice, and my husband, J. L. Olsen, for his help with the experiments.

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The Clock Paradox in Relativity Theory

THE clock paradox discussed by Prof. McCrea in his letter in *Nature* of April 28 is, as he says, no paradox at all. It exists only for observers who have been asleep during the changes of direction of motion of the clocks.

A stumbling-block to handling the problem by using the Lorentz transformations is that these apply only to uniform motion, not to a clock reversing its direction of travel. This difficulty may be avoided if we make use of auxiliary moving clocks, to which the epochs of the original clocks are communicated as they pass each other.

Consider two identical railway trains in uniform motion at different rates; call them *A* and *B*. Observers on these trains make indistinguishable observations of uniform separation or approach. For convenience, locate our co-ordinate system on *A*, that is, consider it stationary. At some point in the progress of *B* let another identical (auxiliary) train *C* pass it going in the opposite direction at such a rate that it ultimately passes *A*. Let the epoch on the clock on *B* be flashed to a clock on *C* as they pass. Then as *C* passes *A* (*B* meanwhile passing off into space), a comparison of the epochs of the clocks on *A* and *C* shows the clock on *C*—since *B* and *C* have both been in motion with respect to *A*—to be behind the clock on *A*. The observer on *A* sees a clock pass him in one direction, and if he has not seen the transfer operation, sees the clock returning, having lost time in the process.

For an observer on *B* the similar experience is presented, when at some point *A* is passed by a train *D* travelling at such a speed that it ultimately overtakes *B*. It reaches *B* by *travelling at a higher velocity* than *B*; the epoch of its clock, originally flashed from *A*, is retarded over *B* because of this higher velocity in travelling over the same distance.

The argument is as follows: Designate by *L* the distance between *A* and *B* when *D* catches up with *B*. The time is then L/v, where v is the velocity of *B*. Because of the slowing down of *B*'s clock, this time will be read:

$$t'_B = \frac{L}{v}\sqrt{1-\frac{v^2}{C^2}} \cong \frac{L}{v} - \frac{1}{2}\frac{Lv}{C^2}.$$

Now *D* traverses the distance *L* in time L/V, where V is *D*'s velocity. This will be read by *D*'s clock as:

$$t'_D = \frac{L}{V}\sqrt{1-\frac{V^2}{C^2}} \cong \frac{L}{V} - \frac{1}{2}\frac{LV}{C^2}.$$

D, however, received its epoch from *A* when *B* had already travelled some distance l, that is at the time l/v, so that the time read on *D* will be:

$$T'_D = t'_D + \frac{l}{v}.$$

Now $\frac{L-l}{v} = \frac{L}{V}$, or $\frac{l}{v} = \frac{L}{v} - \frac{L}{V}$;

so that we have:

$$T'_D = t'_D + \frac{l}{v} = \frac{L}{V} - \frac{1}{2}\frac{LV}{C^2} + \left(\frac{L}{v} - \frac{L}{V}\right)$$
$$= \frac{L}{v} - \frac{1}{2}\frac{LV}{C^2};$$

which is to be compared with t'_B above. Since V is greater than v, the time by *D*'s clock is less than the time by *B*'s clock.

Thus, *B* also observes a clock moving away from him, and later (not having observed the process of transferring epoch from *A* to *D*) sees 'the clock' returning, having lost time. Both observers conclude that it is the other's clock that has slowed down.

If in the first case an observer on *B* is (in a state of unconsciousness) trans-shipped from *B* to *C* at the same time that the interchange of clock readings is made, when he awakes he observes *A* approaching him. When he passes *A* he finds *his* clock is behind *A*'s clock, contrary to his expectation that since *A* has receded and approached it will be *A*'s clock that has lost. He thus discovers that he has been 'Shanghaied' while unconscious. The observer on *A*, as described above, similarly unconscious while the *B*—*C* transfer occurs, agrees with the *B*—*C* observer, when they meet, that the latter's clock has lost time—there is no clock paradox. The observer on *A* is also reassured, if he has followed this argument, that he has stayed on the same train during his nap.

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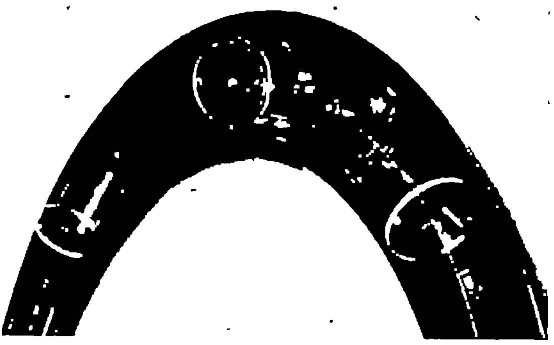
A Toroidal Geiger Counter

A TOROIDAL Geiger counter has been constructed in an attempt to produce a γ-ray sensitivity detector with a response independent of the position of the γ-ray source over a small region of space. The counter was made from two U-shaped half-sections (radius ¼ in.), one of which is shown in the photograph, pressed from 24 S.W.G. oxygen-free copper. The counter was designed in the first instance for experiments in which it was necessary to pass the counter freely over the human head, and for this reason a toroid of mean diameter 12 in. was made. The centre wire, of 0·008-in. diameter tungsten, was supported by eight equi-spaced 'Perspex' disks with central holes through which the wire was a push-fit. These insulators were keyed to one half-section of the counter by phosphor-bronze spigots which projected $\frac{1}{8}$ in. into the edges of the disks. The connexion to the centre wire was taken out through a metal-to-glass seal of commercial pattern, and the two halves of the counter were soldered together using solder-paste and 60/40 soft solder. No difficulty was found in making a vacuum-tight joint without excessive penetration of flux into the tube. A connexion to the vacuum system was made via a lead alloy stem, and the tubes were pumped and filled with a mixture of 10 per cent ethyl alcohol and 90 per cent argon to a pressure of 10 cm. mercury in the usual manner.



Half-section of a toroidal counter showing the lead-out insulator and the 'Perspex' disks supporting the centre wire

A typical counter has an operating threshold of 1,100 volts and a plateau of about 200 volts with a maximum slope of 0·06 per cent volt^{-1}. Unshielded, the background is about 1,000 counts min.$^{-1}$, which appears rather high considering the effective length of the counter; it may be that discharge effects over the 'Perspex' insulators contribute to the background count. In the plane of the counter, the counting-rate due to a small 1-μgm. γ-ray source of radium at the centre of the toroid is 2,500 min.$^{-1}$, which does not change more than ± 10 per cent from the mean for movements within a concentric circle of radius 8 cm. Outside this region the counting-rate increases, especially rapidly as the source approaches the counter wall. With a point source on the central axis at right-angles to the plane of the ring, the counting-rate does not change more than 5 per cent over distances of ± 5 cm. from the plane of the ring.

One interesting property of this counter is its response to γ-rays from the same amounts of radioactive salt dissolved in different quantities of solvents. For example, with 25 μc. quantities of radioiodine in volumes of water of 50–1,000 c.c. filling spherical flasks placed concentric with the counter, the counting-rate was the same (∼ 10,000 counts min.$^{-1}$) within 2 per cent in all cases. This result may be fortuitous, arising from the particular size of the counter which has been made; but it does suggest a simple apparatus for assessing the excretion of radioiodine in thyroid function analyses without making volumetric measurements.

Further details of the counter will be published later. At present, to find under what conditions a uniform sensitivity over a greater volume of space can be obtained, experiments are proceeding with two similar toroidal counters arranged in a system analogous to a Helmholtz coil.

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Dielectric Behaviour of Human Blood at Microwave Frequencies

In the course of studies of microwave absorption in human tissues, measurements have been made of the dielectric constant, $\epsilon'-j\epsilon''$, of whole human blood at a number of frequencies in the range $1·78 \times 10^{8}$ c./s. to $2·36 \times 10^{10}$ c./s., employing co-axial-line and wave-guide methods described elsewhere[1,2]. The specimens used had red cell concentrations within the limits $4·9 \pm 0·1 \times 10^{6}$ cells per mm.[3] and were heparinized to prevent coagulation.

Dispersion was found to occur and the experimental results to agree, within experimental error (± 2 per cent in ϵ' and ± 5 per cent in ϵ''), with values calculated from the Debye equations with a single relaxation time, τ, if dielectric loss due to an ionic conductivity, σ_i, was allowed for. The values of ϵ^* (the value from which ϵ' falls in the dispersion region), ϵ_∞ (the value ϵ' asymptotically approaches at high frequencies), τ and σ_i which have been derived from the analysis of the results at three temperatures are shown in the accompanying table, together with corresponding values of ϵ^* and σ_i for blood plasma.

The dispersion observed can be attributed entirely to dipolar orientation of part of the water present in blood. The dispersion effects of inhomogeneity, investigated previously by others (see, for example, Danzer[3] and Schwan[4]), appear to be absent at microwave frequencies. The relaxation times shown in the table are approximately 8 per cent higher than the values for pure water at the same temperatures. Recent work[1] indicates that this increase is probably related to hydrogen-bond formation between water molecules and active groups of other molecules.

Temp. (° C.)	Whole blood				Blood plasma	
	ϵ^*	ϵ_∞	τ	σ_i ohm^{-1} cm.$^{-1}$	ϵ^* (calc.)	σ_i ohm^{-1} cm.$^{-1}$ (exp.)
15	62·0	4·5	$1·19 \times 10^{-11}$ sec.	0·010	78·3	0·0108
25	58·0	4·6	0·90 ,, ,,	0·012	74·3	0·0128
35	56·0	4·5	0·70 ,, ,,	0·014	70·6	0·0155

Further analysis of ϵ^* and σ_i for whole blood and plasma has been carried out by application of theories for inhomogeneous dielectrics. Those of Maxwell[5], Wiener[6] and Fricke[7] all lead to the relation

$$\frac{k - k_1}{k + xk_1} = \rho\,\frac{k_2 - k_1}{k_2 + xk_1},$$

when k, k_1 and k_2 are the dielectric constants or specific conductivities of the suspension, the suspending and the suspended media respectively, ρ is the volume concentration of the suspended medium and x is a numerical factor depending on the shape of the suspended particles and on the ratio k_2/k_1. Fricke[8] has shown the theory to hold in the cases of the low-frequency conductivity of blood and of cream up to a concentration of 62 per cent of cream in skimmed milk. It will be assumed that the theory also holds in the present case and that the effect of cell-membrane impedance is negligible at microwave frequencies.

Using the values of ϵ^* and the corresponding dielectric constants of blood plasma given in the table, and assuming the effect of cells other than erythrocytes is negligible, the above relation gives the dielectric constant of the contents of the red cell as 43·9, 40·1 and 39·8 at 15°, 25° and 35° C. respectively. Further, assuming the relation also applies to the cell contents and that a hæmoglobin molecule with its hydration sheath is an oblate spheroid of axial ratio 2, further use of the above equation gives the volume and hydration of the cell hæmoglobin. The mean value for hydration found from the results at the three temperatures is $0 \cdot 23 \pm 0 \cdot 16$ gm. water per gm. hæmoglobin. This is in fair agreement with the estimate derived by Haggis *et al.*[9] from microwave measurements on hæmoglobin solutions.

It is of interest to note that if the hydration is calculated by use of a simple volume proportion relation[10,11] for the dielectric constant of the cell contents, the estimate obtained is twice the figure quoted above.

In the case of ionic conductivity, application of the above law for inhomogeneous media using the conductivities given in the table shows that the ionic conductivity of the intracellular fluid is 83 per cent of that of the plasma. This is in good agreement with published data[12] for the ion balance of normal human erythrocytes and plasma, from which a ratio of 0·79 is obtained.

Full details of this work, and of corresponding microwave studies on human tissues, will be published elsewhere.

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Relation between Polyploidy and the Amounts of Deoxynucleic Acid per Nucleus in the Liver and Kidney of Adult Rats

The nuclei of the livers of rats vary greatly in size, and it was found[1,2] that the nuclear volumes formed a geometric series of type 1, 2, 4. Beams and King[3] showed that the doubling of the nuclear volumes was due to polyploidy, so that within the cells of the liver there were nuclei which contained the diploid, tetraploid or octoploid number of chromosomes. In the liver of the adult rat, 70–80 per cent of the nuclei were tetraploid, and almost all the nuclei in the remaining 20–30 per cent were diploid with only a few per cent octoploid[1,2]. Mirsky and Ris[4] demonstrated that in tissues the deoxynucleic acid was situated in the chromosomes, and it was suggested that the amount of deoxynucleic acid per nucleus was related to the chromosome number. Therefore, a large proportion of the nuclei in the liver of the adult rat should contain twice the amount of deoxynucleic acid found in the diploid nucleus. No direct evidence has been obtained for the rat; but Swift[5] has shown in the adult mouse, by using the absorption of Feulgen-stained nuclei in histological sections as a measure of the amount of deoxynucleic acid per nucleus, that most of the nuclei in the liver contained twice the common amount of deoxynucleic acid which had been found in the small liver nuclei and in the nuclei of other tissues, including the kidney.

From the analyses of suspensions of nuclei it is only possible to obtain a mean value for the amount of deoxynucleic acid per nucleus. However, for the mammalian tissues so far investigated, it has been found that the mean amount of deoxynucleic acid per nucleus is always about 6×10^{-6} μgm.[6-8]. This value is presumably equal to the amount of deoxynucleic acid in the diploid nucleus. If the amount of deoxynucleic acid per nucleus is associated with the chromosome number, it should follow by simple proportion that, in the liver containing 70–80 per cent tetraploid nuclei, the mean amount of deoxynucleic acid per nucleus should lie between 10 and 11×10^{-6} μgm. deoxynucleic acid per nucleus (assuming that the percentage of octoploid nuclei is negligible). Values of this order were obtained by Dounce, Tishoff, Barnett and Freer[9] for rats of the Wistar strain. Further, it has recently been found that the mean amounts of deoxynucleic acid per nucleus in the livers of three male and three female black-and-white hooded rats, of mean weight 270 gm. and 205 gm., were 9·6 and $10 \cdot 2 \times 10^{-6}$ μgm. respectively. It is proposed to report these findings in more detail elsewhere.

In order to determine whether a relationship does exist between the amount of deoxynucleic acid and the number of chromosomes in the nucleus, it was decided to estimate in the same animals the mean amounts of deoxynucleic acid per nucleus in the kidney as well as in the liver, since the former tissue contains only nuclei with the diploid number of chromosomes. The livers and kidneys were removed from seven adult female black-and-white hooded rats of the Lister strain and of mean weight 200 gm. The samples of liver and of kidney cortex were each separately pooled for analysis. The nuclear suspensions were prepared by the method of Dounce[10] in an aqueous citric acid medium at pH 4. The deoxynucleic acid was estimated as deoxynucleic acid phosphorus after removing the acid-soluble, phospholipid and ribonucleic acid fractions[11]. The nuclei in the suspension were counted in a hæmacytometer, and from these results the mean amount of deoxynucleic acid per nucleus was deduced.

In the liver the mean amount of deoxynucleic acid was $10 \cdot 1 \times 10^{-6}$ μgm. per nucleus, whereas the mean amount in the kidney was $5 \cdot 7 \times 10^{-6}$ μgm. deoxynucleic acid per nucleus. The value for the kidney is in close agreement with that reported for the diploid nuclei. From these values for the liver and the kidney it may be calculated, assuming as before that the percentage of octoploid nuclei is negligible, that about 76 per cent of the nuclei contained the tetraploid number of chromosomes. This result agrees very closely with that observed histologically by Sulkin[1] and McKellar[2].

From the results it may be concluded that the high values which have been obtained for the mean amount of deoxynucleic acid per nucleus in the liver of the rat have been due to the presence of nuclei containing the tetraploid and octoploid number of chromosomes. The striking agreement between the values for the degree of polyploidy obtained by histological measurements and by calculation from chemical analyses suggests that a doubling in the number of chromosomes is accompanied by a doubling in the amount of deoxynucleic acid per nucleus. Therefore, it would appear that for the rat there is a direct relationship between the amount of deoxynucleic acid per nucleus and the number of chromosomes. The significance of these findings in the calculation of the mass of the liver cell will be discussed in a later paper.

I am indebted to the International Federation of University Women for the award of the Alice Hamilton International Fellowship.

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Coenzyme of Kidney Phosphatase

IT has been deduced from dialysis at different *p*H that kidney phosphatase can be separated according to the scheme:

holophosphatase ⇌ coophosphatase + apophosphatase[1].

By mixing the dialysis liquid with the solution of inactivated phosphatase and adding magnesium, reactivations up to 100 per cent can be reached: by adding to the apoenzyme boiling solutions of the enzyme, in which the coenzyme remains unaltered, partial reactivations can also be obtained. Albers thinks that the coenzyme cannot be magnesium, but a labile organic substance which has not been identified.

These results have been ascribed alternatively to the presence of small amounts of zinc or cobalt ions, which are able to form a dissociable complex[2]. On the same lines, kidney phosphatase has been considered as an enzyme with dissociable metal (magnesium and also zinc) which may not contain a dissociable coenzyme; so the enzymatic activity would be connected with co-ordination in a metal complex of various fragments of the apoenzyme[3].

It has also been suggested that the dialysable prosthetic group could be a combination of a metal and a substance containing amino-acids; this has been inferred from experiments of reactivation of phosphatase with amino-acids in the presence of metallic ions[4]. But the active entity of boiled solutions cannot be replaced by amino-acids, according to another series of experiments[5].

Following our research on organic models of phosphatase[6] and in order to get a better knowledge of the composition of the enzyme, we have carried out experiments on the dialysis of kidney phosphatase. This was obtained by the Albers method, and we have verified previous results on inactivation, going further in the study of the dialysed liquid.

The liquid of acid dialysis, on evaporation *in vacuo*, gives a residue having 5·2 per cent nitrogen. The spectral analysis of the ash gives magnesium, zinc, nickel, calcium, iron, sodium and potassium—the same metals present in the phosphatase before dialysis[7], but which are not contained in the apoenzyme.

The same residue, treated with alcohol, deposits the mineral part—an insoluble white solid containing the metals referred to before, except magnesium. It also contains phosphorus (24·1 per cent of phosphate) corresponding to a formula PO_4HM^{II} with an average atomic weight of 30 for M^{II}.

From the filtrated solution a very hygroscopic organic residue (N = 10·7–11 per cent) containing magnesium can be crystallized (see accompanying illustration); it melts at 110–120° (with softening), is precipitated by ammonium molybdate and gives yellow needles, m.p. 180° (decomp.), with picric acid.

By treatment with hot, concentrated hydrochloric acid, another portion containing PO_4^{---} is separated, a pentose is identified and another nitrogen compound (N = 23·5 per cent), which is not precipitated with ammonium molybdate and picric acid, is isolated. The spectrum of this substance is now under study.

The results so far obtained suggest that kidney coophosphatase is a metallic derivative of a diphosphonucleoside, probably derived from adenosine, as can be deduced from analytical data and spectral analysis.

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Adrenotropic Hormone (ACTH), Aminopterin and Eosinophil Count

Recent experiments indicate that a relationship might exist between aminopterin and adrenal cortex function. Dougherty and Dougherty[1] report that, following adrenalectomy, mice do not show the lymphopenia and acute atrophy of lymphatic tissue which are observed following a lethal dose of aminopterin. Higgins[2], using aminopterin and aminoteropterin, showed that adrenalectomy minimized considerably the changes induced by such drugs within the spleen, the thymus gland, the peripheral blood and bone marrow of rats. They assumed that some effects of aminopterin can be due to a stimulation of the adrenal cortex. On the other hand, Hanlon[3] of the Mayo Clinic has observed that aminopterin in human subjects gives a rather marked decrease in the output of corticosteroids and, in no case, an increase.

In our experiments we first attempted to see whether administration of adrenotropic hormone (ACTH) (kindly supplied by Irby Bunding, of the Biochemical Department, Armour and Company, Chicago, Illinois) would influence the survival time of mice injected with 50 mgm. per kgm. of aminopterin (kindly supplied by Dr. J. M. Ruegsegger, of the Lederle Laboratories Division, American Cyanamid Company, Pearl River, New York).

Twelve albino mice (mean weight 20 gm.) were divided into two groups. Each mouse of the first group was injected with 1 mgm. of aminopterin intraperitoneally and these were used as controls. The mice of the second group received 1 mgm. of aminopterin intraperitoneally and 2 mgm. of ACTH intramuscularly, divided in two doses. The ACTH was then given to them in the same dosage every day until death occurred. All the animals of both groups died within the fourth day after the injection of aminopterin. No appreciable difference was detected in the time of survival between the animals not treated with ACTH and those which received 2 mgm. of ACTH daily. In other words, in our experiments a stimulation of the adrenal cortex by ACTH does not affect the toxicity of aminopterin, although an absence of its function has been stated to minimize the effects of the aminopterin and teropterin.

Another point we tried to establish was whether aminopterin could interfere with the response of the adrenal cortex to ACTH. The response of the adrenal cortex to the stimulation by the adrenocorticotropic hormone was tested by means of an eosinophil count. The eosinophils were stained by Pilot's method[4].

Experiments were performed on eight guinea pigs (mean weight 500 gm.). On each of the animals an eosinophil count was done. The following values were obtained: 116, 84, 90, 45, 160, 35, 214, 180. Then 1 mgm. of ACTH was given to each animal, and after four hours another eosinophil count gave the following results: 45, 50, 35, 10, 40, 0, 60, 70. In other words, all the animals showed a drop of eosinophils which was about one-half or more of the initial count.

Then each guinea pig received one mgm. of aminopterin intraperitoneally every day for five days. On the fifth day another eosinophil count was made on them and the following values were obtained: 45, 32, 64, 0, 700, 40, 0, 400, 27. (The two guinea pigs which showed an increased eosinophil count were found at necroscopy to be pregnant at a very early stage.) Then 1 mgm. of ACTH was given to each animal, and after four hours a new eosinophil count was made. The results were respectively: 10, 0, 3, 0, 120, 0, 0, 85, 0. In other words, the animals treated with aminopterin showed a normal response (so far as it can be determined through the eosinophil count method) of the adrenal cortex to ACTH. Since the decrease of eosinophils following ACTH in animals treated with aminopterin has been more marked than in the control animals, it might be assumed that the response to ACTH is increased in animals treated previously with aminopterin. This would concur with the findings of adrenal cortex hypertrophy in animals treated with aminopterin. On the other hand, it is difficult for us to explain the observation by Hanlon[3] of a decreased output of corticosteroids in patients treated with aminopterin, unless it might be caused by the difference in the dose of aminopterin.

I am grateful to Mr. Maurice Szafarowicz for technical assistance.

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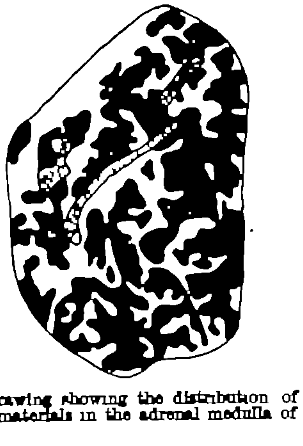
Histochemical Evidence of the Presence of Acid-Phosphatase-Positive and -Negative Cell Islets in the Adrenal Medulla of the Rat

Recent investigations have demonstrated the presence of *nor*adrenaline as well as adrenaline in the adrenal medulla of some mammals. In this communication, histochemical observations are reported indicating the presence of two different kinds of cell islets in the adrenal medulla of the rat.

The material consisted of about fifty adrenals of healthy rats. For the demonstration of acid phosphatase an improved technique[1] modified from Gomori's[2] procedure was used. This technique always gave reproducible results free of the capricious variations frequently characterizing the original method.

The greater part of the adrenal medulla contained large amounts of histochemically demonstrable acid phosphatase, already evident after immersion for 10 min. in the substrate solution. Another part, on the contrary, was still pale in sections treated for two hours in the substrate. The accompanying



Camera lucida drawing showing the distribution of acid-phosphatase-positive materials in the adrenal medulla of a male rat camera lucida drawing shows the distribution of phosphatase-positive and -negative substances, the former shown as black. In preparations stained by the ordinary histological methods, these tissues did not differ from each other and both of them were composed of typical chromaffin medullary cells.

The influence on the adrenal medulla of procedures stimulating medullary secretion was examined; for example, adrenals of rats killed during prolonged severe insulin shock were compared with those of normal controls. No certain qualitative differences could be seen. Therefore, areas of phosphatase-positive and -negative tissues were measured planimetrically in sections cut serially. These quantitative studies revealed a statistically significant increase in the volume of the phosphatase-negative tissues of the animals treated with insulin. The volumes of the phosphatase-positive tissues were approximately equal in both groups.

The presence of two kinds of medullary tissues can also be demonstrated with other histochemical techniques[3]. The phosphatase-negative islets are selectively darkened by a short immersion in ammoniacal silver nitrate and they fluoresce brilliantly in ultra-violet light. The significance of the two types of islets is not clear; but both of them have hitherto been seen only in species the adrenals of which contain both *nor*adrenaline and adrenaline.

Further work is in progress.

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Methylation of a Phenolic Hydroxyl Group in the Human Body

In the course of clinical trials of the antithyroxine compound, *n*-butyl 3 : 5-diiodo-4-hydroxybenzoate[1], on patients with thyrotoxicosis, the nature of the substances excreted in the urine was investigated. Practically the whole of the urinary iodine (545 mgm. per diem) was accounted for by the presence of a mixture of 3 : 5-diiodo-4-hydroxy- and, somewhat surprisingly, 3 : 5-diiodo-4-methoxy-benzoic acids in approximately equal proportions.

The acidified urine was extracted with ether, and the ether layer further extracted with sodium hydroxide. Acidification of the alkaline solution precipitated a mixture of iodinated benzoic acids, which, after crystallization from alcohol, melted at 247° (decomp.). This is rather higher than the figure in the literature[2], namely, 237°, for 3 : 5-diiodo-4-hydroxybenzoic acid. The analytical figures (C, 24·4; H, 1·6; I, 62·2 per cent), however, approximated more closely to those for 3 : 5-diiodo-4-methoxybenzoic acid (calc. for $C_8H_6O_3I_2$: C, 23·7; H, 1·5; I, 62·8 per cent) than to those for the hydroxy-acid (calc. for $C_7H_4O_3I_2$: C, 21·5; H, 1·0; I, 65·2 per cent). Repeated recrystallization finally raised the melting point to 261° (decomp.). Wheeler and Liddle[3] report that the methoxy-acid decomposes at 255–256°.

Esterification of the mixed acids with methanol and sulphuric acid gave a mixture of the methyl hydroxy- and methoxy-esters, which were separated by virtue of the solubility of the former in alkali. The methyl 3 : 5-diiodo-4-hydroxybenzoate crystallized from methanol in colourless needles, melting point 168° (in the literature[3], 166–167°) (found: C, 24·2; H, 1·6; I, 62·7; calc. for $C_8H_6O_3I_2$: C, 23·7; H, 1·5; I, 62·8 per cent). A mixed melting point with an authentic sample produced no depression. The methyl 3 : 5-diiodo-4-methoxybenzoate, crystallized similarly, had melting point 95° (in the literature[3], 95°) (found: C, 26·1; H, 1·9; I, 60·6; calc. for $C_9H_8O_3I_2$: C, 25·85; H, 1·9; I, 60·8 per cent). Admixture with an authentic specimen did not depress the melting point.

This work will be discussed more fully elsewhere; but in view of the absence of references in the literature to the methylation of phenolic hydroxyl groups in the animal body (see Lederer[4]), we considered it desirable to place these preliminary results on record.

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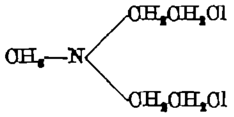
Combination of Nitrogen-15-labelled Nitrogen Mustard with Proteins

The nitrogen mustards readily inactivate certain enzymes[1] and they also react with many other proteins[2], including the components of hæmolytic complement[3]. Although it has been established by various investigators that the amino, sulphydryl, sulphide, carboxyl and pyridine groups of proteins are affected by the action of the nitrogen mustards[4], there appears to be no precise quantitative information about the combination of the mustard with proteins.

We have recently prepared one of the most commonly used nitrogen mustards, methyl *bis*(β-chloroethyl)amine (code No. HN2), labelled with nitrogen-15, and have used this tagged compound (containing 30·4 atoms per cent excess nitrogen-15) to determine the amount of nitrogen mustard which combines firmly with various proteins at *p*H 7·4 and 37°.



Methyl *bis*(β-chloroethyl)amine

Our investigations have shown that considerable amounts of this nitrogen mustard combine firmly with the serum proteins and ovalbumin. The compounds produced contain appreciable amounts of nitrogen-15 even after prolonged dialysis, or precipitation followed by repeated washing with methanol, to remove loosely attached nitrogen mustard and its 'hydrolysis' products (cyclic and other transformation compounds formed by the nitrogen mustards in aqueous solution). The following results of typical experiments with ovalbumin show that the protein treated with nitrogen mustard may contain 3·5

Nitrogen mustard added to 624 mgm. ovalbumin		Molecular ratio* (nitrogen mustard/ovalbumin) in the product	
(Mgm.)	Mol. per mol. of ovalbumin	After dialysis	After precipitation with methyl alcohol
8	2·8	0·5	1·4
12	4·3	1·1	2·4
16	5·7	1·5	3·5

* Assuming a molecular weight of 42,000 for ovalbumin.

nitrogen mustard residues per molecule of ovalbumin, and there is no reason for believing that this is a maximum value.

Part of the nitrogen mustard in the product is apparently not firmly combined with the protein, since it is removed during prolonged dialysis against sodium chloride solution; and this observation is consistent with results we have obtained in immunological studies with proteins treated with nitrogen mustard[5]. These immunological investigations have shown that nitrogen mustard effects a slight but detectable change in the immunological properties of proteins. Thus, the injection of ovalbumin treated with nitrogen mustard into rabbits leads occasionally to the production of antibodies capable of giving slight precipitation of heterologous nitrogen mustard-proteins (for example, horse serum proteins treated with nitrogen mustard). Because of the small amount of precipitate obtained, we have not yet been able to make a complete analysis of it with the heterologous antigen, but precipitates obtained with the labelled homologous antigen have been examined. For example, precipitates obtained with the nitrogen mustard–horse serum protein and nitrogen mustard–ovalbumin antigen–antibody systems contained, respectively, 0·086 and 0·024 atoms per cent excess nitrogen-15. Assuming a nitrogen content of 16 per cent and an arbitrary mean molecular weight of 100,000 for all the proteins, these values correspond to 3·3 and 0·8 nitrogen mustard residues per molecule of total protein (antigen plus antibody).

These results with the serological precipitates, like those with dialysed and methanol-precipitated nitrogen mustard-treated ovalbumin (and serum proteins), show that nitrogen mustard combines firmly with various proteins under physiological conditions of *p*H and temperature.

We are indebted to the Medical Research Council and the British Empire Cancer Campaign for grants which have covered the expenses of this investigation.

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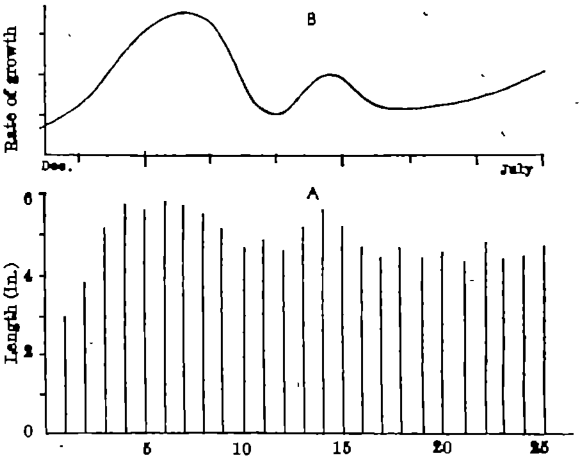
Intraseasonal Growth Variation and Cultivation of Sugar-cane

In my previous work[1,2], I have explained the parabolic growth-variation as noticed in the sizes of the successive leaves, internodes, flowers, fruits and seeds formed from time to time during a season, stressing the importance of this knowledge for the selection of better planting material. The influence of the robustness of seed or planting material on the progeny and yield has been sufficiently stressed by many[3]. I have applied this method successfully to the cultivation of sugar-cane, rice, cotton, mulberry, turmeric and many other plants on an experimental scale, and feel that this could be applied with advantage to the cultivation of most plants.



A, Successive internodes and their lengths; *B*, general growth-curve for the period

The variety of the cane selected was *CO* 419, a hardy variety, introduced into the farms round about Mandya and extensively cultivated. Growth of the cane from time to time was recorded, to have an idea of the growth peculiarities. The accompanying figure is the record of a cane harvested from a standing crop about a year old. It shows the length and number of the successive internodes formed during the several months (*A*) and part of the annual growth-curve (*B*) recorded by me[2]. The agreement is noticed during the earlier period; but this agreement is disturbed as the cane begins to mature, although the growth-vigour of the planting material from this part satisfies the growth-curve of the season. From a standing crop about a year old, canes were harvested and 'setts' were cut from the top and numbered, so that the setts of the same number of all canes might represent the growth region of the same period. These setts, each with three eye-buds, were planted in the experimental plots on October 8, 1947, and the crop of the experimental and the bulk plots was harvested during the last week of November 1948. The method of cultivation for both the plots was the same. The results in the accompanying table will give an idea of the various aspects connected with the different setts.

From these results, it is noticed that on the whole the first two setts are the best for early October planting. The next in order are the third and the fourth. The fifth and the sixth setts are poor because of age, while the other available setts often made

No. of the setts	Average No. of tillers and primaries (after 4 months) per sett	Average No. of canes per sett	Estimated tonnage per acre (approx.)	Percentage of sucrose in juice
I and II	6·1	3·68	38¼	18·96
III and IV	4·7	3·61	36¼	19·22
V and VI	3·3	3·2	31¼	19·01
Bulk	—	3·2	33	19·05

Age of the canes used for cultivation, 1 year approx., date of planting, October 8, 1947; date of harvesting, November 28, 1948, number of selected setts, 456; number of setts for bulk planting, thousands.

use of by the farmers for planting were the poorest, because they were even older. The same order does not hold good for planting during the other months. The figure will explain this point clearly. The method of selection based on this knowledge will denote the following advantages: (1) economy in the planting material; (2) uniformity in the quality of the yield; (3) maintaining and probably improving the vigour of progeny; (4) increasing the yield per acre.

A detailed paper dealing with this subject will be published later on.

I am indebted to the authorities of the Mysore Sugar Co. for giving the necessary facilities for this work in their factory and farms in Mandya.

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Effect of Light on the Germination of Watercress Seeds

In obtaining data for the two species of watercress for "Biological Flora" accounts, it was found that, whereas the seeds of *Nasturtium officinale* R.Br. would germinate both in the light and in the dark, those of *N. microphyllum* Boenningh. ex Rchb.[1] would only germinate in the light. This has been checked, as is shown below—there were fifty seeds in each Petri dish and they were kept on moist filter paper at laboratory temperature (about 65° F.).

Table 1

	Light		Dark	
	Percentage germination after		Percentage germination after	
	1 week	2 weeks	1 week	2 weeks
N. officinale	84	86	82	82
N. microphyllum	22	60	0	0
N. microphyllum	12	56	0	0

The amount of light required for the germination of *N. microphyllum* seeds appears to be very small. Thus, in one experiment five minutes light given one day after setting up the dishes produced 4 per cent germination in two weeks, and a second exposure of five minutes light given at the end of this two weeks period produced a further 92 per cent germination in the following two weeks. In another experiment the dishes were given single exposures of five minutes light one, two, three and four days after setting up, and the percentage germinations after two weeks were 8, 36, 60 and 58 respectively, the dark control having 0 per cent and the light control 82 per cent germination.

The effect of light on germination can be either by altering some condition of the testa (for example, in relation to permeability to oxygen) or by bringing about some change in the embryo or endosperm (for example, by catalysing the conversion of reserves into soluble substances). In *N. microphyllum* the endosperm can probably be neglected, since in mature seeds it consists of a single layer of cells only. It also appears that the effect of light is on the embryo and not on the testa, since pricking the testas after the seeds had absorbed water did not lead to any germination in the dark, although the pricked seeds germinated as well as the controls when they were later exposed to light.

Another method of deciding for *N. microphyllum* whether the light acts upon the testa or upon the embryo is to utilize three types of hybrid seeds for experiments. This method will also, of course, give some genetical information. These three types of hybrid seed are (*a*) *N. microphyllum* female × *N. officinale* seeds, which have a hybrid embryo in an *N. microphyllum* testa; (*b*) autotetraploid *N. officinale* female × *N. microphyllum* seeds, which have a hybrid embryo in an *N. officinale* testa; and (*c*) seeds obtained by selfing an amphidiploid produced by colchicine treatment of the hybrid *N. microphyllum* × *officinale*—these seeds have both hybrid testas and hybrid embryos. Results for these three types of seed and for autotetraploid *N. officinale* were:

Table 2

	No. of seeds in each dish	Light Percentage germination after		Dark Percentage germination after	
		1 week	2 weeks	1 week	2 weeks
Autotetraploid *N. officinale*	25	20	32	8	28
N. microphyllum × *N. officinale*	88	53	66	0	0
Auto-4 × *N. off.* × *N. microphyllum*	62	37	77	0	0
Amphidiploid *N. microphyllum-officinale*	27	22	69	0	7

Although the percentage germination of autotetraploid *N. officinale* was rather low, it can be seen that it behaves like *N. officinale* itself. The other results suggest first that the effect of light on germination is via the embryo and not via the testa, and secondly that inability to germinate in the dark is dominant to ability. This second conclusion would be expected, since it has been shown that *N. microphyllum* is an allotetraploid species from *N. officinale* and some other species[2].

Results for the occasional seeds produced by the hybrid *N. microphyllum* × *officinale* support the above conclusions. Such seeds will all have hybrid testas, but a segregation of the two types in their embryos would be expected. In an earlier experiment it was, in fact, found that 5·0 per cent of 121 such seeds germinated in the dark and 31·8 per cent of 164 seeds germinated in the light.

Similar results to those reported above for watercress have been obtained by Honing[3] for *Nicotiana*. He found first that the need of light for germination was dominant to the indifferent condition in which seeds germinate both in darkness and in the light, and secondly that in reciprocal crosses of light-needing and indifferent types the effect could not be due to the testas but must be due to either the embryo or the endosperm.

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Organic Acids of the Apple Fruit

It has generally been assumed that the only carboxylic acid present in the fruit of Bramley's Seedling apple is malic acid; but in 1949, when examining chromatograms run in *n*-butanol–formic acid–water (40 : 10 : 50 v/v[1]) of methyl alcohol extracts of pulp tissue of young Bramley's Seedling apples, we noted that several spots having an acid reaction to bromophenol blue appeared on the chromatograms.

In addition to a relatively large spot corresponding with malic acid ($R_F = 0{\cdot}49$), there appeared a second well-defined spot ($R_F = 0{\cdot}18$) and traces of a third spot ($R_F = 0{\cdot}07$). It was possible to wash some of the acid ($R_F = 0{\cdot}18$) from the chromatogram and carry out tests on the solution so obtained. The acid gave a strongly positive citrazinic acid test[2], given also by citric and aconitic acids. The R_F value of the unknown acid was, however, quite different from citric acid (0·40), aconitic acid (0·74) and *iso*citric acid lactone (two spots, 0·64, 0·69, probably due to stereoisomerism).

From the R_F values obtained under carefully controlled conditions at 20° C., the R_M values[3] $\left[\log\left(\frac{1}{R_F}-1\right)\right]$ of the new acid (+ 0·66), citric acid (+ 0·18) and tricarballylic acid (− 0·31) were found to differ by almost equal amounts ($\Delta R_M = 0{\cdot}48$, 0·49) and suggest a stepwise addition of hydroxyl groups to tricarballylic acid. It would appear, therefore, that the new acid might well be a dihydroxy tricarballylic acid.

The acid appeared to decrease in amount as the fruit ripened and also appeared to be present in the pulp of the fruit of peach and plum.

One of us (A. C. H.) has since examined other varieties of English apples for the presence of the new acid. It has been found in much greater quantity in young Worcester Pearmain and young Cox's Orange Pippin apples. In order to study its chemistry, an appreciable amount of the acid has now been obtained from young Worcester Pearmain apples. The fruit was extracted with cold 80 per cent alcohol and the alcohol removed by evaporation. Amino-acids and bases were removed from the resultant aqueous solution by passing it down a column of 'Zeo Karb 215', and the carboxylic acids were absorbed from the filtrate on a column of 'Deacidite E'. Displacement of the acids from this column with 0·1 *N* hydrochloric acid gave several hundred milligrams of the new acid (as the lactone) free from malic acid and chromatographically homogeneous. The chemical characterization of the acid will be described elsewhere.

A. C. Hulme

Ditton Laboratory,
East Malling, Kent.

T. Swain

Low Temperature Research Station,
Downing Street, Cambridge.
April 10.

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[1] Lugg, J. W. H., and Overell, B. T., *Aust. J. Sci. Res.*, 1 A, 98 (1948).

[2] Feigl, F., and Anger, V., *Mikrochemie*, 11, 35 (1935).

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Formation of Green Pigment in Grasshoppers

The factors which lead to the production of green pigment in grasshoppers are still in doubt. Some authors[1-3] claim that the deposition of green pigment, like that of grey, orange and brown, is determined by the background; others[4-6] have found that the background is without effect. Faure[5] obtained green individuals only when they were fed on growing grass in a humid atmosphere.

Observations carried out in the University of Ankara during 1949 and 1950 support the findings of Faure. Yellow hoppers of *Acrida turrita* were reared in green cages. When fed on growing grass, 69·8 per cent became green; when fed on cut grass changed every other day, 10·9 per cent became green; when fed on dry grass, none became green. If green hoppers were kept in green cages and fed on dried grass, only 21 per cent remained green; whereas if they were fed on growing grass, 78 per cent remained green.

Similar results were obtained with the hæmolymph. The hæmolymph of yellow hoppers collected from dry grassy places is yellowish or colourless, never green. In green hoppers collected from areas of green grass the hæmolymph is green in 90 per cent of them. If the yellow hoppers from the former locality are fed on green grass, the hæmolymph gradually becomes green, and after moulting the integument becomes green. The green pigment thus appears in the blood before it is deposited in the integument.

The green pigment is known to be a combination of a yellow carotene-protein with a blue bile pigment protein[7-9]. The appearance of green individuals depends on the formation of bile pigment. It seems possible that this pigment is derived from the breakdown of chlorophyll and that for some undetermined reason this happens only when the grasshopper feeds on fresh growing grass. It is noteworthy that the excreta contain a large amount of free magnesium in hoppers of both colours.

It is hoped to confirm and extend these results in further laboratory experiments.

Selahattin Okay

Department of Zoology,
University of Cambridge.
April 16.

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[1] Chauvin, *Ann. Soc. ent. Fr.*, 110 (1941).

[2] James, *Canadian Ent.*, 76 (1944).

[3] Ergene, *Z. vergl. Physiol.*, 32 (1950).

[4] Przibram, *Arch. Entwmech.*, 23 (1907).

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[6] Hertz and Imms, *Proc. Roy. Soc.*, B, 122 (1937).

[7] Junge, *Hoppe-Seyl. Z.*, 268 (1941).

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[9] Goodwin and Srisukh, *Biochem. J.*, 48 (1951).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer, and an Assistant Lecturer, in the Department of Chemistry—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4 (August 17).

Assistant (female) for field experiments on fruit crops for the Plant Pathology, Entomology and Plant Protective Chemistry Sections—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (August 18).

Assistant, Grade B (graduate, preferably with some knowledge of a branch of applied chemistry or of geology) in the Department of Chemistry, a Lecturer in Physics, and an Assistant Teacher of Microbiology, Nutrition and Food Analysis in the Department of Bakery and Catering—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (August 18).

Scientific Officer (with first- or second-class honours degree in mechanical engineering) for research and development work on mechanical engineering problems (Ref. R/A); a Senior Scientific Officer (with first- or second-class honours degree in mechanical engineering and at least five years experience in industry and/or research and development work) for development to prototype stage of mechanical mechanisms of an original nature (Ref. R/C.1); a Scientific Officer (with first- or second-class honours degree in mechanical engineering and two to three years industrial and/or research experience) for work on combustion and heat transfer problems (Ref. R/C.2); an Experimental Officer (with pass degree or equivalent and at least four years experience in industry and/or research) with experience in electrical instrument design and electronics control and supervisory equipment (Ref. R/C.3); a Senior Scientific Officer (with first-class degree in agriculture, or first- or second-class honours degree in natural science with postgraduate diploma in agriculture) for department carrying out impartial tests of the performance of agricultural and horticultural machinery under practical conditions (Ref. A/T.1); and a Scientific Officer (with first- or second-class honours degree in mechanical engineering, and two to three years industrial experience desirable) to work on engineering problems arising during impartial tests of the performance of agricultural and horticultural machinery under practical conditions, and to develop special testing apparatus (Ref. A/T.2)—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds. (August 18).

Lecturers (Grade I and Grade II) in the Department of Chemical Engineering—The Secretary, The University, Birmingham 3 (August 20).

Scientific Technologist, Grade I (with a good general training in chemistry, preferably up to degree standard) at the Coal Survey Laboratory in Nottingham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting CT/360 (August 20).

Assistant (Grade B) to teach Geography for Inter.B.Sc., and an Assistant (Grade B) to teach Mathematics for Inter.B.Sc., O.N.C. mechanical engineering, and also Final B.Sc. and H.N.C., at the Luton and South Bedfordshire College of Further Education—The Borough Education Officer, Education Office, 63–69 Guildford Street, Luton, Beds. (August 25).

Assistant Physicist (with an honours degree in physics) to the Radiotherapy and X-Ray Diagnostic Departments—The Personnel Officer, St. Thomas's Hospital, London, S.E.1 (August 25).

Operational Research posts in the Field Investigation Group of the Directorate of Scientific Control (candidates should have a good honours degree, or equivalent, in science, mathematics or engineering)—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed 22/361 (August 25).

Tutorial Studentship in Mathematics—The Registrar, King's College, Strand, London, W.C.2 (August 25).

Assistant Lecturer in Agricultural Botany, and an Assistant Lecturer in Agricultural Chemistry (Dairy Chemistry)—The Registrar, The University, Reading (August 27).

Assistant Lecturer in Physics—The Registrar, The University, Leeds 2 (August 27).

Deputy Mechanical Engineer—The Clerk of the Metropolitan Water Board, New River Head, Rosebery Avenue, London, E.C.1, quoting Ref. (T) (August 29).

District (Forest) Officers to the Forestry Commission (with university degree in forestry, a university diploma in forestry, or a postgraduate degree in a forestry subject)—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 146/51 (August 30).

Lecturer (Grade II) in Coal Preparation—The Secretary, The University, Edmund Street, Birmingham 3 (August 30).

Research Fellow (with the degree of Ph.D., and good experience in research in organic chemistry) to act as leader of a team engaged upon research in the Chemical Constitution of Coal, and a Research Assistant (with a good honours degree in chemistry) in Coal Constitution—The Secretary, The University, Edmund Street, Birmingham 3 (August 30).

Assistant in the Department of Moral Philosophy—The Secretary, The University, Old College, South Bridge, Edinburgh (August 31).

Assistant Lecturer in Botany—The Registrar, University College, Cathays Park, Cardiff (August 31).

Food Technologist in the Department of Health, Southern Rhodesia—The Secretary to the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (August 31).

Lecturer in Animal Husbandry—The Registrar and Secretary, The University, Bristol (August 31).

Lecturer (with good qualifications in Chemistry and prepared to specialize on problems connected with the physico-chemical structure of collagen, the chemistry of collagen, or the chemistry of the vegetable tannins), an Assistant Lecturer or Lecturer (with practical experience in Leather Manufacture, especially in leather dyeing and finishing, and able to take charge of an experimental tannery), and a Research Assistant (with a good honours degree in Leather Chemistry, Chemistry, Biochemistry, or Bacteriology with, preferably, some research experience) in the Procter International Laboratory—The Registrar, The University, Leeds 2 (August 31).

Scientific Officers (with a first- or second-class honours degree or equivalent in physics, electrical engineering, mathematics, mechanical or aeronautical engineering, and capable of undertaking research or development work in general physical problems, electronics, aerodynamics, instrumentation or light mechanisms) at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.212/51A (August 31).

Lecturer in Bacteriology in the Department of Pathology, University College of the West Indies—The Secretary, Senate Committee on Higher Education in the Colonies, Senate House, University of London, London, W.C.1 (September 1).

Plant Physiologist in the Department of Botany, for work with radio-active isotopes—The Registrar, The University, Leeds 2 (September 1).

Senior Lecturer or Reader in the Chemistry of High Polymers in the Department of Textile Industries—The Registrar, The University, Leeds 2 (September 1).

Assistant Lecturers (2, with qualifications in either the microbiology of dairying, or the biochemistry of micro-organisms) in the Department of Microbiology—The Registrar, The University, Reading (September 3).

Assistant Lecturer (honours graduate in chemistry or metallurgy with special interests in physical chemistry) in Metallurgy—The Registrar, The University, Manchester 13 (September 4).

Readership in Pathology at the Institute of Ophthalmology—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 5).

Chemist I by the Ministry of Supply in London, for the investigation and assessment of requirements of non-metallic materials for aircraft and associated production, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.544/51A (September 8).

Chemist II or Chemist III (Metallurgist) at a Ministry of Supply establishment in Lancashire, to assist the Chief Metallurgist in the control of laboratories dealing with development work, experimental heat-treatment problems, and production of electric steel and steel heat-treatment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.543/51A (September 8).

Chemist III/Engineer III by the Ministry of Supply in London, for the investigation of requirements for materials used in aircraft production, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.545/51A (September 8).

Lecturer in Chemical Engineering at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 8).

Entomologists (with a degree in zoology and a sound knowledge of entomology and botany) to carry out a survey of the tsetse areas of the Sudan and undertake research work—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Entomologist' (September 15).

Lecturer in Child Psychiatry—The Registrar, The University, Manchester 13 (September 15).

Lecturer in Mineral Dressing and Assaying in the Department of Chemical Engineering, University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 15).

Lecturer in Physiology—The Secretary of University Court, The University, Glasgow (September 15).

Chair of Zoology—The Secretary, The University, Edmund Street, Birmingham 3 (September 17).

Electrical Engineers and Physicists (Senior Scientific Officer grade) (with a first- or second-class honours degree in the appropriate subject, at least three years postgraduate research experience, and a wide knowledge of communications work and H.F., V.H.F. or display techniques for research work associated with design and development of airborne and ground equipments) at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.159/51A (September 22).

Mathematicians, Mechanical and Aeronautical Engineers at Ministry of Supply headquarters in London: Senior Scientific Officer (Ref. C.441/51A) for administration of bomber aircraft research and development, Scientific Officer (Ref. C.442/51A) for co-ordinating aerodynamic research work in the Ministry and of research projects at aircraft firms, and a Scientific Officer (Ref. C.422/51A) for performance assessment of fighter aircraft in connexion with industrial firms' projects—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 22).

Physicists and Mathematicians at a Ministry of Supply experimental establishment in Essex, for work connected with out-of-door instrumentation: Physicist (Senior Scientific Officer grade) with some mathematical knowledge including statistics or a Statistician with some interest in experimental procedure to be in charge of a team investigating the performance of weapons, Physicists (Scientific Officer grade) preferably with some knowledge of experimental range technique and procedure, Experimental Physicist (Scientific Officer grade) with experience of metallurgical techniques, and a Mathematician (Scientific Officer grade) with interest in experimental methods and some knowledge of hydrodynamics—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.220/51A (September 24).

Chair of Mathematics at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 1).

Senior Lecturer in the Department of Civil Engineering, University of Natal—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

TUBE INVESTMENTS RESEARCH FELLOWSHIP in the Department of Engineering Production—The Secretary, The University, Edmund Street, Birmingham 3 (October 31).

DIRECTOR OF THE DEPARTMENT OF AGRICULTURE, STOCK AND FISHERIES, Territory of Papua and New Guinea—The Secretary, Department of Territories, Canberra, A.C.T., Australia (December 31).

ASSISTANT LECTURER IN PHYSICS—The Registrar, The University, Nottingham.

CIVIL ENGINEER in the Department of Works and Hydraulics, Trinidad—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27322/74.

DISTRICT ENGINEER in the Public Works Department, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting 'District Engineer 4/19 S.T.'.

IRRIGATION ENGINEERS under the Government of Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27322/154.

JUNIOR RESEARCH OFFICER (male, with honours degree in chemistry or equivalent) for analytical work, including research on the development of new methods and application of existing methods for special purposes—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

LECTURER IN FOOD SCIENCE in the Department of Bakery and Confectionery—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

LECTURER IN THE DEPARTMENT OF MATHEMATICS AND MECHANICS, capable of taking pure and applied mathematics up to final honours standard—Prof. H. Levy, Imperial College of Science and Technology, South Kensington, London, S.W.7.

PHYSICISTS (with a first- or second-class honours degree in physics, or equivalent qualification) to supervise and undertake research work involving the application of physical methods to the study of metals and the control of new metallurgical processes—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

PRINCIPAL METALLURGIST to take charge of a laboratory engaged on research into powder metallurgical techniques of rare metals, SENIOR METALLURGISTS to supervise groups engaged on powder metallurgical research, and METALLURGISTS to undertake research work on the powder metallurgy of rare metals, in the Research and Development Branch, Risley—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for.

RESEARCH DEMONSTRATOR IN MATHEMATICS—The Registrar, University College, Exeter.

SENIOR ELECTRICAL ENGINEER in the Public Works Department, Sierra Leone—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27326/47.

TECHNICAL ENGINEER to undertake fundamental technical work in the application of engineering principles to the design of nuclear reactors and allied atomic energy projects, and to predict the performance of such plants—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

TELECOMMUNICATIONS ENGINEERS and PHYSICISTS (Principal Scientific Officer or Senior Scientific Officer grade) (with a first- or second-class honours degree in physics or telecommunications and upwards of five years experience of research and development in R.F. techniques at centimetric wave-lengths, centimetric radar (preferably for airborne application), servo mechanisms or telecommunication networks and feedback amplifiers) at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.158/51A.

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British Radio and Television for the World. (Radio Show, Earls Court, London, Aug 28–Sept. 8, 1951 Booklet.) Pp. 28. (London: Radio Industry Council, 1951.) [225

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Fire Protection Association. Technical Booklet No. 8. Spontaneous Heating and Ignition in Stored Palm Kernels. By Dr. J. H. Burgoyne. Pp. 12. (London: Fire Protection Association, 1951.) [245

Colonial Office. Two Studies in Applied Anthropology in Kenya: 1. Agricultural Co-operation by Neighbourhood Groups among the Gusii; 2. Bridewealth Limitation among the Gusii. By Dr. Philip Mayer. (Colonial Research Studies, No. 3.) Pp. 33. (London: H.M. Stationery Office, 1951.) 2s. 6d. net. [245

British Museum (Natural History). Economic Leaflet No. 9: Ants. Pp. 8. (London: British Museum (Natural History), 1951.) 2d. [255

Catalogue of an Exhibition illustrating the History of Pharmacy, held during the Festival Period 4 May–28 September 1951 at the Wellcome Research Institution, 183 Euston Road, N.W.1. (Published for the Wellcome Historical Medical Museum.) Pp. 60+6 plates. (London: Oxford University Press, 1951.) 3s. net. [255

Carnegie United Kingdom Trust. Thirty-seventh Annual Report. Pp. viii+49. (Dunfermline: Carnegie United Kingdom Trust, 1950.) [255

Department of Scientific and Industrial Research: Building Research Station. National Building Studies, Bulletin No. 10: External Rendered Finishes for Walls. By G. E. Bessey. Pp. iv+24+9 plates. (London: H.M. Stationery Office, 1951.) 1s. 9d. net. [255

Manchester Museum. Report of the Museum Committee for the Year 1949–50. Pp. 24. (Manchester: The Museum, 1951.) [255

Sixth Congress of the Universities of the British Commonwealth, 1948. Report of Proceedings. Pp. xxvii+238. (London: Association of Universities of the British Commonwealth, 1951.) 21s. [285

Imperial Cancer Research Fund. Forty-eighth Annual Report 1950–1951. Pp. 40. (London: Imperial Cancer Research Fund, c/ Royal College of Surgeons, 1951.) [29

Pitt Rivers Museum. University of Oxford. Occasional Papers o Technology, 4. Notes on the Prehistoric Metallurgy of Copper an Bronze in the Old World. By H. H. Coghlan. Pp. 131+16 plate (Oxford: Pitt Rivers Museum, 1951.) 15s. [30

Department of Scientific and Industrial Research. Brief Guide t the Research Activities of the Department of Scientific and Industria Research and the Research Associations. Pp. 56. (London: Department of Scientific and Industrial Research, 1951.) [4

Economic Proceedings of the Royal Dublin Society. Vol. 4, No. 1 The Apple in Ireland; its History and Varieties. By Dr. J. G. D Lamb. Pp. 63+13 plates. (Dublin: Royal Dublin Society, 1951. 20s. [4

University of Leeds: Department of Coal Gas and Fuel Industries, with Metallurgy. Report on the Session 1947–48. Pp. 20 Report on the Sessions 1948–49 and 1949–50. Pp. 28. (Leeds: Th University, 1950–1951.) [4

Readers' Guide to Books on Botany. (Readers' Guide, New Serie No. 11.) Pp. 32. (London: Library Association, 1951.) [5

Council for the Preservation of Rural England, Sheffield and Peak District Branch. Annual Report. Pp. 28. (Sheffield: Hon. Treasurer Vale House, 1951.) [5

British Institute of Management. Production Management Serie 2: Work Study. By R. M. Currie. Pp. 24. (London: British Institute of Management, 1951.) 3s. 6d. [5

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Report of the Museum of Applied Science of Victoria, with Statement of Receipts and Expenditure for Twelve Months ended 30th Jun 1950. Pp iv+20. (Melbourne: Museum of Applied Science, 1951.) [25

Department of Agriculture, Ottawa. Report of the Director o Science Service for the Year ended March 31, 1950. Pp. 120. (Ottawa King's Printer, 1951.) [28

East African High Commission: Virus Research Institute. Annua Report, 1950. Pp. iv+32. (Nairobi: Government Printer, 1951.) [28

University of Natal. Wattle Research Institute. Report for 1950 Pp. 36. (Pietermaritzburg: Wattle Research Institute, 1951.) [28

World Health Organization. Technical Report Series. No. 37: Joint FAO/WHO Expert Panel on Brucellosis; Report on the First Session. Pp 34. 2s.; 25 cents. No. 38: Malaria Conference in Equatorial Africa, Report. Pp 72. 3s. 6d.; 45 cents. No. 40: Joint WHO/FAO Expert Group on Zoonoses (Bovine Tuberculosis, Q Fever, Anthrax, Psittacosis, Hydatidosis); Report on the First Session. Pp. 48. 2s. 3d.; 30 cents. (Geneva: World Health Organization; London: H.M. Stationery Office, 1951.) [28

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East African Tsetse and Trypanosomiasis Research and Reclamation Organization. Annual Report, 1950. Pp. 56. (Nairobi: East Africa High Commission, 1950.) [29

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Institut Royal Météorologique de Belgique. Miscellanées, Fasc. 37 De la correction thermique du baromètre à cuvette et à échelle fixes Par Dr. R. Sneyers. Pp. 16. (Uccle: Institut Royal Météorologiqu de Belgique, 1951.) [4

Kongelige Danske Videnskabernes Selskab. Biologiske Skrifter Bind 6, Nr 7: Cytological and Embryological Studies in the Amphi-Apomictic *Arabis Holboellii* Complex. By Tyge W. Bocher. Pp. 59 (København: Ejnar Munksgaard, 1951.) 9 kr; 1.75 dollars; 10s. [4

Federal Security Agency: Office of Education. Biennial Survey o Education in the United States, 1946–48. Chapter 7. Statistics o Nonpublic Secondary Schools, 1947–48. Prepared by Rose Mar Smith. Pp. iv+11. (Washington, D.C.: Government Printing Office 1951.) 10 cents. [5

South Australia. Annual Report of the Director of Mines an Government Geologist for 1949. Pp. 32. (Adelaide: Governmen Printer, 1951.) [5

Lutte antipaludique par les insecticides à action rémanente résultats des grandes campagnes. Par Dr. E. J. Pampana. (Organisation Mondiale de la Santé, Série de Monographies, Nr. 3.) Pp. 72 (Genève: Organisation Mondiale de la Santé, 1951.) 4 francs. [5

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Indian Council of Agricultural Research. Bulletin No. 47: Definitions of Characteristics of Kangayam, Khillari and Tharparkar Cattl and Nili and Surti Buffaloes. Second revised edition. Pp. vii+22+ 16 plates. (Delhi: Manager of Publications, 1950.) 1.8 rupees 2s. 3d. [7

United States Department of the Interior: Geological Survey Bulletin 955-E: Fluorspar Prospects of Montana. By Clyde P. Ros (Contributions to Economic Geology, 1947–48.) Pp. iv+173–224+ plates 18–28. 1 dollar. Bulletin 963–B: Copper Deposits of th Prince William Sound District, Alaska. By Fred H. Moffit and Rober H. Fellows. (Mineral Resources of Alaska, 1945–46.) Pp. iv+47–80+ plates 2–6. 75 cents. Bulletin 963–C: Garnet Deposits near Wrangell Southeastern Alaska. By C. T. Bressler. (Mineral Resources of Alaska 1945–46.) Pp. iii+81–93+plates 7–8. 1 dollar. Bulletin 974-A The 1949 Summit Eruption of Mauna Loa, Hawaii. By Gordon A Macdonald and James B. Orr. (Contributions to General Geology 1950.) Pp. iv+33. 20 cents. Bulletin 976-C: Geophysical Abstract 142, July–September 1950 (Numbers 12126–12359.) By Mary C Rabbitt and S. T. Vesselowsky. Pp. iii+141–209. 25 cents. (Washington, D.C.: Government Printing Office, 1950.) [8

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BIOLOGY IN EDUCATION

THE recent issue of *The Advancement of Science*[1] contains the interim report of a special committee which, brief though it is, reveals a disturbing situation demanding the attention of all who are concerned in one way or another with the biological sciences. The committee was set up by the British Association to consider the position of biology and rural science in the school curriculum and matters relating thereto. The material contained in its interim report is the result of questionnaires sent to university departments of education and teachers' training colleges.

Among other findings the committee reports that in secondary modern schools biological work varies from total neglect to a few very good courses based on gardening, etc.; and that in these schools there is a grave shortage of keen, well-qualified teachers. Laboratory work is neglected. In the secondary grammar schools it finds again a serious shortage of well-qualified teachers, though the number with general degrees, or no degree, who teach the subject is increasing. If general science is offered, it is almost always in the hands of non-biologists, and biology is omitted. Out of forty-nine teachers' training colleges from which replies have so far been received, nineteen offer no courses in biology; and including all colleges together, only about 10 per cent of the entrants take biology. Both the quality and quantity of biology entrants are falling off. There is also evidence that students avoid biology since too academic a school training has prevented development of interest in the subject.

The committee does not consider that, in general, any serious hindrance is being presented to the teaching of biology through the lack of suitable laboratory accommodation. On the other hand, it finds that there is gross neglect of work with living organisms and almost total neglect of field-work. In the grammar schools, particularly, courses in biology are too academic and bookish.

To remedy this state of affairs it is felt by the committee that the vicious circle of the too academic approach must be broken in the universities, and that this can be done by much greater stress on field-work. The greater emphasis on the teaching of practical ecology, now apparent in the universities, is therefore, it considers, to be welcomed.

These findings, tentative and incomplete as they are, are in agreement with the experience of others who are familiar with biology teaching in the schools; and had the committee extended its inquiries to private preparatory and public schools it would have been able to confirm that while at sixth-form level some excellent courses in biology are now being offered, often accompanied by good work in the laboratory, and occasionally by well-planned field studies, not much biology is being taught to the younger pupils, and it is still a common experience for a large proportion of the more promising pupils to go up on the classical or literary side.

These facts lead us to the realization that in Great Britain at the present day, in comparison wit subjects as history and literature, and even chemistry and physics, biology is playing a minor part in education. Whether at primary or secondary level, and whether in State or private institutions, as well as in the teachers' training colleges, many children and students take no regular courses in the subject at all. To others it is looked upon as a 'soft option', or as necessary preliminary training for some career. As a whole, such courses in the science of life as are offered are not felt by parents, students and teachers of other subjects to be of such significance as to induce any but a small minority of the more gifted pupils to take it up. To complete the picture, it needs to be stated that during recent months more than one biologist of considerable experience has publicly admitted that he can see no special educational value in biology.

Besides constituting a question of extreme educational importance, this state of affairs is an anthropological situation of absorbing interest.

The committee set up by the British Association is a fact-finding body; only indirectly, in emphasizing the need for more field-work and ecological studies, were its members concerned with motives. They assume that a direct association of interest exists between school and university teaching in biology. In doing this the committee is adopting a relatively narrow concept of biology as an educational medium; one, however, which is widely held by most members of the public as well as by a large proportion of biologists, and which is fostered by the departmental basis on which studies in the life sciences are pursued at the universities.

At school-level, biological studies spring from two main sources. One of these is nature study, a subject suitable for pupils of any age but which appeals only to a certain number of boys and girls, sometimes for psychological reasons. Because of this it is best looked upon as a personal hobby to be pursued chiefly as a voluntary activity. On the other hand, nature study of a more serious kind provides valuable basic training for the specialized courses which follow later at school, and which may be continued at the university.

The other source is to be found in health education. In times past much interest and effort have been put into the teaching of hygiene; but, perhaps because in this case no close link exists between school and university, the subject has failed to keep pace with the advance of medical science; its educational mission has tended to lose impetus and its popularity has waned. Hygiene, as such, is not now often found as a regular subject in the grammar schools, although, as the committee notes, it is retaining a place in the secondary modern schools, sometimes with biology as an adjunct. In making this observation the committee seems to imply that there is a distinction at school-level between biology and hygiene; that is, between biology and biological science.

In the minds of a small but growing number of teachers, such a distinction ought not to be made; the two subjects should be fused together, particularly since in any one school they are usually taught by the same member of the staff. To them it seems that while simple, utilitarian reasons for the inclusion of hygiene in the curriculum for all children are irrefutable, biology, even in the narrowest sense, should also be taught as an essential element in the comprehension of man's place in the universe. They find support for their views coming from individuals and groups of people concerned with social welfare who have been putting forward with increasing insistence demands that the schools should do more than at present in helping to solve problems of moral behaviour, juvenile delinquency, relations between the sexes, marriage breakdown, or those presented by other related social questions.

To requests of this nature, teachers have made varying responses, and a new conception of the educational mission of biology has begun to take shape, which has come to be called social biology. In this respect, it is significant to note that teachers of geography, history, and at a higher level, of economics, are also beginning to feel that greater emphasis should be placed on the social aspects of their work.

The conception of social biology is the product of no single mind or organization. It has, however, been developed farthest by the British Social Biology Council, and brought most consistently before the public through the Council's journal, *Biology and Human Affairs*. Social biology differs from biology as usually accepted in bringing man into the centre of the sphere of interest, and seeking to advance not merely his material welfare but also the whole of his culture through application of the biological sciences wherever opportunity occurs. Apart from the desire to endow biological studies with some social purpose, subject to modification in the light of further research, at no stage has any attempt been made, in Great Britain, to inject into social biology some particular bias or philosophy; its foundations remain strictly scientific. It is merely that a conscious basis has been chosen for these studies in place of the unconscious social situation which served in the past.

Social biology is also in line with what on wider considerations should be the object of all forms of science in education. Clearly, all science should be presented as one single unity, an outlook and a body of knowledge arrived at through the application of scientific method. The links between physics, chemistry and biology need to be strengthened; at the same time, all biological studies should be included, whether they relate particularly to botany, zoology, agriculture, medicine, genetics or physiology. In addition, contacts should be established with psychology and anthropology so as to embrace the other major life sciences, too.

It may be thought to be a stupendous and impossible task for any teacher to undertake to present a balanced conception of all the life sciences; yet with longer traditions behind them similar tasks are willingly shouldered by teachers of history, literature and physics. The task would be impossible at university-level; but it becomes much easier and simpler when it is realized that the school teacher is dealing with ordinary children and that a primary educational requirement is not to leave them with mental indigestion but with minds alert to the continuing progress of science and ready to develop further understanding as they become adult. Viewed in this light, the teaching of social biology becomes a definite obligation which ought not to be shirked. It is one which is being gradually accepted by a growing number of teachers, who, however, find their difficulties increased by their relative isolation and by the varied nature of the departments, institutions and publications from which they have to draw their material.

The movement towards social biology in the schools calls for a similar movement in the universities, where at the present time departmental specialization may foster sectional efficiency but at grave risk of failure to visualize the greater whole. Yet just as the educational process extends from the cradle to the grave, lines of interest should run all the way down from the research worker to those stock figures, the man in the street and the woman in the home. Only with this wider vision does it become clear that in human progress science is fundamental, and that there can be no genuine progress without the understanding that studies of living matter alone can provide; for many of the problems that beset the world to-day, whether personal, social, communal or international, social, moral or spiritual, are essentially biological. It is a vision of this nature that is required to fire the imagination of a larger proportion of the more gifted minds among us; for these minds, particularly, need to have the ideals of truth, goodness and beauty presented to them in forms which are directly applicable in human life and associated with the main interests and strivings of humanity. Such a vision would accord to biology in the schools the status it now so sadly lacks, while at the same time solving the related problems of the poor supply, and frequently meagre attainments, of those who study and teach the subject.

[1] *Adv. Sci.*, 8, No 29, 66 (1951).

THE BEGINNING OF THE UNIVERSE

The Primeval Atom

An Essay on Cosmogony. By Canon Georges Lemaître. Translated by Betty H. and Serge A. Korff. Pp. ix+186. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1950.) 22*s*. 6*d*. net.

L'Univers

Par Canon Georges Lemaître. Pp. 73. (Louvain: E. Nauwelaerts, 1950.) n.p.

CANON LEMAÎTRE is well known among relativists as one who has made fundamental contributions to the theory of the expanding universe. Soon after his first work on the expanding universe, he advanced the hypothesis that the matter in the universe originally formed a giant atom, from which the atoms at present existing were produced by progressive fission. In "The Primeval Atom", the reasons which led him to this hypothesis are set out in detail. The book, which is the translation of one which appeared in French in 1946, is based on lectures and articles dated between 1929 and 1945, and intended for non-specialists.

The first lecture (1929) introduces the finite but unbounded space of relativity, and suggests that space is expanding. The second (1931) discusses the expansion of the universe in detail and then, extrapolating backward, infers that the universe began in a dense 'atom'. The third lecture (1934) considers the formation of stars and galaxies at the birth of the universe, and suggests that most stars have evolved very little since their formation. The fourth (1945) relates the concept of the primeval atom to the cosmogonic hypotheses of Buffon, Kant and Laplace. The fifth and last (also 1945) runs over the whole range of ideas covered before. In addition to these sections, there is a short mathematical appendix, a preface by Prof. F. Gonseth considering the philosophical aspects, and a foreword by Prof. H. N. Russell, specially written for the English edition.

The earlier sections are as originally written, and have not been modified in accordance with later developments. This has both advantages and disadvantages. The advantages are in giving a more vivid picture of the progress made; the disadvantages, in a certain amount of repetition. As Lemaître says, all the ideas are actually present in the last section, though this would be found too concise by most readers not prepared by reading the earlier sections.

The book certainly is a clear, vivid and fascinating account of the author's own ideas; however, it makes no reference to the divergent views of others. When the first sections were written, the author's hypothesis stood almost alone; now alternative suggestions are being vigorously examined. Lemaître infers the primeval atom by extrapolating backward from the expansion of the universe, from the progressive degradation of energy into increasing numbers of lower-energy quanta, and the progressive increase in numbers of atoms by radioactive fission. But extrapolation over such large ranges of time is notoriously unreliable. Expansion may be only an illusion; it may be characteristic of only part of the universe; or (as in the continuous creation hypothesis) it need not lead back to a dense state. Degradation of energy, though characteristic of laboratory experiments, need not apply to the universe as a whole; and present ideas suggest a progressive decrease in numbers of atoms (by the conversion of hydrogen into helium) rather than an increase by radioactive fission. Again, Lemaître quotes the existence of cosmic rays in support of his ideas; they are the relics of the display of fireworks which attended the birth of the universe. But at present it is regarded as not impossible that cosmic rays are not present everywhere in space, but are confined to the neighbourhood of the sun, or to some region of the Milky Way; and their generation by ordinary electromagnetic processes is being considered, not without prospects of success. Finally, in the light of developments of atomic theory, it is not clear what significance can be attached to the idea of an atom containing all the mass of the universe.

For all these reasons the picture presented by Lemaître must be regarded as only one of the possible pictures. Nevertheless, it is valuable to have this picture. It represents one extreme of the possible cosmogonic hypotheses—the extreme in which the beginning of the universe was as unlike the present and the future as is possible. Such an extreme provides a comparison for assessing later hypotheses.

The translation does not seem to be wholly correct; "une trentaine" and "une trentième" seem to have been confused on p. 32, and there is more than one bad sentence on p. 49. But the difficult points are few. The translators have set out to represent as closely as possible the author's outlook, rather than to translate the words literally; and on the whole they have succeeded.

"L'Univers" is a published version of a series of broadcast talks given by Canon Lemaître in 1950. It gives a popular account of the ideas described in more detail in "The Primeval Atom".

T. G. Cowling

MEASURE AND MEASURABLE FUNCTIONS

Measure Theory

By Prof. Paul R. Halmos. (University Series in Higher Mathematics.) Pp. xi+304. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1950.) 45*s*. net.

THE theory of measure is an essential part of modern analysis, and an up-to-date treatment of it in the English language is very welcome. Prof. P. R. Halmos states that his purpose is to provide a book that should be found usable both as a text for students and as a source of reference for the more advanced mathematician. In my opinion, the advanced mathematician will find the work more useful than the student, who may be discouraged by the somewhat surprising arrangement of its contents. The preface says that "The only necessary prerequisite for an intelligent reading of the first seven chapters is what is known in the United States as undergraduate algebra and analysis. For the convenience of the reader, §0 is devoted to a detailed listing of exactly what knowledge is assumed in the various chapters. The beginner should be warned that some of the words and symbols in the latter part of §0 are defined only later, in the first seven chapters of the text, and that, accordingly, he should not be discouraged if, on first reading of §0, he finds that he does not have the prerequisites for reading the prerequisites." In fact, pp. 3–8 may well terrify the beginner, and are not needed until the last three chapters of the book are reached. If the young student omits these, he may yet be puzzled by the first sentence of chapter 1 (p. 9): "Throughout this book, whenever the word *set* is used, it will be interpreted to mean a subset of a given set, which, unless it is assigned a different symbol in a special context, will be denoted by X".

After this the book becomes more lucid, and the first seven chapters give a good account of sets and classes, measures and outer measures, extension of measures, measurable functions, integration, general set functions, and product spaces. There are many examples which are not as useful as they might have been. The author himself says (p. vi): "It might appear inconsistent that, in the text, many elementary notions are treated in great detail, while, in the exercises, some quite refined and profound matters (topological spaces, transfinite numbers, Banach spaces, etc.) are assumed to be known. The material is arranged, however, so that when a beginning student comes to an exercise which uses terms not defined in this book, he may simply omit it without loss of continuity."

Chapters 8 and 9 are rather more difficult: the former, on transformations and functions, uses the concepts of metric space, completeness, separability and uniform continuity of functions on such spaces; the latter, on probability, includes some important theorems due to Kolmogoroff. This chapter is rather outside the main stream of the argument represented by the rest of the book.

There is a great increase in difficulty in chapters 10–12, in which systematic use is made of many of the results of topology and topological group theory. These are enumerated in pp. 3–8, to which I have already referred. Chapter 10 deals with locally compact spaces, chapter 11 with Haar measure, and chapter 12 with measure and topology in groups. The book concludes with a bibliography and a list of references to it appropriate to different passages of the text, a list of frequently used symbols, and an index.

The book has many merits, and one hopes it will reach a second edition so that the author can remove the unnecessary difficulties in the first few pages, which may conceal these merits from a timid beginner.

H. T. H. Piaggio

LIFE IN THE GRAN CHACO

A Naturalist in the Gran Chaco

By Sir John Graham Kerr. Pp. xiii+235+24 plates. (Cambridge: At the University Press, 1950.) 21*s*. net.

THERE is a rich tradition of naturalist travellers in the University of Edinburgh, dating from the days of James Bruce and Mungo Park in the eighteenth century, and this record of Sir John Graham Kerr's work in the Gran Chaco of South America places him worthily in their distinguished company. It is only from this account, with its day-to-day records and connecting narrative, that one can picture, half a century and more after the events took place, the foresight and planning skill, the endurance, persistence and enthusiasm which brought to successful conclusions two expeditions to a region then practically a scientific blank.

The whole story hangs by a thread—on a bleak afternoon in February 1889 an Edinburgh medical student picks up a copy of *Nature* at the bookstall in Waverley Station, sees a note about a projected Argentine expedition to certain high tributaries of the Rio de la Plata, and so the adventure is conceived and Graham Kerr's scientific future potentially fashioned. As naturalist on Captain Juan Page's expedition, the author penetrated the Gran Chaco, and his observations, made during 1889–91, form the greater part of the book. The second part describes the Lepidosiren Expedition in the same region, undertaken with John Budgett during 1896–97.

The aims of the two journeys were different in kind: the second had a definite objective, the elucidation of the habits and early development of the American lung-fish, about which nothing was known; but that does not preclude supplementary descriptions of other notable inhabitants of the swamps. Vividly the narrative recounts the difficulties and early disappointments encountered and surmounted; and most naturalists to-day are familiar with the value of the direct results, embryological and evolutionary, which followed from the observations and collections then made in the marshes of Paraguay.

The first journey was of another sort: it was a naturalist's roving commission, and every observation in this unobserved country came as grist to the young and enthusiastic traveller. The final and mysterious disappearance of his collections after he had left the river-steamer *Bolivia* was a serious but not a crippling loss, for the vital contributions to knowledge were the field observations recorded in this book. They include a comprehensive account of the Chaco fauna in the neighbourhood of Fortin Page; but more revealing are the innumerable notes on habits, on obliterative coloration, which in its manifold aspects clearly made a deep impression on the author, on the adaptations of the animal inhabitants of the swamps, and, most striking of all, on the characteristics of the human inhabitants, an outlying and restricted branch of the redskin Tobas, the Natokoi.

These wandering and marauding people, without huts or tents or domestic animals except the dog, unable to count above seven, recognizing the moon's phases but with no idea of the number of days in a month, depending on wooden weapons, though their bows had back-strings and their arrows were feathered to rotate, represented at its simplest a primitive hunter–fisherman stage of culture. The account of their daily routine, their simple industries and social customs makes a fascinating tale which could have been revealed only to one received into the bosom of the tribe.

The author has done well in resuscitating these old diaries, so that others may share in the observations and stimulation of his Gran Chaco adventures, which long since have borne rich scientific fruit.

James Ritchie

TAXONOMY OF *PENICILLIUM*

A Manual of the Penicillia

By Kenneth B. Raper and Charles Thom. Pp. ix+875+10 plates. (London: Baillière, Tindall and Cox, 1949.) 91*s*. 6*d*.

Species of the genus *Penicillium* are of common occurrence, wide distribution, and considerable economic importance. Naturally the taxonomy of the genus has received much attention, in spite of its great difficulty. Thom himself has been studying *Penicillia* for half a century, during which time he has gradually brought order out of chaos. His monograph of 1930, though unsatisfactory in some details, laid down broad lines of classification which have stood the test of time. It is a tribute to the soundness of his work that most of the new species described by others during the intervening years are accepted by Raper and Thom in their new manual.

The book is arranged on much the same plan as the earlier "Manual of the Aspergilli" (1945), with three main sections: general discussion, the manual proper, and reference material. Although it is expressly stated that the manual is not a monograph, the first two chapters include a fairly comprehensive account of the history of the genus and synonymy. Chapter 3, "Observation and Description of Penicillia", deals fully with the morphological characters on which classification is based. Then follows a chapter on methods of cultivation and preservation of cultures, and the section concludes with a brief but useful account of the production of penicillin, the stress naturally being on the purely mycological aspects.

The second section of the book begins with a chapter on the use of the manual, and includes two keys to the main groups and series. The succeeding eight chapters deal respectively with the main groups within the genus, and the section concludes with a chapter on the three related genera, *Gliocladium*, *Paecilomyces* and *Scopulariopsis*. Each chapter includes a key, or keys, to the series and individual species; full diagnoses, including descriptions of colonies on three different culture media; discussion of synonymy; and a section on occurrence and distribution, which not only gives a picture of the ubiquity of these organisms, but also provides a useful fund of information on their biochemical characteristics. There are numerous illustrations from photographs of colonies, and photomicrographs and drawings of typical fruiting organs, also ten plates in colour.

The final section of the book comprises a topical bibliography, covering most of the literature on systematics and activities of *Penicillia*; a general bibliography; check list of species and genera, accounting for all names which have been applied to *Penicillia*, and other names which are synonyms of *Penicillium* and the three related genera; and finally a list of accepted species.

The "Manual" is a magnificent piece of work, deserving of the highest praise. Everything has been done to aid the student of the genus and to simplify identifications. Thom's conception of 'group species'—fundamentally the recognition that, in any species of living organism, no two individuals are identical—has been extended to cover the majority of the 137 species recognized. In addition, closely related species are grouped into 'series', the results of this classification being embodied in a diagrammatic key (p. 120) which makes the approximate identification of any isolate a comparatively simple matter. Another excellent feature is the direct comparison of the various species belonging to a single series. Anyone familiar with Thom's monograph will notice that a number of species have now been transferred to different series or groups. In all such cases the new classification makes for a more rational grouping, and will facilitate identifications.

A few minor points require criticism. The term 'phialides' is not of Latin origin, and the singular is not 'phialis' (p. 45). The antibacterial spectrum test, as an aid to confirming identifications of some species, is useful, but no mention is made of testing culture fluids with ferric chloride, a test which is simpler to carry out and which has a wider application. Few mycologists would agree with the statement that the chlamydospores (or aleuriospores) produced by *Paecilomyces varioti* have any connexion with ascus formation in *Byssochlamys fulva*. The topical bibliography, a most useful adjunct to the taxonomic sections, is unfortunately marred by many orthographic errors, chiefly in the German titles of papers. These, however, are small blemishes in a first-class book, which is likely to remain the standard treatise on *Penicillium* for many years to come.

The format of the book maintains the high standard set by the earlier "Manual of the Aspergilli", and the text is commendably free from misprints. In spite of its somewhat high price the book should, and undoubtedly will, become an indispensable part of the equipment of every serious student of moulds.

G. Smith

Medical Botany

A Hand-book for Medical Men and All who are Concerned in the Use of Plants; Nutritionists, Dieticians, Pharmacists and Veterinarians. By Dr. Alexander Nelson. Pp. xi+544+16 plates. (Edinburgh: E. and S. Livingstone, Ltd., 1951.) 30*s*. net.

THIS book sets out to give an account of the uses to which plants can be put by man as food and drugs and also of those plants which directly cause disease or injury to man.

The field covered is very wide and thus the amount of information which can be conveyed under any one heading is rather small. This results in the book being too generalized for the serious student of dietetics or nutrition or pharmacology and not elementary enough for the "members of the general public" mentioned in the introduction.

The most serious criticism of this book which can be offered is that the information contained is thrown together without any attempt at a critical assessment on the part of the author. This, together with a somewhat unkind use of the English language, makes recommendation impossible.

Two quotations must suffice to illustrate these points. On p. 209, in the section on the broad bean, occurs the following sentence: "Apart from the use of garden beans in the young state, these seeds are used, almost exclusively, for stock food. A bean feast was not a feast of beans—the name has quite a different origin." (But we are not told what this different origin is, which is a pity; though authorities do not seem clear about it. The term may have originated from the custom of having a feast on Twelfth Night when a cake with a bean buried in it was cut; the person who received the slice containing the bean was elected 'bean-king'.)

Again, from p. 464 comes the following: "The probability of addiction following the use of opium and its derivatives has led to an increasing degree of control being exercised by governments on the growth of the poppy and the subsequent handling of the drug." Which sentence, taken at its face value, means that government controls must be added to the factors limiting plant growth.

Finally, not all will applaud the classification of alcohol as a food while tea is considered as a drug.

G. E. H. Foxon

Giordano Bruno

His Life and Thought. With annotated translation of his work, On the Infinite Universe and Worlds. By Dorothea Waley Singer. Pp. xi+389+9 plates. (New York: Henry Schuman; London: Constable and Co., Ltd., 1950.) 40*s*. net.

GIORDANO BRUNO the Nolan (1548 ?–1600) presents us with a problem of exceptional interest both for philosophers and historians of science. Scarcely less important is the place which he occupies in the development of ecclesiastical politics. As a personality, too, he is without rival among extreme psychological types, conditioned by a series of complex events. It is impossible to read this book without an intense sympathy for this "martyr of science", notwithstanding his infuriating follies.

Bruno's philosophy is essentially that of "an infinite universe with an infinity of worlds". Several consequences follow, of which his formulation at least cannot be regarded as particularly original. His role was more that of a seer. But, oddly enough, his cosmology stemmed from two opposing roots, namely, those of Lucretius and of Cusanus. The former's thought was fundamentally mundane, the latter's subservient to his theology.

As the theme unfolds, we see something of Bruno's couple of years in Elizabethan London, of his rare periods of comparative repose, and of the gathering storm, culminating at the stake. Of special value is the annotated translation of his "On the Infinite Universe and Worlds". Like his great contemporaries, the humanist architects, Bruno found fascination in numbers, and in a certain species of transcendence.

Mrs. Singer has performed a great task—her erudition and restraint make the living and dying of her fulminating hero a stern reality in this twentieth century.

F. I. G. Rawlins

Synthetische Methoden der organischen Chemie

Von W. Theilheimer. Repertorium 3. Pp. viii+412. (Basel and New York: S. Karger, 1949.) 40 Swiss francs.

THIS volume is the third of a series devoted to an attempt at the systematic recording of new synthetic methods in organic chemistry. Such a classification involves inherent difficulties which the author overcomes by the introduction of a novel system of reaction symbols representing processes such as addition, elimination, rearrangement and exchange, which are used in conjunction with a few empirical rules. For the casual reader who may have neither the time, nor perhaps the inclination, to master this new technique, there is an alphabetical subject index which covers the first three volumes.

It is not clear on what basis the selection of material is based. It is sometimes difficult to decide with certainty whether a reaction is in fact new, and even more difficult to decide whether a given method is an improvement on a known process or not. In these circumstances, the selection of the subject-matter must become largely a matter of personal experience and opinion. The present volume refers mainly to publications of 1946 and 1947 and contains a high percentage of references to work published in the United States, which is intended to compensate in some measure for the paucity of American references in Vol. 2.

The volumes in this series are likely to be of some value to research workers and others engaged in preparative organic chemistry, in that they provide that type of information which might otherwise be difficult to locate. The inclusion of the "English Index Key" grossly underrates the intelligence of the average English-speaking reader.

Advanced Organic Chemistry

By Prof. Reynold C. Fuson. Pp. x+669. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 64*s*. net.

THIS book departs from the usual structural method of depicting organic chemistry, with its use of homologous series and well-defined compound groupings (for example, amino-acids, steroids, etc.) as didactic stepping-stones. Instead, it concentrates on the reactions of the fundamental organic radical groupings in an attempt to delineate "the fundamental behavior patterns of organic compounds"; the emphasis throughout is on the practical, and theoretical concepts are kept to the bare essentials. This method of presentation combined with the succinct, factual style used throughout has produced a book reminiscent of the well-known Houben–Weyl 'Die Methoden der Organischen Chemie", of which this publication may indeed be regarded as a modern corollary. It is thus a reference work rather than a text-book and as such it performs its function admirably. It is a mine of well-arranged and well-chosen information documented by leading references characterized by their up-to-dateness; the text is remarkably free from errors, the printing clear and the binding admirable.

It should be emphasized, however, that this book is not suitable for the beginner in organic chemistry who is not completely familiar with the fundamental framework of the subject as usually taught. In my opinion the optimum usefulness of the book would accrue to graduates or near-graduates who are being initiated into research. R. A. Raphael

Industrial and Safety Problems of Nuclear Technology

Edited by Prof. Morris H. Shamos and Prof. Sidney G. Roth. Pp. xiii+368. (New York: Harper and Brothers; London: Hamish Hamilton, Ltd., 1950.) 4 dollars: 28*s*.

THIS book collects the contributions made at a three-day conference sponsored by the United States Atomic Energy Commission and Division of General Education of New York University. The subjects cover a very wide field, including a general talk by the chairman of the Atomic Energy Commission, together with an account of its contractual and patent arrangements. There are a section on radiochemistry and isotopes, one on the design and equipment of radiochemical laboratories, and finally six articles on radiation hazards, their evaluation and control.

Many of these articles are too short and scrappy to have justified publication. For example, a single article of five and a half pages on electronuclear apparatus describes particle accelerators and their protective shielding. The articles on general hazards of nuclear radiation and evaluation of radiation hazards and their control give no table of agreed tolerances.

The only articles of any substantial value are one by P. C. Aebersold on the present and potential uses of isotopes, and another by C. Rosenblum on what isotopes can mean to industry. Industry in Great Britain has been slow to realize the potentialities of isotopes as a research tool. These articles give some very interesting examples of work which has been carried out in the United States, particularly on the mechanism of synthesis of hydrocarbons and on the role of polymerization catalysts.

J. D. Cockcroft

Mothproofing

By R. W. Moncrieff. Pp. 200+10 plates. (London: Leonard Hill, Ltd., 1950.) 17*s*.

THE damage caused to wool and related fibres by certain kinds of moths and beetles has been known since the dawn of history, but it is only within comparatively recent years that a systematic study has been made of the habits of these pests and of methods for combating them. The economic importance of moth-proofing is reflected in the very large number of substances recommended for the purpose, and the appearance of a book on this subject at a time of world shortage of wool is particularly appropriate.

The first three chapters deal with the life-history of the various insects, their habits and the damage they do and, logically, should have been followed by Chapter 12 on the nutritional requirements of the larvæ. The chemistry and methods of application of the more important classes of moth-proofing substances are then described in some detail, many extracts and examples being quoted from the relevant patent specifications; the cost and fastness to washing of the various processes are also discussed. Another line of approach to the problem is one based on modification of the structure of the wool molecule, and an interesting account is given of Harris's pioneer work and of the author's glyoxal process. For the care of materials which have not been moth-proofed, special infestation precautions and remedies are called for, and the directions given in Chapter 15 will be of general interest. The concluding chapters give details of standardized procedures for breeding and rearing moths and for the larval and chemical testing of moth-proof efficiency.

The book is written in a lively and stimulating fashion and will appeal not so much to the specialist as to the general reader who wants to get a detailed picture of the progress made in this field of research. The illustrations and index are good, and there are ample references to scientific and patent literature.

British Birds

By F. W. Frohawk. Pp. 256+31 plates. (London and Melbourne: Ward, Lock and Co., Ltd., 1951.) 17*s*. 6*d*. net.

THE late F. W. Frohawk was well known not only as a sound and careful naturalist but also as no mean bird and insect artist. His accurate and beautiful sketches of British butterflies told us that. Now we have in this volume 105 colour illustrations of birds on the British list, accompanied by excellent letterpress, in which the information is given under the headings of "Distribution", "Description", and so on. It is easy to look up any species and any detail concerning it. This will be a very useful volume to the novice needing help in identification and information about habits. He will find in it all the birds normally met with in our countryside and many not ordinarily found there.

If the author and artist had lived a little longer, we may surmise the book would have been yet more comprehensive and that he would have included such species as the Scottish crested tit, which is somewhat surprisingly omitted. There are a large number of useful black-and-white sketches included in the text; there is also a helpful appendix dealing with recognition, a number of tables being given in which species are arranged alphabetically under "Haunts", "Size and Colour (General Impression)", "Head", Wings", "Flight", etc.

Reverting to the colour plates, colour reproduction is notoriously tricky, and it may be doubted if every reproduction does justice to the originals, for in some cases the tints are a little hard; however, the volume as a whole is excellent and it will form an admirable present for the young person with bird-watching aspirations, who should read the paragraph on "Record Keeping" and mark the last sentence concerning the value of accurate notes . . . "This type of record-keeping forms the only alternative to the destruction of many of our finest and rarest birds whose skins are kept for 'identification purposes' ".

Frances Pitt

ACOUSTICS OF THE ROYAL FESTIVAL HALL, LONDON

By P. H. PARKIN

Building Research Station (Department of Scientific and Industrial Research), Watford

AT a recent meeting of the Acoustics Group of the Physical Society, the late Dr. Alex. Wood remarked that when he was a young man at the beginning of the century the problems of concert hall acoustics had been solved. Sabine[1] had recently defined and measured reverberation time; all that was necessary was to adjust the reverberation time of a concert hall to a certain optimum value and then to sit back and enjoy the music. Nowadays, Dr. Wood continued, we know that we are only beginning to discern the problems of designing a concert hall with excellent acoustics.

The theory of sound waves in rooms has received considerable attention, from Lord Rayleigh[2] to the recent publications by Morse and Bolt[3], and others. The theoretical solutions of quite simple practical acoustical problems are, however, so complicated that their application is very limited, even if all the physical factors were known. For example, it has been pointed out that the solution of the steady-state sound in a rectangular room, one wall of which has on it a few patches of absorbent flush with the surface, requires a notation of more than sixty-five symbols. When we remember that musical sounds are mostly transient in character, it is clear that for some time to come the approach must be an experimental one. With so incomplete a background it may be asked[4] why science should be consulted at all in the design of a concert hall. The answer is that the man of science forms a link between the architect and the musician: however imperfect the scientific knowledge, it is a better basis than any other for the intelligent guesses which have to be made.

One major contribution of science to the design of the Royal Festival Hall on the South Bank, London, has been an attempt to assess and define the musical requirements. Hitherto the worker in acoustics has tended to rely on his own subjective judgments, an unethical practice, but one which has been largely forced on him by the lack of organized musical opinion. This assessment started in 1947 when a questionnaire was sent to all professional musicians who could be classified as listeners (as distinct from performers), in which they were asked their opinions on the acoustics of ten selected concert halls. Also, listening tests were made in several halls, where teams of listeners sat successively in different positions during concerts. From such tests as these; from public meetings such as the one organized by the Acoustics Group of the Physical Society[5,6] where musicians, architects, engineers and physicists met to discuss the problems; and from private discussions with musicians and other workers on the subject, it was possible to formulate the musical requirements. The positive virtues required are: (1) definition, (2) fullness of tone, (3) blending, and (4) balance; the negative virtues required are (5) a low level of intruding noise and (6) no echoes.

There is a further requirement which did not arise from these discussions, and that is for the acoustics to be reasonably uniform over the whole audience area. Professional musicians usually sit in the acoustically best seats, and are not always aware of the need for uniformity.

Turning now to the design problems, and taking the negative requirements first, the sound insulation was the second contribution of science to the design of the Royal Festival Hall. It was, of course, necessary to know the noise-levels on the site and the permissible noise-levels inside a concert hall. The outside levels, which were caused by the trains over Hungerford Bridge, were easily measured; the permissible inside levels were more difficult to determine. To reduce the external noise to inaudibility in the Hall would have required an excessively complicated structure. Instead, measurements of the sound-pressure levels due to nearby main-road traffic were made, during pauses in quiet passages of music, in two concert halls. Teams of listeners in these halls during concerts were not conscious of the intruding noise. As a design principle, it was decided to insulate the auditorium itself to this standard and not to rely on any additional insulation obtained from the surrounding foyers and corridors. The insulation of the proposed wall and roof was checked on the site by building a hut of the same construction. After the Hall had been under construction for some months, the railway authorities relaid the tracks on Hungerford Bridge, and the noise-level decreased by 18 decibels. The old rails had become badly corrugated; this phenomenon is not fully understood and the new rails may eventually become corrugated, although after two years use they have shown no sign of doing so. This reduction in the noise-level and the additional insulation due to the surrounding foyers have made the Hungerford Bridge trains completely inaudible in the auditorium. The actual insulation achieved has not yet been measured, as it is now necessary to construct microphones which will measure below the threshold of audibility.

Another possible source of noise in the Hall was the underground trains which run directly under the site. The vibrations due to these trains were measured on the foundations of the old brewery then existing on the site. The maximum vertical amplitude (peak-to-peak) was of the order of 0·0002 in. at 10 c./s., and although this amplitude of vibration is classified as 'not perceptible' to the human frame, it was very difficult to decide whether audible frequencies would be produced in the Hall, for example, by exciting wood panels. It was decided that the risk would have to be accepted without attempting structural precautions. In fact, there was the possibility in reserve of putting the underground rails on resilient mountings. In the event, one underground train out of four or five, presumably due to differences in the rolling stock, produces maximum noise-levels in the Hall of about 30 phons. This noise would not be distinguishable if it were not for the otherwise very quiet conditions. At the first test concert, 240 listeners were specially asked to listen for the trains; only eighteen thought that they could hear them, and then, of course, only when they coincided with pauses in the music.

The other negative requirement, no echoes, was met mainly by due regard to the shape of the Hall, but also by absorbent treatments of various kinds on the rear wall, along the junctions of the side walls and the ceiling, and on the side walls close to the orchestra where lateral echoes might have occurred.

There is another fault, not listed by the musicians, which may occur in halls. This is the occurrence of one or more particular eigentones with a decay time much longer than the general reverberation time. Such a fault occurred in the large concert studio in the Danish Broadcasting House, and in that case was cured by inserting Helmholtz resonators in the ceiling, tuned to absorb 63 and 98 c./s.[7]. The ceiling of the Royal Festival Hall was constructed with about twelve hundred 2¼-in. diameter holes for use with resonators if the need arose.

Dealing now with the design problems associated with obtaining the positive musical requirements, it must be emphasized that the following statements should be regarded as hypotheses. The two major requirements are for definition and fullness of tone. The meaning of definition is obvious; fullness of tone is not so obvious. Apparently musicians mean the same quality when they use such terms as warmth, richness, body, singing tone, sonority or resonance. (It should be remembered that 'resonance' has different meanings for the musician and the physicist; the "Oxford English Dictionary" defines it as the reinforcement or prolongation of sound by reflexion.) It is reasonable to assume that, other considerations apart and within limits, the longer the reverberation time the more chance there is of achieving this quality. If this is so, there must be some conflict between 'definition' and 'fullness of tone'.

Definition can be obtained by a clear path for the direct sound from all the instruments to all parts of the audience. The intensity of this direct sound will, at least for individual instruments if not for the whole orchestra, decrease as the square of the distance. In the Royal Festival Hall the intensity of the direct sound at the back of the Hall would be 20 decibels less than in the front row, while the reverberant sound, by definition, would be approximately of the same intensity throughout the Hall. Now for reasonable uniformity the ratio of direct sound to reverberant sound should not vary too greatly, and we know from Haas's work[8] that, for speech at least, the direct sound can be followed shortly after by reflexions of intensity greater than the direct sound without any loss of definition. That is to say, there is a time limit; reflexions which arrive at the listener within this limit can be classified with the direct sound and do not detract from the definition; reflexions arriving after this limit can be classified as reverberant sound and hinder definition. For speech this time is about 30 msec. and for music we can assume that it is of the same order. The canopy over the orchestra in the Royal Festival Hall is designed to reflect sound towards the rear of the Hall in order to maintain the intensity of the direct plus 'first-reflected' sound. To achieve fullness of tone, the Hall was designed to have as long a reverberation time as possible; the absorbing surfaces were kept to the minimum necessary to prevent echoes, and the volume of the Hall was made as large as was structurally possible.

The primary purpose of the four trial concerts which were held in the Royal Festival Hall before its opening was to test for faults, for example, echoes, since acoustics is a wave phenomenon and predictions based on geometrical analysis may not be borne out in practice. It was clear after the first trial that there were no major faults, and attention was concentrated on the problem of definition versus fullness of tone. Again, the professional musicians were consulted, but it soon became apparent that, for musicians conditioned by ten years of listening in over-reverberant halls, the acoustics of the Royal Festival Hall were too different for reliable and consistent judgments to be made. Thus, at one trial concert, ten out of fourteen musicians wanted more fullness of tone and accordingly some of the absorbent areas were removed, at the risk of echoes. In the event, due to the remainder of the upholstered seats being installed, the reverberation time was still the same at the next trial. Nevertheless, ten of the fourteen critics volunteered the information (they were not specifically asked) that the acoustics were now considerably improved; only two still wanted more fullness and nine wanted the Hall left as it was (and is).

When the Hall has been in use for six months, it is proposed to make a detailed survey of authoritative musical opinion on the acoustics. It seems to be generally agreed at the present time that the definition is outstandingly good, and, as a result, all the parts in the most complex modern orchestrations can be heard, presumably as the composers intended. Also, mezzo forte and pianissimo passages sound excellent, due in part no doubt to the good sound insulation; but there is some argument as to the effectiveness of the louder passages. A lot depends, of course, on the orchestral layout, which there is not space to discuss, and indeed on the standard of performance. Nor is there space to discuss the problems of balance and blend. From the performer's point of view, it is worth noting that Mr. Jascha Heifetz and Mr. Yehudi Menuhin have both remarked to the Press, one in Australia and the other in America, that the Royal Festival Hall has the best acoustics of any hall they have played in. Mr. Leopold Stokowski has also remarked to the present writer that he considers it the best hall he knows, although he would prefer a longer reverberation. In comparison with the seven concert halls which the 1947 survey of musical opinion, referred to above, showed to have good acoustical reputations, the reverberation time of the Royal Festival Hall (see Figs. 1 and 2) is the longest except for St. Andrew's Hall, Glasgow, which only achieves its exceptionally long time at the expense of troublesome echoes at the front part of the hall. Fig. 1 also shows the optimum reverberation time as a function of volume as recommended by Bagenal and Wood[9] and Knudsen and Harris[10]. The measured

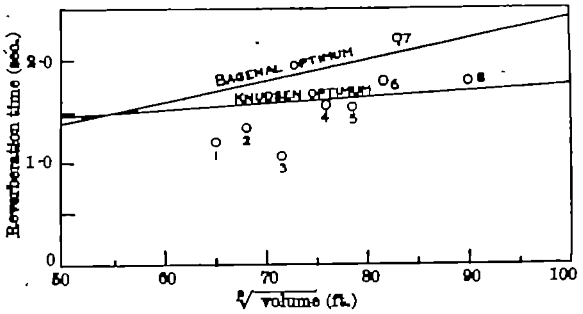

Fig 1. Reverberation times at 500 c./s. with halls full. 1, White Rock Pavilion, Hastings; 2, Peoples' Palace, London; 3, Royal Opera House, Covent Garden, London; 4, Simon de Montfort Hall, Leicester; 5, New Philharmonic Hall, Liverpool; 6, Usher Hall, Edinburgh; 7, St. Andrew's Hall, Glasgow; 8, Royal Festival Hall, London

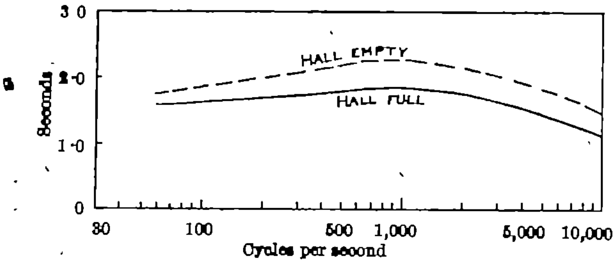

Fig. 2. Reverberation time of the Royal Festival Hall, full and empty

reverberation time takes no account of the behaviour of the sound during the first 50 or 100 msec., and it may be that because of the strong direct and first-reflected sound in the Royal Festival Hall the reverberation time could well be longer.

A final assessment must await further experience, and the problem has been elegantly put by the music critic of *The Times*, writing about one of the trial concerts[11]; after remarking that a little more 'warmth' was desirable, he continues: "Yet to be able to hear all parts within a tutti, to have the piano . . . sound in the huge hall with the intimacy of the drawing room, and really to be aware of all that is going on in a complex score like Debussy's 'La Mer' are experiences that can only be had elsewhere in the Liverpool Hall and must not be sacrificed too far to the desire of the ear for a feather bed on which to recline voluptuously".

It would not be fitting to conclude without a tribute to Mr. Hope Bagenal, the acoustic consultant, whose judgment in these problems, where so much is qualitative, has been infallible.

This work will be described in detail elsewhere; it forms part of the programme of the Building Research Board of the Department of Scientific and Industrial Research, and this article is published by permission of the Director of Building Research.

[1] Sabine, W. C., "Collected Papers on Acoustics" (Oxford University Press).

[2] Rayleigh, Lord, "Theory of Sound" (Macmillan).

[3] Morse, P. M., and Bolt, R. H., *Rev. Mod. Phys.*, 16, No. 2 (1944).

[4] Newman, E., *The Sunday Times*, May 6, 13 and 20, 1951.

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[7] Jordan, V. L., *J. Acous. Soc. Amer.*, 19, No. 6, (1947).

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[9] Bagenal, H., and Wood, A., "Planning for Good Acoustics", 116 (Methuen).

[10] Knudsen, V. O., and Harris, C. M., "Acoustical Designing in Architecture", 194 (Wiley).

[11] *The Times*, March 15, 1951.

RELATIONSHIP BETWEEN HÆMOGLOBIN AND ERYTHROCRUORIN

By Prof. D. KEILIN, F.R.S., and Dr. E. F. HARTREE

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THE name 'hæmoglobin' was introduced by Hoppe-Seyler in 1864[1] for the red pigment of blood which was previously referred to as hæmatoglobulin by Berzelius (1840)[2] and hæmatocrystallin by Lehmann (1853)[3]. Stokes (1864)[4], not being aware of these terms, proposed for this pigment the name 'cruorine'. In 1868 Ray Lankester[5] announced the discovery of 'Stokes's Red Cruorine' in non-corpuscular vascular fluids of *Lumbricus*, *Eunice sanguinea* and *Hirudo*, in blood plasma of *Planorbis corneus* and in the body fluid of the larva of *Chironomus plumosus*. He noted that "in vertebrates the Red Cruorine is concentrated in corpuscles, whilst in the Mollusc, Insect and Annelid, it is diffused in the plasma". In some annelids, including *Sabella*, he found that vascular fluid contains "a green body of the same nature as the Red Cruorine of Stokes". He concluded that this "green body may be called Chloro-cruorine whilst the red is termed Erythro-cruorine. There is an indication of the existence of a violet and yellow form of cruorine in certain Molluscs. Many Annelids, very nearly all Insects, Crustacea and Molluscs have not a coloured Cruorine in their blood. Is it not probable that they possess a colourless body possessing the same oxygen-carrying properties which Stokes attributes to Red Cruorine? If so it should be classed with the red and green forms as a modification of Cruorine."

There is no doubt that Ray Lankester used the term erythro-cruorine to cover all red oxygen-carrying pigments both of vertebrates and invertebrates. However, in 1870, while retaining the term chloro-cruorine for the green pigment, Ray Lankester[6] abandoned the term 'erythro-cruorine', replacing it both in the case of vertebrate and invertebrate pigments by Hoppe-Seyler's term 'hæmoglobin', which was by this time generally accepted.

More recently, Ray Lankester's term erythrocruorin (with slightly different spelling) was revived by Svedberg and Eriksson[7] to designate the red blood pigments of *Arenicola marina* and *Lumbricus terrestris*. The reason they gave for so doing was formulated as follows: "The detailed ultracentrifugal investigation has shown that the red respiratory pigment dissolved in the blood of these worms is with regard to the properties of the protein part of the molecule, more allied to chlorocruorin and to hemocyanin than to hemoglobin of the vertebrates. It therefore seems inappropriate to call it a modification of hemoglobin"; and further, "It seems to us appropriate to revive Ray Lankester's term and we therefore propose the name erythrocruorin for the red respiratory proteins of the invertebrates". With the limited information then available, the contrast between erythrocruorin and hæmoglobin was well defined: erythrocruorin being dissolved in plasma, having a high molecular weight (*c.* 3,000,000) and a low isoelectric point (~ 4·8); hæmoglobin being intracorpuscular, having a lower molecular weight (*c.* 68,000) and a higher isoelectric point (6·5–7·5).

The term 'erythrocruorin' was extended by Svedberg and Eriksson-Quensel[8], Svedberg and Pedersen[9], Roche[10] and Roche and Fontaine[11] to the hæmoglobin-like pigments of all invertebrates as well as of cyclostome fishes among the vertebrates, the name 'hæmoglobin' being reserved for the blood pigments of all other vertebrates.

This classification was based by them upon determinations of (1) the molecular weight, (2) the isoelectric point, and (3) the chemical composition of the proteins of these pigments. However, as will be shown presently, a thorough analysis of the results obtained under the above headings does not support the separation of these pigments into hæmoglobins and erythrocruorins.

(1) *Molecular weight.* Determinations of molecular weight of different oxygen carriers have been summarized and tabulated by Svedberg and Pedersen[9].

Table 1. Molecular Weights of Different Hæmoglobins (II) and Erythrocruorins (I and III) according to Svedberg and Pedersen (ref. 9)

Lampetra	17,000	I
Chironomus	17,000 34,000	
Glycera	34,000	
Fishes, birds and mammals	68,000	II
Amphibia and reptiles	68,000 150,000 290,000	
Daphnia	400,000	III
Planorbis	1,630,000	
Arenicola	3,000,000	
Lumbricus	3,000,000	

Thus, the molecular weights of erythrocruorins found dissolved in the plasma of different invertebrates vary from 17,000 to about 3,000,000 (I and III, Table 1). The values for intracellular erythrocruorin both of certain invertebrates and of cyclostomes are 17,000 and 34,000 (I, Table 1). The pigment in *Daphnia* contains a main component of molecular weight about 400,000 ($S_{20} = 16\cdot3 \times 10^{-13}$) and varying proportions of a smaller molecular species (about 44,000) which at *p*H 8 may constitute as much as 40 per cent of the total pigment. The hæmoglobins of mammals, birds and fishes have the mean value $S_{20} = 4\cdot3 \times 10^{-13}$, which corresponds to a molecular weight of 68,000, while those of amphibians and reptiles have a somewhat higher value: $S_{20} = 4\cdot7 \times 10^{-13}$. What is, however, of special interest is that the blood of these vertebrates, according to Svedberg and Pedersen[9], "nearly always contained a second component having S_{20} about 7×10^{-13} and probably having twice the molecular weight of normal hæmoglobin. Furthermore, in a single case a third component was observed with $S_{20} = 12\cdot5 \times 10^{-13}$ (molecular weight probably 4 × hæmoglobin)." In other words, the intracorpuscular hæmoglobin of certain amphibians (for example, *Bufo valliceps*) may reach values as high as 150,000 and 290,000. The molecular weights of the intracorpuscular hæmoglobins of vertebrates (68,000–290,000) occupy a comparatively small range (II, Table 1) within the very wide limits of molecular weights exhibited by erythrocruorins, which may vary between 17,000 and 3,000,000 (I and III, Table 1). Molecular weight data, therefore, give no support to the separation of these pigments into two groups.

Table 2. Isoelectric Points of Different Respiratory Pigments (see Svedberg and Pedersen (ref. 9), and Roche and Fontaine (ref. 11)). I.P. of *Gastrophilus* according to Keilin and Wang (ref. 15)

The line drawn between *Gastrophilus* and toadfish separates the so-called 'erythrocruorins' from hæmoglobins

	Isoelectric points
Arenicola	4·6
Chironomus	5·4
Lampetra	5·7
Notomastus	6·0
Gastrophilus	6·2
Toadfish	5·75–6·23
Cyprinus	6·5
Horse	6·9
Man	7·1
Duck	7·5

(2) *Isoelectric points.* The isoelectric points (I.P.) of respiratory pigments, as shown in Table 2, vary from *p*H 4·6 to *p*H 7·5. Although precise determinations have so far been carried out in only a few cases[9,11,15], yet within the above range no distinct break in the values can be observed. The line drawn between *Gastrophilus* and toadfish separating the pigments into erythrocruorins (I.P. 4·6–6·2) and hæmoglobins (I.P. 5·75–7·5) is a purely arbitrary division.

Table 3. Amino-Acids in Respiratory Pigments according to Roche (ref. 10) and Roche and Fontaine (ref. 11)

Respiratory pigment of	Pigment classified as	Arginine (per cent)	Histidine (per cent)	Lysine (per cent)	Cystine* (per cent)
Lampetra	Erythrocruorin	3·52	3·37	7·51	4·40
Arenicola	,,	10·04	4·03	1·85	4·08
Glycera	,,	9·64	5·39	4 90	3 40
Lumbricus	,,	10·07	4·68	1·73	1·47
Sabella (= *Spirographis*)	Chlorocruorin	9·64	2·38	3·64	1·64
Horse	Hæmoglobin	3·57	8·13	8·31	0·74
Horse (according to Tristram, ref. 28)	Hæmoglobin	3·65	8·71	8 51	1·01

* Cystine: the value of 1·01 given by Tristram is the sum of cysteine and cystine. Roche's figures were obtained by a method which also gives the sum of these acids.

(3) *Amino-acid content of proteins.* The estimation of a few amino-acids in pigments classified as erythrocruorins was carried out by Roche and Fontaine[11] in four cases (*Lampetra*, *Arenicola*, *Glycera* and *Lumbricus*) and a comparison was made with amino-acids in chlorocruorin of *Sabella* and in horse hæmoglobin. However, since some of this material was available only in small amounts and was of doubtful purity, the estimations can be considered as only approximate. Even if we accept the values shown in Table 3, there is no indication of uniformity in amino-acid distribution among different erythrocruorins. Whereas the arginine and lysine contents of *Lampetra* erythrocruorin are very similar to those of horse hæmoglobin, the values for histidine and cystine are not far from those found in the pigments of the invertebrates. On the other hand, if their cystine contents are compared, the pigment in *Lumbricus* is more closely allied to horse hæmoglobin than to the pigment in *Arenicola*. Thus, the amino-acid contents of these oxygen carriers do not support their separation into erythrocruorins and hæmoglobins.

Other Properties of Oxygen Carriers

The comparative study of protohæm–protein oxygen carriers of different origin reveals that they differ between themselves not only in the three properties examined above, namely, their (1) molecular weight, (2) isoelectric point, and (3) amino-acid content, but also in other important properties, such as: (4) solubility, (5) ease of crystallization, (6) crystalline structure, (7) affinity for oxygen, (8) relative affinity for oxygen and carbon monoxide, (9) shape of the oxygen dissociation curve, (10) absorption spectrum, (11) autoxidizability of the iron, (12) ease of denaturation by alkali and other factors, and (13) antigenic properties.

Unfortunately, only three of these properties have been investigated more or less systematically for respiratory carriers both of vertebrates and invertebrates. These are: affinities of the pigments for oxygen, their relative affinities for oxygen and carbon monoxide and the positions of their absorption bands in the visible region of the spectrum.

Affinity of the respiratory pigments for oxygen. This can be expressed in terms of the oxygen tensions in millimetres of mercury (p_{50}) at which the pigments are half-oxygenated. This property has been extensively investigated because of its great physiological significance. The scattered literature on this subject up to 1933 was collected and critically reviewed by

Table 4. Affinities of Respiratory Pigments for Oxygen
Oxygen tensions (p_{50}) in mm. mercury, for 50 per cent oxygenation of pigments in the blood of different organisms; (*a*) as determined by Fox (ref. 13), (*b*) as quoted by Redfield (ref. 12). The pigments of organisms named in italics are classified by Svedberg and Roche as erythrocruorins

		p_{50}		
		17° C.; no carbon dioxide	17° C.; + 1 per cent carbon dioxide	38° C.; + 5 per cent carbon dioxide
(*a*)	*Chironomus riparius*	0·6	0·6	
	Tubifex sp.	0·6	—	
	Ceriodaphnia laticaudata	0 8	1·0	
	Thalassema neptuni	1·4	1·8	
	Arenicola marina	1·8	2·6	
	Planorbis corneus	1·9	2·9	
	Daphnia magna	3·1	4·9	
	Man	1·2	3·9	
(*b*)	Man			26
	Horse			26
	Sea lion			40
	Eel	2–3		
	Pike	2–3		

Redfield[12], while more recently Fox[13] has determined p_{50} for a number of invertebrate pigments by microspectroscopic methods. A few examples selected from these papers as having a direct bearing on the relationship between oxygen carriers of vertebrates and invertebrates are given in Table 4. In all cases the determinations were carried out on whole blood. To these examples we can add the values of p_{50} = 0·1 mm. at 15° obtained by Keilin and Wang[14] for the hæmoglobin of the root nodules of leguminous plants and p_{50} = 5 mm. at 39° obtained by Keilin and Wang[15] for the hæmoglobin of tracheal cells of *Gastrophilus* larvæ. An exceptionally high affinity for oxygen is shown by the hæmoglobins of *Ascaris lumbricoides*. This organism, as was found by Keilin[16], has two distinct hæmoglobins, one in the perienteric fluid, the other in the body wall. It was recently shown by Davenport[17] that both these hæmoglobins exhibit a remarkable resistance to deoxygenation. Thus, in the presence of sodium hyposulphite the half-time (t_{50}) for deoxygenation is 150 sec. for perienteric and 80 sec. for body-wall hæmoglobins, as compared with 0·008 sec. for sheep hæmoglobin.

All the available data clearly indicate that p_{50} values, like the oxygen dissociation curves, do not follow at all the classification of pigments into hæmoglobins and erythrocruorins. On the contrary, they only reflect more or less consistently the physiological requirements of the organisms, such as can also be illustrated by the relationship between blood hæmoglobin and myoglobin of the same organism, or between maternal and fœtal hæmoglobins. Moreover, since p_{50} decreases when a solution of hæmoglobin is diluted[18], a comparison of the pigments in Table 4 at equal hæmoglobin concentrations would, if anything, further diminish the distinction between hæmoglobins and erythrocruorins.

Relative affinity of the respiratory pigments for oxygen and carbon monoxide. This ratio is expressed as an equilibrium or partition constant

$$K = \frac{[\mathrm{HbCO}]pO_2}{[\mathrm{HbO_2}]pCO}.$$

The value of this constant for the hæmoglobins of certain vertebrates was determined by Anson, Barcroft, Mirsky and Oinuma[19]. The problem was recently carefully re-investigated by Fox[20], who determined this constant for the oxygen carriers of several vertebrates and invertebrates. The results of these determinations, together with the data obtained for the pigments in the root nodules of leguminous plants[14] and the tracheal cells of *Gastrophilus* larvæ[15] as well as for myoglobins of different mammals, are summarized in Table 5.

Table 5. Values of $K = \frac{[\mathrm{HbCO}]\,pO_2}{[\mathrm{HbO_2}]\,pCO}$ for different respiratory pigments according to Fox (ref. 20), except for root nodules and *Gastrophilus* (Keilin and Wang, ref. 14, 15). Pigment of *Branchioma* is chlorocruorin; those marked with an asterisk belong to the supposed erythrocruorins, the remainder to the hæmoglobins

	K
Branchioma	570
*Chironomus**	400
Horse	280
Man	230
*Arenicola**	150
*Tubifex**	40
*Planorbis**	40
Rabbit	40
Root nodules*	37
*Gastrophilus**	0·67
Myoglobins	28–51

As in the case of oxygen affinities, no line can be drawn separating the values of K for erythrocruorins and hæmoglobins.

Absorption spectra. That the absorption spectra of hæmoglobins of different origins are not the same was shown for the first time by Sorby[21] in 1876 in his classical paper "On the Evolution of Hæmoglobin". In comparing human and *Planorbis* hæmoglobin, he found that the absorption bands of the latter lie about 3 mμ nearer the blue end of the spectrum. Sorby did not fail to give the correct interpretation of this phenomenon, as the following quotation shows: "This difference cannot be due to any difference in the physical state of the substance since in both cases it was perfectly dissolved in a relatively large quantity of water. It is rather of such a character as would result from the substitution of one kind of albuminoid for another in the combination with the same modification of hæmatin, into which both are decomposed when boiled with ammonia or decomposed by acids." Sorby also found that these pigments differ in their susceptibility to heat and to acids. These observations were confirmed by Vlès[22] and by Anson *et al.*[19], who extended them to hæmoglobins of a greater variety of organisms. However, since most of these data were obtained with impure material and not with modern and more precise spectrophotometric methods, they can only be considered as approximate and need not be recorded here. Nevertheless, they clearly show that the positions of the absorption bands of different hæmoglobins are irregularly distributed between those of pigments classified as erythrocruorins.

General Considerations

Although the oxygen carriers of different organisms show marked differences in their properties, not one of these properties supports the classification of the hæm–protein compounds into erythrocruorins and hæmoglobins. In fact, it is primarily the important advance made in the study of this subject by Svedberg himself that has made it impossible to retain the term 'erythrocruorin' which he introduced during the first stage of his work on the oxygen carriers of invertebrates. The term 'erythrocruorin' can therefore be abandoned and all protohæm–protein oxygen carriers should now be brought together under the general term 'hæmoglobin'. The specific cases of these pigments can be referred to as hæmoglobins with an appropriate indication of their origin; for example, human hæmoglobin, *Planorbis* hæmoglobin, *Gastrophilus* hæmoglobin, etc. Muscle hæmoglobin can be referred to as myohæmoglobin, which is usually abbreviated to myoglobin.

The hæmoglobin of the root nodules of leguminous plants is of special interest. It was discovered by Kubo[23] and its oxygenation was demonstrated by Keilin and Wang[14], who also determined the spectrophotometric curves of its main derivatives and its affinities both for oxygen and carbon monoxide. What is remarkable, however, is that neither the plant cells alone nor the symbiotic micro-organism (*Rhizobium*) cultivated separately are capable of synthesizing hæmoglobin. It is only when the root cells are invaded by the specific micro-organism and begin to proliferate that hæmoglobin is formed. *Rhizobium* not only induces growth and multiplication of the cells but also supplies these proliferating cells directly or indirectly with a factor necessary for synthesis of hæmoglobin[14]. Root nodule, or simply nodule, hæmoglobin is an appropriate name for this pigment, since it gives sufficient indication of its peculiar localization and dependence upon an association between the plant cells and *Rhizobium*. (The name 'leghæmoglobin' proposed for this pigment by Virtanen[24] is not suitable since the prefix 'leg' is not an adequate abbreviation of the Latin *legumen* and is ambiguous in English.)

We shall now briefly consider the term 'chlorocruorin' which was introduced by Ray Lankester in 1868 for the green blood pigment of certain polychæte worms. Chlorocruorin was re-investigated by Fox[20,25,26], who, in a series of important papers on this pigment, established its characteristic properties. Chlorocruorin differs from hæmoglobin in the structure of its hæm as well as that of its protein. The hæm, according to Fischer and Seemann[27], differs from protohæm in having one of its vinyl side-chains replaced by a formyl group. The term 'chlorocruorin' should be retained, since it indicates the green colour of the pigment; it also suggests a marked difference from hæmoglobin and is closely associated with the extensive investigations on this subject by Fox and other workers.

It may be interesting to mention here that the blood of polychæte worms generally contains either hæmoglobin or chlorocruorin or is devoid of both pigments. However, it was recently found by Fox[20] that the genus *Serpula* differs from all other known organisms in possessing two oxygen carriers, hæmoglobin and chlorocruorin, in the blood plasma.

Since the prosthetic group of all hæmoglobins is the same protohæm nucleus, the differences in their properties, as was clearly formulated by Sorby[21], is due to differences in the nature of the protein portions of their molecules. What is of special importance is that in spite of the great variety in the amino-acid contents of these proteins and the great diversity in their physico-chemical properties, they all have one character in common, and that is the ability to impart to the hæm nucleus the remarkable property of reversible oxygenation. This important property, which cannot be imitated by any other naturally occurring or synthetic compound, depends upon the integrity of the structural configuration of the protein and is abolished when the protein undergoes denaturation. By bringing together all protohæm-protein oxygen carriers into the one group—hæmoglobin—one's attention becomes rightly focused upon their common fundamental property of reversible oxygenation, the intimate mechanism of which still awaits elucidation.

To avoid confusion and unnecessary complications of nomenclature, the classification of all biologically active protein compounds, such as oxygen carriers or enzymes, should be based not upon their physico-chemical properties as proteins but upon their specific biological activities and the nature of their active, or prosthetic, groups.

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THE COSMIC RAY OBSERVATORY AT OTTAWA

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THE National Research Council of Canada has recently constructed at Ottawa a small observatory for cosmic ray measurements. Such an observatory at or near sea-level (the present site is about 200 ft. above mean sea-level) may be considered novel at a time when so much important work is being done at high altitude. There are still, however, many interesting things to be learned from sea-level measurements, and the advantages of fixed rather than airborne apparatus are great. Practically all the nuclear phenomena (probably all except collisions due to heavy energetic primary particles) occur at sea-level, though less frequently than at higher altitude. Many experiments which require continuous observation can only be carried out with fixed equipment, and few long-term measurements which depend on geomagnetic effects have been taken at the high geomagnetic latitude (56·8° N.) at which the new laboratory is situated.

The programme of work, which was started about three years ago and was moved recently to the new observatory, includes the study of the nature of cosmic ray particles and showers at sea-level, and experiments which would lead to more information about the source of cosmic rays.

The new building was designed to supply laboratory facilities wherein the amount of absorbing material

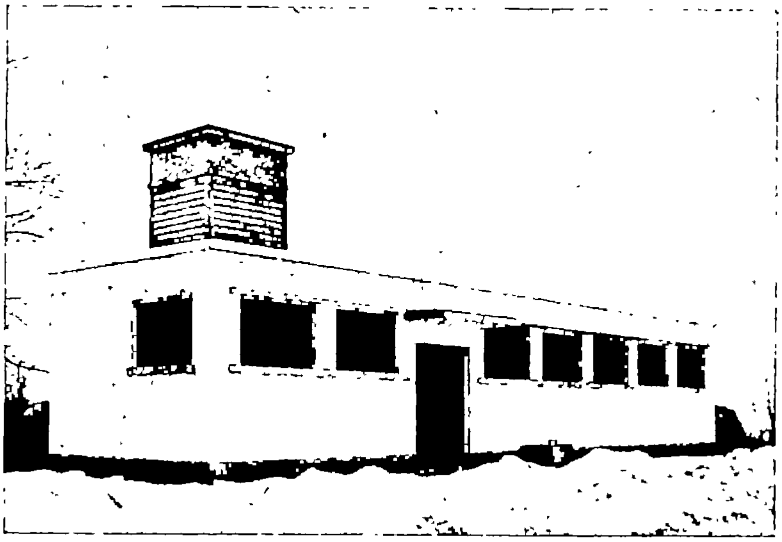

Fig. 1. The cosmic ray observatory at Ottawa (December 1950)

could be known and varied at will without interfering with building structures. Further, the increasing use of accelerators and radioactive material was putting serious limitations on the cosmic ray measurements that could be taken at the main laboratory headquarters of the National Research Council. A site was chosen well away from other buildings and located on high ground with a clear vista in all directions from the roof.

The building is essentially an observatory and has no space for the construction of apparatus. These facilities remain in the main laboratory, about four miles away. The observatory is, however, located in the same area as the aeronautical and mechanical engineering laboratories of the National Research Council, so supplies are readily available. There is also transportation every hour throughout the day each way from this area to the main laboratories.

The inside dimensions of the building are 50 ft. by 12 ft., and except for a small wash-room and dark-room at one end, the interior is not partitioned. It is one story high and has a flat roof, the roof being used for experimental purposes. An area on the roof, 6 ft. by 12 ft. at one end, is reinforced to carry heavy loads up to 10 tons. The rest of the roof is designed for 50 lb. per square foot, so that it can carry lighter equipment.

There is an opening in the roof six feet square over the centre of the laboratory space. This opening has a movable cover which in suitable weather may be left off, or at other times covered with light weather-proof material of known absorbing power. Experiments in which the exact quantity of absorber overhead must be known can, therefore, be carried out anywhere on the roof if the total weight is low, on the reinforced area if the weight is large, or in the laboratory below the opening. For work on the roof, which is carried out in all weathers, movable penthouses have been constructed. These are heated electrically and the temperature is controlled.

The floor of the laboratory is of hard wood laid on concrete. The concrete was poured on a rock fill about two feet thick lying on solid rock. The floor will, therefore, hold very heavy loads, and there is no hesitation in building a lead castle weighing several tons around measuring apparatus in any part of the laboratory.

The building and the furniture, with the exception of a desk and chairs, are of fire-proof construction, the floor and the window frames being the only wood in the structure. This fire-proof construction was followed because a considerable quantity of electronic and recording apparatus is left running continuously, and even with careful engineering it is possible that something may become overheated and start a fire. The building is left unattended for long periods, at night and over week-ends, and an attempt has been made to arrange all equipment which is operating continuously so that, should one component burn up when there is no one in attendance, it will do no more harm than put that piece of equipment out of order and make a certain amount of smoke. Fig. 1 shows a picture of the building from the front, and Fig. 2 is an inside view showing a rack of scalers and recording apparatus.

The plans for the equipment of the observatory included ionization chambers, Geiger–Muller counters with associated coincidence and anti-coincidence circuits, proportional counters and Wilson cloud chambers. Up to the present, there has been some specialization in Geiger–Muller counter work and ionization chambers. Wilson cloud chambers have not yet been used, but will be built in the near future. The facilities for the construction of apparatus in the National Research Laboratories are considerable, and all the apparatus except the Geiger–Müller

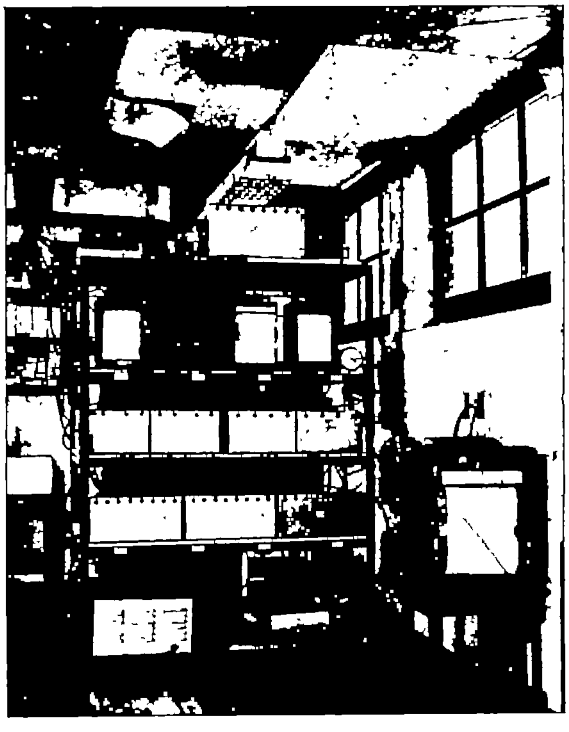

Fig. 2. Rack carrying scalers and recording equipment. The recorder at the right is a differential rate meter

tubes themselves and the recording instruments are constructed in the laboratories.

One of the important experiments is to keep a continuous watch for sudden increases in the cosmic ray intensity associated with solar flares, such as that observed on November 19, 1949[1]. Counter telescopes are used for these measurements. Another major investigation being undertaken with counter telescopes is a thorough study of north–south and east–west asymmetry in cosmic ray intensities. At high geomagnetic latitudes and particularly at large zenith angles, the north–south asymmetry is as prominent as the east–west differences, and both may be sensitive to geomagnetic disturbances.

Counters are also being used in a study just completed of the directional intensity of mesons and in another on the angular spread of penetrating showers. This latter experiment is being followed up by a study of the production of local penetrating showers in different materials. For this study, large quantities of absorbing materials of different atomic weight, namely, lead, copper, aluminium and carbon, have been obtained.

An attempt has been made to standardize some of the electronic equipment used in the observatory. Versatile equipment has been developed in such a way that any arrangement of counter trays in coincidence and anti-coincidence up to sixfold can be made just by plugging the components together and making simple adjustments of one set of bias voltages. Each counter tray has a simple preamplifier which also partially quenches the counter. (Self-quenching counter tubes are used, but the quenching circuit is believed to prolong the life of the counters.) This is followed by a cathode follower stage with a low impedance output, so that the signal may be carried twenty feet or more by cable. It then goes through a pulse-shaping and discriminating circuit ending in a pulse about three microseconds long. This pulse is then fed into mixing stages (up to three-fold) by adding the signals at the grid of the mixing pentode rather than by the more conventional Rossi circuit. For higher orders of coincidence, the output of a mixing stage may be fed to further mixing stages or a Rossi circuit.

From here it is fed to scaler circuits. The scaler circuits are all of the binary type, built in units of two stages, four stages, and eight stages. The output of the scalers will operate telephone message registers or one circuit of an Esterline Angus twenty-pen operations recorder or both in parallel. All the circuits have been designed for continuous operation, and quite complicated arrangements have often been operated for months without adjustment.

The observatory is now equipped with about forty scalers, and about thirty double- and triple-coincidence units, mixing units, units for higher order coincidence or anti-coincidence arrangements. Counter trays with their preamplifiers are usually made to fit experimental arrangements as required.

Besides the investigations mentioned above, an investigation is in hand on the range spectrum of mesons at this observatory both by coincidence and anti-coincidence arrangements of counters. Delayed coincidence in which the meson is detected by its decay electron is also used.

Proportional counters were used in an experiment designed to look for highly ionizing particles in cosmic rays at sea-level. The results were negative; but they produced an interesting study of the statistical variations in the production of ions along the path of an ionizing particle. Two large high-pressure ionization chambers have been constructed which are being used for continuous intensity measurements and a study of bursts. Both photographic recording with an electrometer and a vibrating reed electrometer are being used with these.

Associated with this observatory is a cosmic ray station in the Canadian Arctic (geomagnetic latitude 83·0° N.) at one of the joint Canadian–American weather stations. Continuous measurements have been taken for about two years, and during the 1950–51 winter, a programme of work there was undertaken in which an accurate comparison of intensities and the spectral distribution of mesons were made. At present a watch is being kept there for the sudden increases in intensity associated with solar flares.

The staff of the group normally consists of three physicists on the National Research Council staff and three technicians. There is room for three post-doctorate Fellows; these fellowships are offered by the National Research Council of Canada to students of Ph.D. standing who wish to work in Canada for a period before taking a permanent post.

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DETERMINATION OF THE ABSOLUTE CONFIGURATION OF OPTICALLY ACTIVE COMPOUNDS BY MEANS OF X-RAYS

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J. H. VAN 'T HOFF extended the structural formulæ of organic chemistry to include spatial configuration ("La chimie dans l'espace" (1874), the aliphatic carbon atom with hydrogen or other atoms at the corners of a tetrahedron surrounding it). X-ray analysis has determined the exact configurations and the interatomic distances accurately to within a hundredth of an angstrom unit.

Optically active compounds are not superimposable and are the inverted image of each other. Now it is a remarkable fact that while all details of such configurations can be determined, it yet remained unsolved, whether model or inversion corresponds with a given—say the dextrorotatory—compound. Our present investigation was concerned with this question.

It is impossible to determine absolute configurations by chemical means, which show only the relationship between different structures. These relationships would not alter in any respect if every optically active compound should possess its inverted configuration. Absolute configurations—introduced for the sake of expressing relationship—were based on mere convention. Emil Fischer attributed the configuration of Fig. 2*b* to natural, dextrorotatory, tartaric acid—with an even chance that this choice would fit the real situation.

Of the physical methods of determining absolute configuration, the theoretical calculation of the rotatory power is the most obvious and that most studied; hitherto, the results, however, have lacked conclusiveness. Recently, a discussion of the relation between crystal structure and face development has been put forward. As to the X-ray method, X-rays are not supposed to be able to determine absolute configuration as they measure the interatomic distances, which do not differ for model and inversion.

This condition may be illustrated by the simple schematic diffraction experiments indicated in Fig. 1. Compared with (*a*), the diffraction object in (*b*) has been inverted. The path (phase) differences for each pair of atoms involved in the same direction of diffraction (*p*) remains unchanged (except for sign); hence the resultant interference effect will be the same for both conditions. The removal of this equivalence is the essential point of the determination of absolute configuration by X-rays.

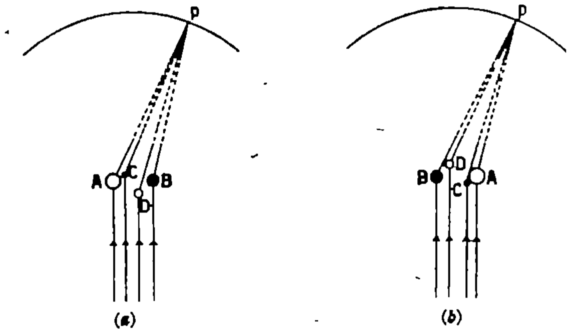

Fig. 1. Equal phase differences (except for sign) for model and inversion in the same direction of diffraction. By introducing a phase-lag in the scattering of one of the atoms, this equivalence is removed

A phase-lag can be introduced into the primary scattering process by one of the atoms[1], say atom *A*. This is achieved by using X-rays of a wave-length that just excites atom *A*. Again, for the conditions (*a*) and (*b*), compare the phase differences operative in the diffraction *p*. Consider the phase difference between the waves scattered by the atoms *A* and *B*. In (*a*) the characteristic phase-lag in the scattering of atom *A* is seen to be connected with the longer light path, in case (*b*) with the shorter. Hence, the total phase difference operative in the interference of the waves scattered by *A* and *B* will no longer be opposite, and the diffraction intensities will differ for these two conditions. (In the crystal diffraction, besides the inequality $I^a_{hkl} \neq I^b_{hkl}$ (*a* and *b* denoting the two optical antipodes) the following relation exists: $I^a_{hkl} = I^b_{\bar{h}\bar{k}\bar{l}}$. According to the latter relation, the films of optical antipodes do not differ in diffraction intensities, but only in their succession on Weissenberg diagrams with fixed rotation sense of the crystal.)

This difference of corresponding diffractions, which vanishes for X-rays of arbitrary wave-length, has been observed in the case of sodium rubidium tartrate using zirconium $K\alpha$ rays which just excite the rubidium atom[2]. It enabled us, analogous to the case discussed above, to decide between the diffracting model and its inversion. The result is that Emil Fischer's *convention*, which assigned the configuration of Fig. 2 to the dextrorotatory acid, *appears to answer to reality*.

Obviously, the agreement between conventional and real model then also embraces all compounds, the configurations of which—relative to tartaric acid—have been determined. Details are given in ref. 2 and in a forthcoming paper in *Acta Crystallographica*. (A preliminary account was given by one of the authors (J. M. B.) at a conference in Pennsylvania State College in April 1950.)

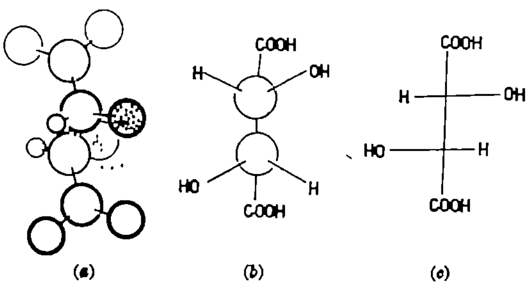

Fig. 2. Absolute configuration of natural dextrorotatory tartaric acid

a, As determined by X-rays in sodium rubidium tartrate.
b, In normalized configuration by rotating around single bonds.
c, In projection.

The question of nomenclature is beyond the scope of our investigation. Absolute configuration determined, the standard substance for which hitherto a configuration had to be assumed becomes a redundant concept. The problem of nomenclature now concerns given configurations, and requires a notation which denotes these configurations in an unambiguous and if possible self-explanatory way. The usual notations like D_g or L_s for dextrorotatory tartaric acid, based on chemical relations, seems rather unsatisfactory from the latter point of view. For a recent study of the problem reference should be made to the literature[3].

We wish to thank the Netherlands Organization for Pure Research (Z.W.O.) for its support of this investigation.

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BREEDING GROUND OF PILCHARDS OFF THE COAST OF SOUTH-WEST AFRICA

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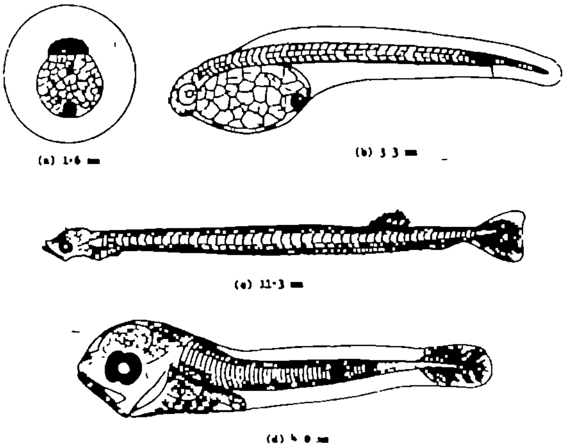
During the recent whale-marking voyage of the R.R.S. *William Scoresby* (Lieut.-Commander A. F. Macfie), notable concentrations were found of the eggs and larvæ of the pilchard (*Sardinops sagax*) off the coast of South-West Africa. In view of the large scale of the modern South African pilchard fishery, this indication of the breeding ground, hitherto unknown, is likely to be of considerable importance.

The R.R.S. *William Scoresby* is equipped for making oceanographical surveys, and it had been arranged that during her passages between whaling grounds in the Atlantic and Indian Oceans the



Early stages in the life-history of the pilchard, *Sardinops sagax* (Jenyns), and the stockfish, *Merluccius capensis* Castelnau, from South-West African waters · (*a*) developing egg, 1·6 mm. ; (*b*) a newly hatched larva, 3·3 mm. ; and (*c*) a post-larva of the pilchard, 11·3 mm.; (*d*) post-larva of the stockfish, 4·0 mm.

opportunity should be taken to make detailed studies of the plankton and water conditions in the Benguela Current. The main purpose was to obtain a closer understanding of the exceptional organic productivity of the region, and to compare its main features with those of the still more productive region in the Peru Current, for the investigation of which the same vessel was used in 1931 under the Discovery Committee. The work off the African coast was mainly between 19° and 29° S., and two surveys were made, in March and September 1950.

During the sorting of the material collected during the first survey, large catches of clupeoid eggs, larvæ and post-larvæ, have been noted, and they have been identified as belonging to *Sardinops sagax* (Jenyns) (see diagram). The preliminary examination gives a clear indication that spawning took place within twenty-five sea-miles of the coast in depths of 50–150 metres throughout the area surveyed, but mainly between 22° and 26° S. A few post-larvæ were taken in deeper net-hauls, but none in the deeper, warmer water outside the continental shelf. The eggs were found where the mean temperatures of the upper 50 m. of water were less than 17·5° C., the heaviest catches being made where the mean temperature was between 13° and 14·5° C. This suggests a close parallel between the spawning temperature of this species and the limits established for the California pilchard (*S. cœruleus*), for which the inclusive temperature range was found to be 12·5°–16·5° C. The season (early autumn) in which the South African pilchard was found to be spawning is not remarkable, since closely related clupeoid fishes in Australian and European waters spawn at opposite seasons near the extremes of their geographical distributions. Information about the spawning in other seasons off the African coast is limited to the R.R.S. *William Scoresby's* second survey (spring), and the preliminary examination of the catches indicates that very little spawning had taken place and only at two stations close inshore.

A quantitative comparison between the abundance of eggs and larval stages taken off the African coast with observations on related species in other regions is rather uncertain, because of the difference and variability of the filtering power of the nets and sampling procedures that have been used; but a conservative estimate suggests that the richest hauls off the African coast in early autumn represent spawning concentrations considerably greater than those reported in European and Californian waters. It seems probable, therefore, that the spawning of *S. sagax* may have been near its climax in early autumn.

During the sorting of the plankton collections, some association was noted between the occurrence of the pilchard eggs and the increasing abundance of *Fragilaria* ribbons among the diatoms; also with the occurrence of *Cladocera* among the smaller crustaceans and of polychæte and lamellibranch post-larvæ. But these features are part of the increasingly neritic facies of the community as land is approached, and are apparent at other seasons. The catches of Cumacea (mainly *Iphinoe* sp.) corresponded very closely with the pilchard egg numbers, and these particularly, being comparatively large and easily recognized, might prove to be useful pointers to the presence of pilchard eggs.

The eggs and young stages of other commercially important fishes were taken, particularly of the stockfish (*Merluccius capensis*), which is very like the European hake. Since ripe and running stockfish were trawled in early autumn, it is not surprising that larvæ and post-larvæ were taken during this season (see drawings), but they also formed part of the spring plankton. Evidently the spawning season is prolonged, as with other members of this genus.

The material is not yet completely sorted, and it is likely to be some time before its implications are fully understood and a detailed account prepared.

NEWS and VIEWS

Presidency of the British Association, 1952: Prof. A. V. Hill, C.H., F.R.S.

The election of Prof. A. V. Hill to the presidency for 1952 of the British Association for the Advancement of Science, in succession to H.R.H. the Duke of Edinburgh, is timely in view of the fact that at the end of this year Prof. Hill resigns from the Foulerton professorship of the Royal Society—a chair which he has held with such distinction since 1926. Prof. Hill was Brackenbury professor of physiology in the University of Manchester during 1920–23, after which he was appointed Jodrell professor of physiology in University College, London. In 1926 he became Foulerton professor of the Royal Society, working at University College. When, in 1926, he ceased to be Jodrell professor in University College, the University of London appointed him honorary professor. His honorary professorship also expires at the end of this year under the age-limit, and the University has now conferred upon him the title of emeritus professor. Prof. Hill intends to continue his researches at University College, London, accommodation having been placed at his disposal through the courtesy of Prof. G. L. Brown, the present Jodrell professor. Also at the end of this year, the Biophysics Research Unit at University College, of which Prof. Hill has been such a distinguished head and which hitherto was financed by the Royal Society and the Rockefeller

Foundation, will come under the financial charge of the College and will be raised to the status of a Department, with Dr. B. Katz, at present reader in experimental physiology, as professor.

Prof. Hill was awarded the Nobel Prize for Physiology and Medicine in 1922, and the Copley Medal of the Royal Society in 1948. During 1935–45 he was a secretary of the Royal Society and during 1945–46 he was the Society's foreign secretary. This is not the place to deal with Prof. Hill's world-famed researches in physiology, especially biophysics, or to chronicle his many activities in connexion with scientific advancement and education, except perhaps to mention that he was member of Parliament representing the University of Cambridge during 1940–45.

Endeavour Prizes at the British Association

On August 9 at the British Association meeting in Edinburgh, H.R.H. the Duke of Edinburgh presented prizes to the winners in a scientific essay competition for young scientific workers less than twenty-five years of age. This was the second year of the competition, which was sponsored by *Endeavour*, a quarterly review of science published by Imperial Chemical Industries, Ltd. Altogether seventy-six essays were submitted, and the prize-winners (their ages shown in brackets) were as follows: *First Prize of Fifty Guineas*, B. C. Kilkenny (23), of Beaumont College, Old Windsor and New College, Oxford, and now a research student in the Physical Chemical Laboratory, Oxford, for an essay on "Biological Effects of Radiation"; *Second Prize of Twenty-Five Guineas*, J. H. Pantin (21) (the son of Dr. C. E. A. Pantin, president this year of the Zoology Section of the British Association), of Oriel College, Oxford, for an essay on "Animal Locomotion"; *Third Prize of Ten Guineas*, P. G. Garner (24), of Cambridgeshire High School for Boys and King's College, London, and now a research student in physical chemistry at King's College, for an essay on "Chromatography and its Possibilities"; *Special Prize of Five Guineas* (for a competitor under eighteen years of age), M. J. Sheridan (17), of Hornsey County School, for an essay on "Seaweeds and their Uses".

Use of Fuel and Power Resources

Mr. P. J. Noel-Baker, Minister of Fuel and Power, has appointed a committee to consider the use of resources of fuel and power in Great Britain. The terms of reference are: "In view of the growing demands for all forms of fuel and power arising from full employment and the rearmament programme, to consider whether any further steps can be taken to promote the best use of our fuel and power resources, having regard to present and prospective requirements and in the light of technical developments". The membership of the committee is as follows: Viscount Ridley, member of the former Fuel and Power Advisory Council (*chairman*); Mr. Lincoln Evans, general secretary of the Iron and Steel Trades Confederation; Mr. N. W. Gardiner, technical director of Huntley and Palmers, Ltd.; Sir Claude Gibb, chairman and managing director of C. A. Parsons and Co., Ltd.; Prof. W. R. Hawthorne, professor of applied thermodynamics, University of Cambridge; Prof. W. A. Lewis, professor of political economy, University of Manchester; Mrs. M. Mackintosh, tutor in sociology at Bedford College, University of London; and Miss M. R. Schofield, housing manager of Stoke Newington Borough Council.

I. G. Farben Central Laboratory Index

Technical information about chemical products marketed under trade names in Europe and America is available at the Technical Information and Documents Unit, Department of Scientific and Industrial Research, Lacon House, Theobalds Road, W.C.1. The information is contained in twenty-nine reels of microfilm and is a photographic facsimile of the I. G. Farben Central Laboratory Index. The index appears to have been compiled during the years 1933–43, although a few additional notes are dated 1946, and it comprises more than 57,000 cards. The information is given in alphabetical order under trade names and includes the chemical name of each product or its analysis, and its constitution and application. In addition, information about patents and literature reference is given. Most of the entries refer to dyestuffs, but the index also covers resins, plastics, detergents, wetting agents, waterproofing and emulsifying agents, textile assistants, rubber accelerators, cellulose esters, synthetic rubber, oil additives, tannins, insecticides, solvents, pharmaceutical products and other commodities. The index can be inspected at the Technical Information and Documents Unit (Chancery 4411) by appointment and no charge is made for inspection. Photo copies of entries may be ordered and purchased.

Odours of Minerals

An informative article on "The Odours of Minerals", by Dr. W. McCartney, has appeared in *The International Perfumer* (No. 3, 1951, pp. 7–10). The odours attributed to some solid bodies, which, having negligible vapour pressures, might be expected to be entirely odourless, are by no means imaginary, and have attracted attention since as early as 1798, when Fourcroy discussed the odours of metals. Later, in 1898, a study of the odours of a number of metals was described by Ayrton at a meeting of the British Association at Bristol; he concluded that the odours were not those of the metals themselves but of impurities and substances produced, for example, by human breath and perspiration. Later work has substantiated Ayrton's conclusions, and has demonstrated that metal surfaces can adsorb and tenaciously retain traces of organic compounds such as mercaptans and thio-ethers. Another aspect of the same phenomenon concerns natural minerals. The odours emitted on striking white pebbles and other minerals such as quartz, agate and flint have been found to be caused by organic impurities. These impurities may be present as bituminous inclusions or may be derived from dust, lichens, moss or algæ, or from earth or mud; but contamination by organic matter, imparted by contact with human hands, is one of the chief causes of such odours. Brief contact with human skin imparts this property; the impurity is very tenaciously retained, and can only be removed by such drastic treatment as ignition at a dull red heat; washing with alkali or brushing seem to be ineffective. Other types of mineral odours, the odours sometimes noticed by mountaineers in the neighbourhood of landslides and avalanches, may be caused by the frictional heating of rock matter containing traces of pyrites or vegetable matter.

Eelworm Pests of Mushrooms

A paper, "Eelworms (Nematodes) as Pests of Mushrooms", by Charles A. Thomas and George H. Mitchell, is reprinted in Bull. No. 22 of the Mushroom

Growers' Association (January 1951; obtainable from the Association at Yaxley, Peterborough; 5*s*.). It describes how eelworms belonging to the groups *Ditylenchus* and *Rhabditis* may damage mushroom beds by the destruction of mycelium, leaving bare patches, and by the distribution of disease-producing bacteria. They may be carried to the beds initially on the casing soil, but also persist between crops upon the bed boards. Satisfactory control has been obtained by heating the houses uniformly, after filling, to 140° F. for a day or more. Steaming the house for several hours after the temperature begins to fall helps with the sterilization of boarding. The temperature should not reach 150° F. or moulds may bring another kind of damage. Formaldehyde treatment is ineffective as a control, and chloropicrin has given variable results.

Prehistoric Cave Paintings in South Africa

The March issue of the *South African Archæological Bulletin* contains an article by J. R. Harding on his investigations at a rock-shelter site about six miles to the east of Bethlehem, Orange Free State. Some poor paintings occur, the most recent apparently being the figure of a Bush woman. The industries excavated range from Smithfield *C* without pottery to levels where pottery appears, to a latest Smithfield *C* with strong Bantu influence, with even some evidence of true Bushman occupation. It seems scarcely likely that any of the paintings are older than the industries unearthed, and none of these can be assigned to a very remote period. The paintings themselves are poor specimens and not well drawn.

Entomological Testing Methods

In 1948, the Entomology Subcommittee of the Chemical – Biological Coordination Center, U.S. National Research Council, obtained information on insecticide-testing from numerous laboratories and the results were distributed to participants. The Subcommittee planned to continue this successful survey. Recently, after discussions with the American Association of Economic Entomologists and others, it was decided that a book on testing methods in entomology would be more useful and, in April 1951, Dr. Harold H. Shepard, U.S. Department of Agriculture, was appointed editor. The book will include toxicological and screening methods used by entomologists in the United States and other countries and will contain descriptions of methods detailed enough to permit them to be duplicated. It will be published by the National Research Council and sold at cost price. Those who wish to participate in this project by furnishing descriptions of the test methods which they use should apply for forms to Dr. Raimon L. Beard, Chairman, Entomology Subcommittee, Chemical–Biological Coordination Center, National Research Council, 2101 Constitution Avenue, Washington 25, D.C.

Cartography of the Antarctic

Recent American and Norwegian work, as well as the discoveries of the German Swabenland expedition in 1939, are incorporated in a new map of the Antarctic by H. P. Kosack in *Petermanns Mitteilungen* (95, No. 2; 1951). The map, which is in blue and brown, is on a scale of 1 : 11,250,000, and shows surface and bathymetrical relief in 1,000-m. form lines. Notes in the margin give the location of the British, Argentine, Chilean and French stations. Names in the main follow the English usage; but there are many new German names in New Swabenland and American names in Marie Byrd Land and in the Ellsworth plateau. Accompanying this map is one on the scale of 1 : 4,000,000 of New Swabenland and adjoining territories between Coats Land and Princess Ragnhild Coast. A full and critical list of cartographical sources is given. Another article in the same number of this German publication, "Zur Frage der Namengebung in der Antarktis", by Dr. J. Georgi, gives the sources of German names in the Antarctic map with a full list of such names. This is most useful and should be done for all names in the Antarctic before there are no members left of the various expeditions who can supply the information. Already the origin of several German names of the 'nineties are untraceable.

The Chillingham Cattle

For thirty years prior to 1947 the strength of the famous herd of cattle in the park at Chillingham Castle in Northumberland had been fairly constant at about 35–40 head. After the severe winter of 1947, thirteen survived, of which eight were cows, five were bulls and none was young. For eighteen months or so no calf was born, and it was feared that the king bull might have become infertile; it was thought that this bull would have to be destroyed to save the herd from extinction. Fortunately, two bull calves arrived and, later, four heifers. The herd now consists of three bulls, seven cows, two bull calves and four heifer cows and now seems to be re-establishing itself. To help in the preservation of this valuable herd, which has almost certainly been at Chillingham Park since 1240, in 1939 an Association was formed. Those who wish to view the herd and apply for membership of the Association should write to the Secretary, Chillingham Wild Cattle Association, Ltd., Estate Office, Chillingham, Alnwick, Northumberland, for further information.

World Metallurgical Congress

A World Metallurgical Congress will be held in Detroit, Michigan, during October 14–19. It is expected that more than five hundred individuals from some twenty different countries will attend, in addition to American metallurgists. The Congress has the full support of the Economic Cooperation Administration of Washington, D.C. A technical assistance programme covering visitors from E.C.A. countries has been established at the request of the Organization for European Economic Cooperation. Foreign visitors are expected to arrive about September 15 and will spend approximately five weeks in the United States. During the first four, they will be divided into eight groups participating in a series of study tours to industrial, government and educational institutions to observe at first hand the scientific, industrial and educational advances that have taken place in the United States during the past few years. Dr. Zay Jeffries, of Pittsfield, Mass., retired vice-president of the General Electric Company, and a past president of the American Society for Metals, has been appointed director general of the Congress. Early in the Congress a comprehensive summary of raw materials of the world as they relate to the metal industry will be presented. Visiting authorities from various countries will discuss problems of conservation, utilization and substitution of strategic metals. The industrial study tours planned in connexion with the Congress are being arranged in eight categories of the metal industry: steel-making and refining; non-ferrous refining, rolling and fabrication (copper, brass, bronze, aluminium, magnesium); ferrous rolling, forging and hot work in steel mills and heavy industry; stamping, cold work, machining and finishing in lighter industry; heat treatment; welding and joining; inspection and testing; and research, engineering societies and universities. Information concerning the World Metallurgical Congress can be obtained from the Secretary, American Society of Metals, 7301 Euclid Avenue, Cleveland, Ohio.

Symposium at Delft on Abrasion and Wear

A symposium on abrasion and wear, organized by Rubber-Stichting on the occasion of the opening of a new building at Delft, will be held during November 14–15. The first day will be devoted to general aspects of the subject, including problems connected with friction and lubrication, and the second day to the applied side, that is, the abrasion and wear of metals, plastics, rubber and other materials. The symposium will be international in scope, in that a number of foreign workers will be participating, some of whom will be reading papers; the official languages of the symposium will be English and French. In conjunction with the meeting an exhibition of apparatus for measuring abrasion and wear has been arranged. Admittance to the symposium will be free. Further details can be obtained from the secretary of the organizing committee, Dr. H. C. J. de Decker, c/o Rubber-Stichting, P.O. Box 66, Delft.

Colonial Service Appointments

The following appointments in the Colonial Service have recently been announced: A. K. Briant (senior agricultural officer, Zanzibar), director of agriculture, Zanzibar; J. W. D. Goodban (agricultural officer, Nigeria), director of agriculture, British Honduras; C. E. Johnson (agricultural officer, Northern Rhodesia), chief agricultural officer, Northern Rhodesia; C. J. MacK. Krige (senior agricultural officer, Northern Rhodesia), chief agricultural officer, Northern Rhodesia; J. Wright, whose appointment as assistant director of agriculture, Nigeria, was previously announced, re-transferred to his former post of deputy director of agriculture, Jamaica; M. E. Dommen (senior assistant conservator of forests, Nigeria), conservator of forests, Nigeria; W. Crocker (senior assistant, Department of Agriculture, Sarawak), assistant agricultural officer, Sarawak; R. A. Sutton (chemist, Government Chemist Department, Tanganyika), geo-chemist, Geological Survey Department, Tanganyika; F. B. Brown, agricultural officer, Federation of Malaya; C. Purvis, geneticist, Oil Palm Research Station, Nigeria; L. P. Adams, staff surveyor, Kenya; Lieut.-Colonel J. D. Daly, veterinary officer, Federation of Malaya; Dr. R. A. Webb, soil scientist, Gambia.

Announcements

Lord Bruce of Melbourne, formerly Australian High Commissioner in London, has been elected the first chancellor of the Australian National University, Canberra.

Dr. E. U. Condon, director of the U.S. National Bureau of Standards, is resigning as from September 30. It is reported that Dr. Condon is to join the Corning Glass Company as a technical director.

Prof. N. V. Sidgwick, formerly professor of and reader in chemistry in the University of Oxford, has been elected an honorary life member of the Faraday Society in recognition of his outstanding services to physical chemistry and to the Society.

Sir Archibald Gill, engineer-in-chief of the Post Office, is to retire on October 1; he will be succeeded by Dr. W. G. Radley, who is at present a deputy engineer-in-chief.

Mr. E. K. Inall, who until recently was a member of the research staff of Associated Electrical Industries, Ltd., Aldermaston Court, Berks, has been appointed a Research Fellow of the Australian National University, Canberra. He will work in the Department of Nuclear Physics under the direction of Prof. E. W. Titterton.

In order to ensure that the fullest use is made, in the interests of the aircraft industry in Great Britain, of all published scientific and technical information concerning aeronautics, Aslib is establishing an Aeronautical Information Study Group, the inaugural meeting of which is to be held on September 27 at the Royal Aircraft Establishment, South Farnborough, Hants. All those interested in the formation of such a Group should write, not later than September 10, to Mr. Leslie Wilson, director of Aslib, at 4 Palace Gate, London, W.8.

The Research Fund of the Chemical Society provides grants for the assistance of research in all branches of chemistry. About £700 per annum is available, the income being derived from a donation of the Worshipful Company of Goldsmiths, from the Perkin Memorial Fund, and from other sources. Applications for grants will be considered in November next and should be submitted on the appropriate form, to be obtained from the General Secretary, Chemical Society, Burlington House, Piccadilly, London, W.1, not later than November 1, 1951.

The fifth congress of the International Scientific Film Association will be held in the Municipal Museum, The Hague, during September 15–22. At the congress the general assembly of the Association will take place, together with meetings of the permanent committees dealing with medical, research, technical and industrial films, as well as a Festival of Scientific Films. Further information can be obtained from the Secretary, Scientific Film Association, 4 Great Russell Street, London, W.C.1.

The following lectures of the Royal Aeronautical Society have recently been announced. The thirty-ninth Wilbur Wright Memorial Lecture will be given by A. E. Raymond, of the Douglas Aircraft Corporation, California, at 6 p.m. on September 10 at the Royal Institution, 21 Albemarle Street, London, W.1, his subject being "The Well-Tempered Aircraft". The seventh British Commonwealth and Empire Lecture will be given by Air Vice-Marshal Sir L. M. Isitt, of New Zealand, at 6 p.m. on October 4 at the Institution of Civil Engineers, Great George Street, London, S.W.1, his subject being "Air Transport in New Zealand and the South Pacific". Further details can be obtained from the secretary of the Society, A. M. Ballantyne, at 4 Hamilton Place, London, W.1.

Erratum.—In *Nature* of June 30, p. 1060, it is stated that the chairmen of the four Groups of the Physical Society are for the period 1950–51; this should read 1951–52. Further, the chairman of the Colour Group for this period is Dr. T. Vickerstaff.

College of Science PHYSICS Dept.

THERMAL CONDUCTIVITY OF DIELECTRIC CRYSTALS: THE 'UMKLAPP' PROCESS

By Dr. R. BERMAN, Prof. F. E. SIMON, C.B.E., F.R.S., and Dr. J. WILKS
Clarendon Laboratory, Oxford

BECAUSE of the experimental difficulties in obtaining temperatures over the whole range below 100° K., measurements on thermal conductivity have not hitherto been sufficiently extensive to reveal all the characteristics of the conductivity/temperature relationship. We have recently measured the thermal conductivities of several very different dielectric crystals over a wide range of temperatures: Fig. 1 shows the conductivities of single crystals of quartz, sapphire[1], and diamond[2], and Fig. 2 gives values for crystals of solid helium at different densities measured over a smaller temperature range[3]. (We may note that our results on diamond, made on a large, well-cut specimen, confirm Eucken's belief that his own results[4] were unreliable.) It can be seen that all the crystals referred to in Fig. 1 behave similarly and all have a pronounced maximum; more recent measurements have shown that there is also a maximum in the curves for helium at lower temperatures. These results suggest that the thermal conductivities of all pure dielectric crystals behave in the same general way and enable us to discuss the underlying internal processes.

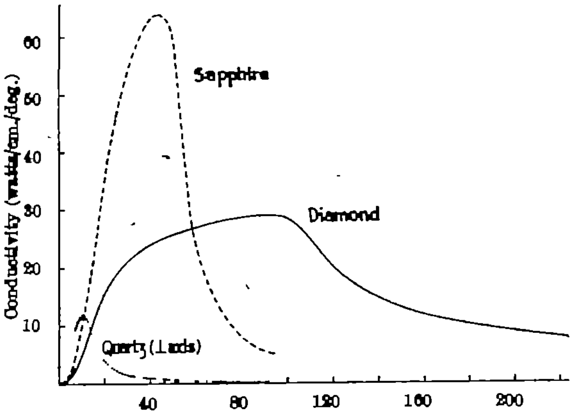


Fig. 1. Thermal conductivities of quartz, synthetic sapphire and diamond

Some years ago, de Haas and Biermasz[5] made measurements on crystals of quartz, potassium chloride and potassium bromide at low temperatures, and together with Casimir[6] demonstrated that in the region where the conductivity falls with temperature the flow of thermal energy is limited by its being scattered at the walls of the crystal. This is the so-called 'size effect' which results in the measured thermal conductivity becoming proportional to the smallest dimension of the specimen and to the cube of the absolute temperature. As a result of this discovery, attention was directed away from the region where the conductivity rises as the temperature falls, and no systematic measurements were made there. While the present results give some additional data on size-effect phenomena, which will be published elsewhere, their main interest is in throwing some light on the intrinsic properties of bulk crystals.

The foundations of all discussions on thermal conductivity were laid down by Debye[7], who treated the atomic vibrations of a solid as an assembly of elastic waves in a continuum. He derived the general formula for conductivity:

$$\kappa = \tfrac{1}{3}lCv, \tag{1}$$

where v is the group velocity of the waves (the velocity of sound) and C the thermal capacity per unit volume. The remaining quantity, l, the mean free path, is the distance which the waves travel before being attenuated by a factor e. He showed that this expression leads to the observed relation $\kappa \propto 1/T$ when the temperature is high enough for C to be taken as constant; but it gives no explanation of the behaviour at lower temperatures.

Later, Peierls[8] treated a crystal as a lattice rather than as a continuum; at high temperatures his theory also predicts that the thermal conductivity varies as $1/T$; but at low temperatures it leads to a relation of the form $\kappa = QT^{\nu}\exp(\theta/2T)$, where Q is some constant, ν is of order unity and θ is the Debye specific heat parameter. (Provided that the conductivity is not limited by size effect, this implies that it should approach infinity at absolute zero.) As the processes responsible for the form of this law are not widely understood, it may be useful to discuss them in some detail.

In a large pure crystal free from impurities, cracks and strains in its structure, the scattering of thermal waves will only be caused by collisions between the waves themselves. Peierls treated these by quantizing the sound waves into quanta of vibration or phonons

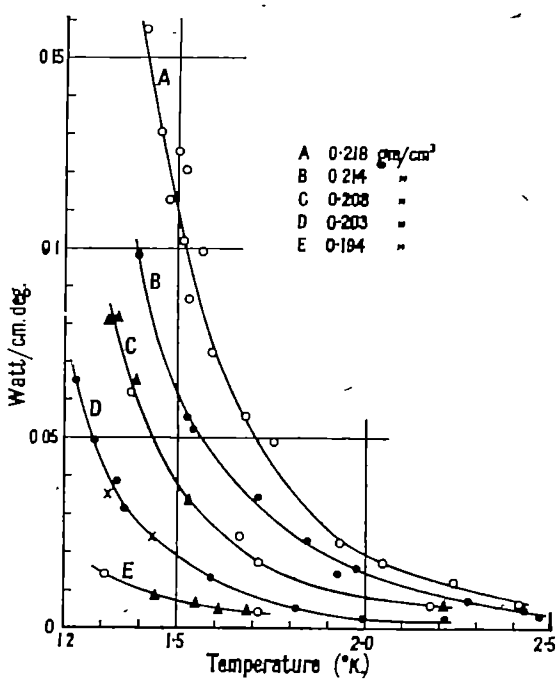


Fig. 2. Thermal conductivity of solid helium at constant density

and then finding the conditions for the phonons to interact. It turns out that the only collisions of importance are three-phonon processes in which two phonons coalesce to give one, or one splits up to give two. Such collisions are shown to be possible if:

$$\omega_1 + \omega_2 = \omega_3, \tag{2}$$

$$\bar{K}_1 + \bar{K}_2 = \bar{K}_3, \tag{3}$$

where the ω's are the angular frequencies and the $\bar{K}$'s the wave numbers associated with the phonons. These conditions correspond to the conservation laws for energy and momentum. Equation (2) states that after a collision the resulting wave or waves are still carrying as much energy as before, while equation (3) implies that this energy is still flowing in the same direction. Hence, no impedance to the flow of energy is introduced by these collisions; that is, they do not give rise to any thermal resistance.

Peierls also showed that collisions are possible if

$$\omega_1 + \omega_2 = \omega_3, \tag{2}$$

$$\bar{K}_1 + \bar{K}_2 = \bar{K}_3 + \frac{2\pi\bar{\varepsilon}}{a}, \tag{4}$$

where a is the lattice constant and $\bar{\varepsilon}$ is a unit vector which can take up any one of six orientations parallel to the axes of the crystal (for simplicity Peierls treats a cubic lattice). To put it colloquially, equation (4) means that for some collisions between phonons 'momentum is not conserved'. More precisely, we can say that though equation (2) implies that there is no energy change resulting from collision, equation (4) states that the direction of flow of this energy will be altered. Although there is some correlation between the initial and final directions of flow (as given by equation (4)), $\bar{\varepsilon}$ can take up any one of six directions, so that the final result is much the same as if the waves were scattered at random. Hence such collisions will impede the flow of energy and give rise to a thermal resistance.

Peierls has named this type of collision an 'Umklapp' process, which can perhaps best be translated as a 'flap-over' process; at a collision the wave number vector 'flaps over' and takes up a new position. Umklapp processes, or U-processes, result from the periodicity of the lattice: they would not occur, for example, in a continuum. They come about because of the possibility of interference effects between the phonons and the lattice by which the lattice can transfer momentum between itself and the phonons. It is as if phonons can suffer Bragg reflexions from the lattice; and equation (4) may be taken to mean that because the lattice is perturbed by the mode $\bar{K}_2$, conditions are favourable for the phonon $\bar{K}_1$ to suffer Bragg reflexion into the phonon $\bar{K}_3$.

If a U-process is to take place at all, we see from (4) that

$$\bar{K}_1 + \bar{K}_2 > \frac{2\pi\bar{\varepsilon}}{a}.$$

This implies that phonons must have a certain minimum energy before they can 'umklapp', and Peierls shows that, as a rough criterion, this minimum energy may be taken as $k\theta/2$, where k is Boltzmann's constant. Hence the probability of U-collisions will contain the term $\exp(-\theta/2T)$; and when T is small the variation of this exponential term will mask any temperature-dependent term of the form T^{r}.

Although Peierls derives the thermal conductivity without using the concept of mean free path, it seems a convenient parameter with which to characterize a given scattering process. Therefore we introduce λ, which we define as the mean distance travelled by phonons between collisions which produce scattering. Since the waves in Debye's theory have now been replaced by quanta, we rewrite equation (1) as

$$\kappa = \tfrac{1}{3}\lambda C v \tag{5}$$

by analogy with the kinetic theory of gases. In particular, for single crystals free from impurities, cracks and mosaic structure, the mean free path is limited only by U-collisions, so that:

$$\kappa = \tfrac{1}{3}\lambda_U C v, \tag{6}$$

where λ_U is the mean free path for U-collisions. It is, of course, important to note that this concept of mean free path is a more complex one than that met with in gas kinetics, because the probability of U-processes depends on the polarization of the colliding phonons as well as on their energy.

Values of λ_U for several crystals, including solid helium, have been calculated from equation (6) by using the measured values of the thermal conductivity and specific heat; the values of the velocity of sound are derived from the corresponding specific heat by Debye's theory. Fig. 3 shows these values plotted against θ/T for artificial sapphire, diamond and solid helium, θ being obtained from specific heat measurements. It is clear that to a fair approximation, over a considerable range, we may write

$$\lambda_U = A\exp(\theta/bT), \tag{7}$$

where A is a constant depending on the crystal and b has a value slightly greater than 2 (2·3 for helium, 2·7 for diamond, 2·1 for sapphire). The fact that we obtain this relation both supports Peierls' theory and also suggests that any thermal resistance due to imperfections in the crystals is small compared with the resistance due to U-processes. Unfortunately, it is not possible to calculate the values of A to be expected on Peierls' theory.

The measurements which have been made on crystals of solid helium are of particular interest as the density of the helium can be changed considerably by using quite moderate pressures, and this makes a very big difference to the thermal conductivity. Although the conductivities at different densities differ greatly (Fig. 2), values of λ_U which have been calculated at temperature intervals of 0·1° for all five densities lie approximately on the same curve. Thus, in helium the number of U-collisions is primarily a function only of θ/T.

We may note here that exact agreement with Peierls' theory cannot be expected, because the behaviour of real crystals only approximates to that of Debye-type models. For example, the specific heat of solid helium at these low temperatures does not vary exactly as T^3, and so there is no unique value of θ corresponding to each density. The values of θ used in Fig. 3 were obtained from the known specific heat by using Debye's formula $C = 464\,(T/\theta)^3$ cal./gm. atom/degree. This is certainly justifiable as a first approximation, since the variation in θ due to the density changes is about ten times as great as the variations due to the temperature changes. The position with sapphire and quartz is also complicated, because these have two or more atoms of different

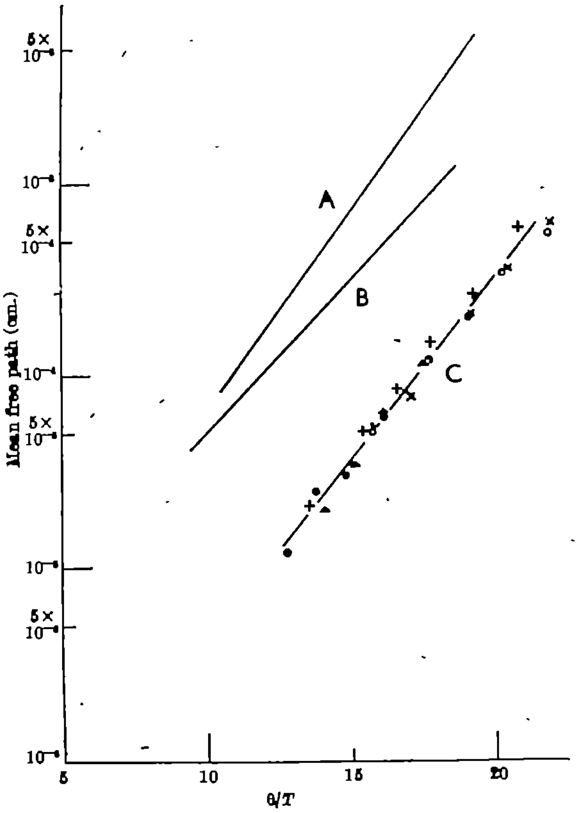


Fig. 3. Mean free path for U-collisions as a function of θ/T. A: synthetic sapphire ($\theta \simeq 980$); B: diamond ($\theta \simeq 1{,}840$); C: solid helium (θ, 28–35). For solid helium the densities are 0·218 (×); 0·214 (○); 0·208 (+); 0·203 (▲); 0·194 (●) gm./cm.^{3}

mass in the unit cell and so again they cannot conform to Debye's theory. Quartz, too, is difficult to treat, as the crystal is strongly anisotropic and the conductivities in directions along, and perpendicular to, the axis differ by a factor of about 2; so quartz has not been included in Fig. 3. Even so, the general behaviour of these thermal conductivities is similar to that in other crystals, as may be seen from Fig. 1.

The picture we have presented so far has to some extent been over-simplified; for example, Peierls[8] pointed out that phonons corresponding to transverse and longitudinal waves behave differently in collision processes. Klemens[9] has recently treated the statistical equilibrium of phonons and shown that it is also necessary to consider collisions which conserve momentum because, while they do not contribute directly to the thermal resistance, they may change the polarization of a phonon and thus render it more susceptible to a U-collision. He derives an expression for the thermal conductivity which is of the same form as Peierls' expression, save that he gives $\nu = 1$. As the term $\exp(\theta/bT)$ is very sensitive to the value of b, it is unfortunately impossible to verify that the power of T in the equation is really 1 and not, say, 2 or zero, particularly as none of the crystals is theoretically ideal. Obviously it would be desirable to make more measurements on crystals with a simple structure; but in practice there are not many suitable crystals available, particularly as the conductivity of ionic crystals is very sensitive to the effect of scattering by impurities, which would mask U-type collisions.

It is interesting to note that for each crystal the maximum in the thermal conductivity occurs at a temperature of about $\theta/20$. At first sight this maximum might be expected where λ_U first becomes limited by the size of the crystal. As the specimens were in the form of rods a few millimetres in diameter, this criterion gives $\lambda \sim 0{\cdot}1$ cm. Therefore, since λ_U is given primarily by θ/T, it is to be expected that the maximum would occur at a particular value of this parameter. Although we find this to be so, the value of the mean free path calculated by substituting the value of the maximum conductivity into equation (5) is an order of magnitude less than the size of the crystals. Klemens, in his more detailed treatment[9], has shown that in the region near the maximum where both U-processes and scattering by the walls play an appreciable part, some such effect is to be expected; but it does not appear sufficient to account for the large reduction in mean free path which is observed.

There is, in addition, the possibility that the mean free path may also be limited by departures from complete regularity in the crystal lattice[10]; the effect of one particular form of mosaic structure has been treated by Pomeranchuk[11]. It seems that it would introduce a thermal resistance which would again account for the reduction of the conductivity near the maximum, so that not until the lowest temperatures, where even this resistance is negligible, should the mean free path become comparable with the smallest dimension of the crystal. This is in agreement with our experiments and those of de Haas and Biermasz. We may note that this reduction in the magnitude of the mean free path near the maximum does not have much effect on the position of the maximum, as λ_U varies very rapidly in this neighbourhood. In particular, the very flat top on the curve for diamond suggests that some such process as this may be taking place.

Values of λ_U for high temperatures are not given in Fig. 3, because the exponential is not varying so rapidly in this region and, owing to the other temperature-dependent terms derived by a more detailed treatment, the simple relation (7) no longer holds. Those measurements which we have made at higher temperatures ($\theta/T < 10$) suggest that, at very high temperatures ($\theta/T \rightarrow 0$), λ_U tends to a value of a few angstroms, a distance of the order of the atomic spacing. This is in agreement with other work done at relatively high temperatures. For example, in potassium chloride[12], one of several substances for which data on single crystals are available, we find that the mean free path at 0° C. ($\theta/T = 0{\cdot}8$) is only a small number of lattice spacings.

Over the range of θ/T between 10 and the maximum, we may write $\lambda_U = A\exp(\theta/bT)$, where A varies from 6×10^{-8} cm. for solid helium to $1{\cdot}4 \times 10^{-6}$ cm. for diamond. In order to relate the constant A to some property of the crystal, we recall (Debye[7], Peierls[8]) that if the forces between the atoms in a crystal were perfectly harmonic, there would be no interactions between the various modes of vibration (that is, no collisions between phonons); thermal equilibrium could never be established and it would be impossible to define a thermal conductivity. Interactions between modes, or collisions of phonons, are only possible if the forces are anharmonic, and it is reasonable to suppose that the greater the anharmonicity the greater the number of collisions. Of course, once collisions occur, their temperature-dependence includes the exponential term; but their absolute number is given by A and must depend in some way on the anharmonicity of the inter-atomic forces. In principle, it is possible to derive A by perturbation theory from the anharmonicity as measured by the second pressure derivative in the equation of state; for example, a solution of a comparatively simple problem of this type has been given by Van Vleck[13]. Unfortunately, the difficulties of solving the relevant equations for the general problem of thermal conductivity appear to be very great; also it would not be easy to get the necessary experimental data for crystals as hard as sapphire. The density of helium, however, may be changed quite easily, and we hope that it may be possible to correlate its thermal conductivity with measurements on its compressibility.

To sum up, we may say that the thermal conductivities of pure dielectric crystals follow a common pattern. At sufficiently high temperatures they vary as $1/T$; then at lower temperatures the conductivities increase more rapidly until they are limited by size effect and fall off towards zero. The shape of the conductivity/temperature curve is to a fair approximation determined only by θ, the specific heat parameter. It is, of course, true that the values of the conductivity in the U-region also depend on the constant A, but as may be seen from Fig. 3 this lies within relatively narrow limits. Thus, while the magnitudes of the thermal conductivities of the different crystals vary greatly (the lowest value measured was 2×10^{-4} watt units for helium at 2° K. and the highest 60 watt units for sapphire at 50° K.), they can all be deduced, at least to an order of magnitude, once the specific heat parameter is known.

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THEORETICAL ASPECTS OF SUPERCONDUCTIVITY

Crystal Structure and Superconductivity

THE prediction that it is the interaction between electrons and lattice vibrations[1] which is responsible for the establishment of the superconductive state has been verified by the discovery of the isotope effect[2]. Theoretically, for a metal to be a superconductor a condition regarding the strength of this interaction has to be fulfilled. This condition requires (see ref. 1*a*, equations (3.19) and (6.8)) that a parameter which depends on the number ν of free electrons per atom must exceed a certain value. This parameter is proportional to $(4\nu)^{1/3}$ if $4\nu < 1$ and proportional to $1/(4\nu)^{1/3}$ if $4\nu > 1$. On the assumption that other quantities entering into it are independent of ν, an optimum for the attainment of superconductivity is reached if $\nu = 1/4$.

The number ν of free electrons of a metal depend on its Brillouin zone structure, which in turn i determined by the lattice structure. Since each zon contains sites for two electrons per unit volume $\nu = 1/4$ means either nearly empty, or nearly full zones. This is actually the case for most superconductors, as was remarked some time ago by Bor and Cheng[3].

The result $\nu = 1/4$ was derived on the assumptio of free electrons. It holds, however, whenever th energy of the electrons is proportional to the squar of the wave-number. For some structures this ma not be so, and thus a modification of the exact valu of ν is required, although the above qualitativ statement regarding the occupation of zones wil probably hold in most cases. [June 9.

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Superconductivity and Effective Mass of Electrons

SOME time ago, Bardeen[1] suggested that a very small effective mass of electrons would lead to superconductivity. Later he found that the theory of the interaction between electrons and lattice vibrations[2] actually yields such a small effective mass[3]. I wish to show here, however, that small effective mass alone leads always to normal behaviour. Even though a state with non-penetrating magnetic field may be relatively stable[3], the normal state if it exists has always the lower Gibbs free energy, provided that no other than magnetic interaction between electrons is considered. Although the small effective mass is no doubt an important property, it is imperative in the presence of a magnetic field to consider the change of interaction between electrons and the vibrational field in order to obtain superconductivity, as has been shown recently[4].

To prove that without this the normal state exists (and hence is stable), let us review the results of the Landau–Peierls theory[5] of the diamagnetism of a gas of free electrons. Here the energy increase due to the presence of an external homogeneous magnetic field H_0 is calculated, based on a Hamiltonian:

$$\mathcal{H}_0 = \sum_k (\mathbf{p}_k - \frac{e}{c}\mathbf{A})^2/2m^*, \tag{1}$$

where m^* is effective mass, $\mathbf{A}$ is the vector potential and the sum extends over all electrons. The result per unit volume is found to be

$$\frac{1}{2}\,|\,\chi_0\,|\,(\text{curl }\mathbf{A})^2, \tag{2}$$

where the quantity $|\chi_0|$ is expressed in terms of various parameters. In particular, $|\chi_0| \rightarrow \infty$ if $m^* \rightarrow 0$. On the other hand, if χ is the magnetic susceptibility of a substance, its energy increases by $\frac{1}{2}|\chi|H_0^2$ if brought into the field, provided that $|\chi| \ll 1$. Hence, in this case χ_0 is equal to the magnetic susceptibility χ. Now since the permeability

$$\mu = 1 + 4\pi\chi = 1 - 4\pi|\chi| \tag{3}$$

must always be positive, then $|\chi| < 1/4\pi$.

It would be wrong to apply the result $\chi \simeq \chi_s$ to the case $m^* \rightarrow 0$ and thus derive a contradiction of the condition $|\chi| < 1/4\pi$. For in this case the Hamiltonian is

$$\mathcal{H} = \sum_k (\mathbf{p}_k - \frac{e}{c}\mathbf{A}_k)^2/2m^* + U_{int}; \tag{4}$$

where U_{int} represents the magnetic interaction energy between electrons, and $\mathbf{A}_k$ is the macroscopic vector potential at the position of the k-th electron diminished by the contribution to $\mathbf{A}_k$ of this electron. This latter is negligible so long as the radius of the classical orbit is large compared with the distance between neighbouring electrons. Hence,

$$\text{curl } \mathbf{A} = \mathbf{B} = \mu\mathbf{H}, \tag{5}$$

where $\mathbf{H}$ is the macroscopic field. Using (4), (2) and (5), the energy increase per unit volume is now given by

$$U = \frac{1}{2}|\chi_s|\mathbf{B}^2 + \bar{U}_{int} \tag{6}$$

where the bar indicates formation of the expectation value.

Expression (6) has to be equated to the energy increase U_m (per unit volume) obtained with the help of the macroscopic theory in terms of χ. Both U_m and U_{int} depend on shape, but the resultant value of χ is, of course, independent of shape. For this reason the simplest procedure is to consider a diamagnetic slab between the poles of a permanent magnet. The value of $\mathbf{B}$ is then the same as in the absence of the slab. Hence $U_{int} = 0$ and $U_m = (HB - B^2)/(8\pi)$. This expression must be equal to (6), which now is equal to $\frac{1}{2}|\chi_s|B^2$. Thus, using (3) and (5), we find

$$\left(\frac{1}{\mu} - 1\right)\frac{1}{8\pi} = \frac{1}{2}|\chi_s| \text{ or } \chi = \mu\chi_s. \tag{7}$$

Hence,

$$|\chi| = \frac{|\chi_s|}{1 + 4\pi|\chi_s|} < \frac{1}{4\pi}, \tag{8}$$

so that no contradiction to the condition $\mu > 0$ can occur, that is, the normal state exists.

Finally, to show that the result is actually independent of shape, consider a diamagnetic needle parallel to the direction of field. In this case $U_m = \frac{1}{2}|\chi|H^2$, because H is now equal to the field in the absence of the body. U_{int} is the self-energy per unit volume of a needle-shaped magnet with polarization $(B - H)/(4\pi)$; that is, $U_{int} = (B - H)^2/(8\pi)$. Equating U_m to U leads to the previous result (7). [June 9.

H. Fröhlich

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Specific Heat of Metals at Low Temperatures

The interaction in a metal between the lattice vibrations and the conduction electrons has been shown by Fröhlich[1] to lead, if sufficiently strong, to the superconductive state. If too weak for this, it can lead to modifications in the properties of the normal state at low temperatures. In suitable circumstances, for example, this S-interaction can lead to a peak in the specific heat at a few degrees absolute.

It has been shown by Fröhlich that if a certain factor, f, depending on the strength of the interaction, is greater than unity, the ordinary spherical distribution of electrons in momentum space is not the one of lowest energy at the absolute zero of temperature. For normal metals, $f < 1$ and the spherical distribution is, in fact, stable.

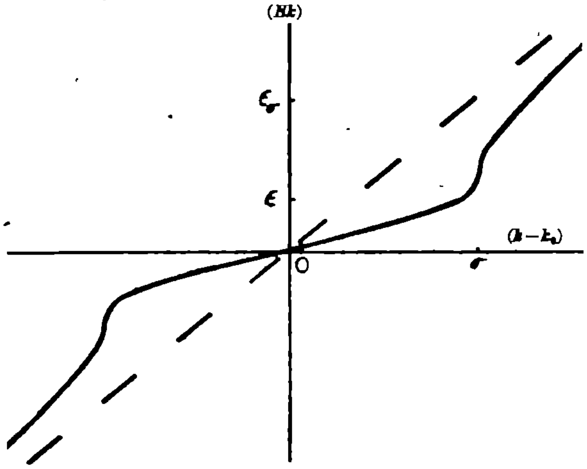

Fig. 1

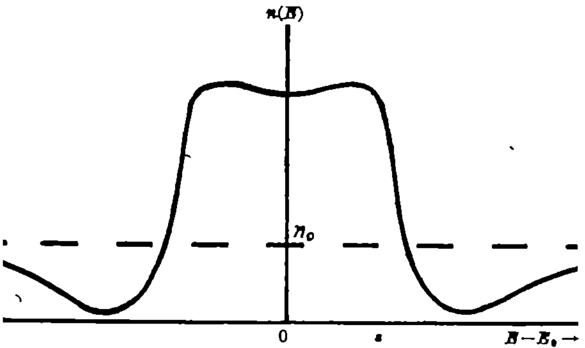

Fig. 2

The energy of an electron near the surface of the distribution at absolute zero is shown as a function of wave number in Fig. 1 for a possible normal state. The corresponding energy-level density is shown in Fig. 2. The broken lines correspond to the case $f = 0$ (or neglect of the S-interaction).

It is intended to discuss the properties of the superconducting state in a later communication, so we confine ourselves here to the case $f < 1$. The energy-level density, $n(E_0)$ at E_0, the edge of the filled region at the absolute zero, is then given by

$$\frac{n(E_0)}{n_0} = \frac{1}{1 - f}\ (f < 1). \tag{1}$$

The specific heat as a function of temperature will have the form shown in Fig. 3 for several values of f,

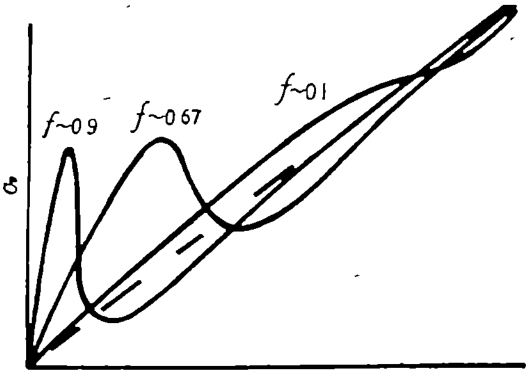

Fig. 3

the ratio of the slopes at $T = 0$ and $T = \infty$ being given by (1). The total energy due to the peak is, of course, of the same order of magnitude as the energy-difference of a superconductor in the normal and superconducting states at absolute zero.

Anomalous peaks of this energy have been observed in the specific heats of sodium[2] and beryllium[3], at about 7° and 11° respectively. The experimental results, however, do not show the linear increase at small temperatures given in Fig. 3, and it is thought that this may indicate an inadequacy in the description of states near the ground-state, a question which arises also in our investigation of the thermal properties of the superconducting state itself.

It is simple to estimate the energy content, ΔE, of the anomalous hump in the specific heat. From Fig. 2, and equation (1),

$$\Delta E \sim \tfrac{1}{2}\,(n(E_s) - n_s)\,\varepsilon^2 = \tfrac{1}{2}\,\{f/(1-f)\}n_s\,\varepsilon^2.$$

Now $\varepsilon = (1-f)\,\varepsilon_\sigma$, where $\varepsilon_\sigma = 2(\sigma/k_s)\zeta = kT_\sigma$, say, ζ being the Fermi energy, and if σ_s is the wave number of an electron moving with the velocity of sound, $(\sigma_s/\sigma)^3 = 4\nu$ (if $4\nu > 1$), where ν is the number of free electrons per atom (see equation (3.4) of ref. 1). From equation (2.7) of the same paper, we then see that $T_\sigma = \theta_D$, the Debye temperature. In the free-electron approximation we have, for one gram molecule:

$$kn_s = \tfrac{3}{2}\,\nu R\zeta^{-1},$$

so that

$$\Delta E \sim \tfrac{3}{4}\nu f(1-f)\,RkT_\sigma{}^2\zeta^{-1}. \qquad (2)$$

The peak containing this energy occurs at a temperature about $T' = \tfrac{1}{2}(1-f)T_\sigma$.

Using values appropriate to sodium, $\theta_D = 150°$, $\zeta = 3\cdot1$ eV., and $\nu = 1$, we must take $f \simeq 0\cdot9$ to make $T' \simeq 7°$ K., and (2) then gives $\Delta E \sim 0\cdot11$ calories, about equal to the value estimated from the experimental curve published by Pickard and Simon.

In the case of beryllium, $\theta_D \simeq 1{,}000°$, but the free-electron approximation cannot readily be applied since there are two zones nearly filled. It would be expected in this case that $T_\sigma \lessdot \theta_D$, but an estimate of ΔE on the lines of that for sodium would have little meaning.

My thanks are due to Prof. H. Fröhlich for many stimulating discussions, and to the Australian National University for the award of a travelling scholarship. [June 9.

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A METHOD FOR MAKING ACCURATELY REPRODUCIBLE MASKS OF THE HUGGINS TYPE

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IN 1929 Bragg[1] described a method for the photographic summation of Fourier series by the addition of the proper patterns of light and dark bands. Huggins[2] in 1941 showed how this method could be improved in accuracy and speed by the use of a previously prepared set of masks, and in 1944 Huggins[3] published a number of illustrations of projected crystal structures produced by means of his masks. In Huggins's first paper[2], he described the photographic procedure that was followed in producing a sinusoidal transparency across the masks perpendicular to the light and dark bands. This procedure involved making what was called mask *A*, from which a second mask *B* was made, before producing the final masks for the Fourier summations. These two preliminary masks were necessary in order to compensate for the non-linearity in response of photographic material to light; and also because of this lack of linearity, no set of finished masks could be used as a master in making further copies of the masks.

The present investigation is based on the knowledge that much of the modern work in photographic reproduction is accomplished by using a master which has only two tone values, white and black, and in which the visual illusion of the various shades of grey is produced by the relative areas occupied by the discrete portions of white and black. This variation in area is usually accomplished by varying the size of the regularly spaced dots. However, in view of the difficulty in getting a perfectly sinusoidal distribution of sizes of black dots across a master figure, it was thought best to make the black areas them-

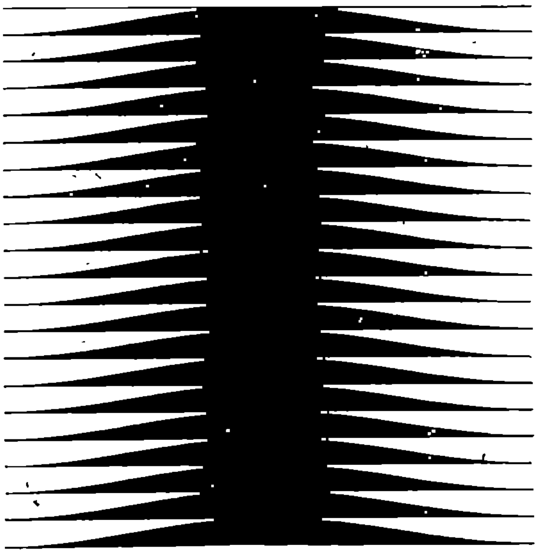

Fig. 1. Unit of pattern for assembling the master figures

selves vary in shape sinusoidally. Fig. 1 shows a unit of area used to build up the master figure. Each black streak in Fig. 1 obeys the equation

$$\omega = \omega_0 \left(1 + \sin \frac{2\pi n x}{L}\right),$$

where ω is the width at any distance, x, from the left-hand edge, ω_0 is the maximum width, and L is the length of the streak.

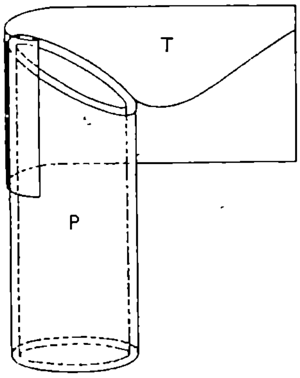

Fig. 2 Manner of making a template for drawing sine curves

Since it is very difficult to plot, from trigonometrical tables, these sinusoidal curves sufficiently accurately for this work, a template was made by the procedure shown in Fig. 2. A piece of 5-mill shim brass T is wrapped about a pipe P with a bevelled end. The inside of the shim brass is marked against the bevelled end of the pipe with a sharp metal scribe. When the brass is unwrapped from the pipe, a sine curve is apparent; and by cutting the brass on the scribed line, the template is ready for making curves and filling in with ink to produce Fig. 1.

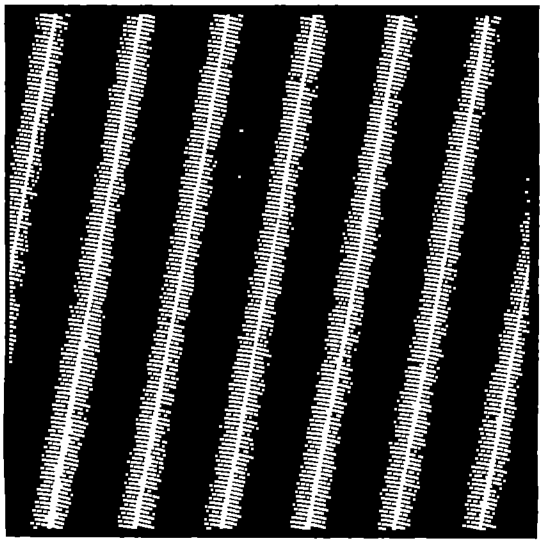

Fig. 3. Example of finished mask, showing the $6\bar{1}$ term

Fig. 3 shows the $6\bar{1}$ mask. Masks up to h and k values of 10 have been prepared and are available through the Universal Microfilming Corporation (277 6th Avenue, Salt Lake City 3, Utah). When these masks are used in the usual manner or in the multiple projector[4], the details of the white and black streaks are lost and a sinusoidal effect of dark and light bands is produced by out-of-focus projection.

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APPLIED ELECTRONICS

THE exhibition of electronic devices which was held at the Manchester College of Technology during the last week of July was the sixth, and by far the largest, of the annual displays organized by the North-West Branch of the Institution of Electronics. The Exhibition, planned as part of the City's contribution to the Festival of Britain activities, included a number of special features in addition to the usual trade displays of production models of electronic equipment. The research section, in which applications of electronics were on show in the 'string and sealing-wax' stage, was particularly interesting; and there were a number of 'guest' exhibits which, in addition to being excellent examples of applied electronics, were also of high entertainment value. Film shows and a series of lectures on specific problems were also part of the programme.

In the space allowed, it would be impossible to describe all the exhibits which were of special interest, and it must be pointed out that the particular devices selected for mention here are not necessarily of greater merit than the rest but are simply those which had the greatest personal appeal to the writer.

Of the 'guest' exhibits, perhaps the most impressive was the 'Electrone' displayed by the John Compton Organ Co., Ltd. This attracted a lot of attention as it was a smaller version of the instrument to be installed in the Manchester Free Trade Hall. The console of the instrument is completely orthodox; the stops, pistons and manuals are identical with those to be found on a modern pipe organ, and in fact no additional knowledge or skill is required by the player than would be required for playing an equivalent pipe organ. The tones are generated electrostatically from capacity changes produced by rotating wave-form electrodes. Harmonics are not produced separately but in groups, so that wide varieties of tone can be produced with a minimum of circuits. Valves are used only for straight amplification. Although the organ occupies a very small amount of floor space, it has a tonal quality which is remarkably close to that of a good pipe organ. Specially designed circuits provide delays (both before and after the depression of a key) which simulate the speaking characteristics of actual pipes with remarkable accuracy, and the instrument has none of the characteristics usually associated with electronic musical instruments.

Ferranti, Ltd. (Edinburgh), displayed a slow-speed relay computer designed to demonstrate the technique of automatic solution of problems in logic. Complex logical problems can, when broken down into a number of 'rules' or logical restrictions, be solved in a very short time even by this slow-speed machine. Two models were demonstrated. One obtained the solution by trying all possible combinations of the variables in turn; this model would give all the possible solutions to a given problem. The other does not try all combinations but is made to converge on a correct solution; this form is much more rapid, can deal with a greater number of variables but gives only one of the possible answers.

Also among the 'guest' exhibits was an amateur radio station in full operation, complete with home-made radio transmitters and receivers and a television receiver.

In the research section, Imperial Chemical Industries (Dyestuffs Division), Ltd., displayed a light-flux integrator. A photo-cell charges a condenser which triggers a flip-flop circuit at a given charge-level. This operates a counter, discharges the condenser and resets the circuit for the next count. A range of instruments involving transformer-type electromagnetic displacement gauges were on show. One such device measured the rate of wetting of a textile sample in water by recording the movements of a torsion balance, to which the sample was attached, as the water was absorbed.

The Electrical Engineering Department of the Manchester College of Technology displayed apparatus illustrating both research carried out in the College, and devices used in teaching. In the former category was an apparatus for indicating the rate of change of mains-frequency directly on a single dial, and designed for use in power stations. A useful device for teaching purposes was a harmonic synthesizer in which one could see, directly on a cathode-ray tube screen, the effect of adding together various proportions of different harmonics.

In the trade section there was a bewildering variety of equipments, all beautifully finished and a large proportion of them actually in operation.

Ferranti, Ltd. (Hollinwood), demonstrated their mercury–argon crater lamps, which give a light output directly proportional to the current passing through the lamp. These have wide application in sound-film recording and picture transmission, as the light can be modulated at frequencies up to 12,000 c./s. Among other interesting items was a new flat-faced television picture-tube with a 14-in. diagonal rectangular screen.

Fielden (Electronics), Ltd., demonstrated a yarn-irregularity meter. The instrument effectively determines the mass of a centimetre length of yarn, instantaneously present in the gap of a special condenser head, in terms of its dielectric properties. The instrument then notes the irregularities, integrates them over a predetermined period and presents the result, on a single dial, as the average irregularity expressed as a percentage of the average mass of the sample. The reading is quite steady and independent of the speed at which the sample is passing through the instrument.

One of the most interesting exhibits on the stand of Marconi Instruments, Ltd., was an audiometer assembly, specially designed for measuring the hearing acuity of young children. The instrument incorporates a standard pure-tone audiometer. The portion of the instrument visible to the child is brightly decorated in nursery style and consists of a loud-speaker and a 'peep-show' arrangement. This is so devised that a brightly coloured picture becomes visible when the child presses a button, provided that a test signal is being applied to the loud-speaker.

The Metropolitan-Vickers Electrical Co., Ltd., displayed their high-speed, recurrent-wave-form monitor which gives, on a cathode-ray tube screen, a trace of a recurrent wave-form with frequency components up to 300 Mc./s. In any one cycle, the instantaneous amplitude at some one point of the wave-form is measured. On successive recurrences, the instantaneous value at other points is recorded and after about 200 cycles a complete picture of the wave is available.

Mullard, Ltd., had on view a number of important additions to their range of valves, including a new disk-seal ultra-high-frequency triode, with a new type of cathode which permits closer spacing of electrodes —with consequent higher maximum frequency of operation—than has hitherto been obtainable, a series of sub-miniature valves and the first members of their range of image-converter tubes.

The Exhibition Committee deserves special congratulations on the organization, which, at any rate to an outside observer, appeared to be particularly free from technical hitches. C. A. TAYLOR

RESEARCH AND DEVELOPMENT IN THE SIMON ENGINEERING GROUP

By DR. W. RHEINALLT THOMAS

Director of Research

THE year 1908 saw the establishment of the first Simon Laboratory for examining and testing the materials used and produced in the coke ovens and coal-washing plant then being built by the firm. In 1912 tests associated with the manufacture of sulphuric acid were also undertaken. In the period between the two World Wars, the Laboratory was enlarged on three occasions to cater for advances in the design of existing plant and the introduction of new activities, which now include the production of power stations, turbine gears and a wide variety of chemical plant and mechanical and pneumatic handling machinery. Each department had also set up its own small teams of research workers and technical development engineers.

Tremendous expansion followed the Second World War, as demonstrated by the fact that orders to the value of £75 million have been taken at home and abroad, and it became clear that existing arrangements for testing, research and development were inadequate. Plans were drawn up to meet the situation, and building began in mid-1949.

On July 3 last, Sir Henry Tizard opened the new buildings, consisting of a central research block, a testing wing housing what was known as the Laboratory and now forming part of the Research Department, and the first of two development wings. These new buildings are almost entirely devoted to the research and development interests of Simon-Carves, Ltd. The Henry Simon companies forming the other half of the Simon Engineering Group, and with very different fields of activity, have entirely independent facilities for research and development, although there is the closest co-operation, particularly where problems of mutual interest are concerned.

The central research building, 159 ft. long, 45 ft. wide and 45 ft. high, contains four research laboratories, microscope, balance and dark rooms, as well as sections for testing metals and refractory and building materials. The library, information room and offices occupy the central portion of the first floor.

The testing wing on two floors is 105 ft. long, 55 ft. wide and 25 ft. high, and is specially designed to cater, on a much enlarged scale, for the activities of the old laboratory. The chemical work is carried out on the first floor, where four laboratories and ancillary rooms are provided. The ground floor contains six laboratories for the mechanical and physical testing of coal and coke, as well as a large workshop capable of dealing with all research and development requirements.

The development wing is a single-story building 165 ft. long, 55 ft. wide and 45 ft. high, and is devoted to experimental pilot plant on coal washing, coke ovens and pneumatic handling machinery. Until such time as the second wing is erected, space has been allocated in the existing wing to the chemical and power-plant development sections.

The main lines of activity fall into four broad classes: chemical analysis and materials testing; research; information; technical development. The division is arbitrary but convenient; overlapping is inevitable and only brief descriptions are given here of a few features of the work.

Before any plant is designed, exhaustive laboratory investigations are carried out on the materials to be used and produced, so as to provide the designer with data that will enable him to predict accurately the suitability of the raw materials and guarantee the performance of the plant.

For coal-washing plant design, information is given on the separation of coal and shale and of the fine coal and tailings as well as for the treatment of water for re-circulation. The assessment of coal for use in coke ovens involves proximate and ultimate analyses, determinations of the swelling properties, the yields of coke and by-products and analysis of the gases evolved. For boilers and power plant using either stoker or pulverized fuel, the calorific and ash fusion values are also determined.

The refractory materials employed in coke ovens are subjected to stringent tests for completeness of firing and strength under load at high temperatures and for resistance to abrasion and to sudden changes of temperature. Building materials undergo rigorous tests and analyses prior to use. A number of mechanical, physical and chemical tests are also carried out on the metals used in plant construction.

The general chemical analyses cover a wide range of organic and inorganic compounds as well as complex ores. Forty-four by-products of coal are analysed as a matter of routine. In connexion with the manufacture of sulphuric acid, catalysts, pyrites and the finished acid are examined, and such problems as treatment of waste acids and gases and phenol recovery from effluents form part of the programme.

To meet the needs for testing facilities on sites, a self-contained mobile laboratory has been fitted up and, by means of interchangeable cabinets, equipment can be quickly changed to permit tests on every type of plant built.

Research on a centralized as opposed to a departmental basis is of recent origin. Some of the problems embrace the activities of the organization as a whole; others are mainly of sectional interest. Reference is made to one of each type.

One field of common practical interest concerns small particles which are involved in the collection, extraction and disposal of industrial mists and dusts; the combustion of pulverized fuel and sulphur-bearing ores; sedimentation and studies in magnetization for dense medium washing.

The restriction of imports of raw sulphur for sulphuric acid manufacture has made it urgently necessary to devise means of purification and recovery of sulphur from alternative sources. The fields of investigation cover the filtration of molten sulphur, the flash roasting of iron pyrites, recovery from waste gases and spent liquors, and removal of hydrogen sulphide from town's gas.

The information section comprises a library and an information staff dealing mainly at present with the scientific and technical needs of the organization. By virtue of its activities it will possess an over-all generalized picture of the whole field of interest rather than a specialized knowledge of part of it.

The three main contracting departments in the organization are the coke-oven and coal-washing department and the power and chemical plant departments, and each has its own technical development sections. Work, hitherto, has been largely carried out on full-scale industrial plant. With the advent of the new wing, however, experiments on the pilot-plant stage will be carried out at first for rationalizing the design of existing plant and later in applying fundamental data to the design of new plant.

The new wing houses a complete dense medium coal-washing plant to one-third full scale, in which up to 25 tons of coal per hour can be treated, and effective separation of coal and shale differing only slightly in density is achieved. From trials on this plant and from the results of the associated laboratory tests, it is possible to erect full-scale plant of guaranteed performance. It will also be used for improving performance and for trying out new ideas. A small-scale self-contained coke oven has also been installed, and the results obtained can be translated to full-scale practice. An integrating radiometer establishes the combustion characteristics of domestic coke.

A pilot distillation plant in process of erection represents development of a new process where an entirely new design of fractionating column promises high efficiency in small volume.

The development sections of the power plant and chemical plant departments await the erection of the second development wing. In the meantime their work continues to be done largely on actual plant; but they have been allocated space temporarily in the existing wing. A test assembly of axial cyclones for gas cleaning has been erected, and at a later stage pilot plant for work on electrostatic precipitation will be installed. The chemical plant section is also co-operating with the British Iron and Steel Research Association in developing a method of recovering sulphuric acid from spent pickle liquor at steelworks. Among the main problems which the power-plant development section proposes to examine in detail are the behaviour and characteristics of pulverized fuel, the treatment of carry-over in steam and the expanding of tubes into drums and headers.

Recruitment of staff for the research department is proceeding and the ultimate establishment proposed will total 55, consisting of the director of research, twelve graduates of varying degrees of seniority, twenty-seven laboratory assistants, ten junior assistants and an administrative staff of five.

Each technical development section has its own staff headed by a senior scientific man. The coke oven and washer department has a team of six graduates, two senior and two junior assistants as well as a team for plant supervision and maintenance. The power-plant section has four graduates and one senior assistant, and the chemical plant section two graduates. Increases will be made when the second development wing is erected.

FACTORS CONCERNED IN FERTILITY OF MAMMALS

THE Society for the Study of Fertility held its second annual Conference on Fertility at Girton College, Cambridge, on June 20 and 21. There were four scientific sessions. The effects of experimental lesions of the hypothalamus in female rats on their œstrous cycles and mating behaviour have been studied by Miss H. M. Bruce and Dr. G. C. Kennedy (National Institute for Medical Research). No specific effects from such experimental lesions were seen on the cycles, whether the operation was followed by the development of obesity or not. However, in those rats which became obese, regardless of whether or no normal cycles continued, mating and pregnancy never occurred. Of ten animals in which obesity did not follow operation, only two mated. All the controls mated. Hypothalamic lesions produced in lactating rats did not always interfere with the continuation of lactation, even though obesity might supervene. The small, discrete, hypothalamic lesions did not result in gonadal atrophy in the rat. So far, only one sex effect could be localized in the hypothalamus, namely, a centre controlling the secretion of luteinizing hormone by the pituitary.

Mr. H. J. Cembrowicz (Ilminster) discussed the fertility-levels of bulls at an artificial insemination centre. Using as an index of conception the non-occurrence of œstrus in the three months following an insemination, it was found that there had been a rise in the conception-rate from 51 to 69 per cent between 1944 and 1950. During the same period, there had been a nearly five-fold increase in the number of inseminations per year, a six-fold increase in the number of inseminations per bull, and a seven-fold increase in the dilution of the semen used for insemination. Although semen production shows differences between breeds, with improved technique these become much less. Unlike the experience of the Milk Marketing Board, at his centre there has been no fall in conception-rate with increasing age of the bull, even when this reached eight and nine years. In the evaluation of the semen, motility has been found to be the best criterion. With different bulls, from one to three ejaculations per week can be obtained. It was found that 0·5 c.c. of diluted semen is just as effective a dose for insemination as 2 c.c.

Dr. Edmond J. Farris (Wistar Institute, Philadelphia) described his rat ovary hyperæmia test for the prediction of the day of ovulation in humans, and summarized some of the experimental work he has done to confirm its validity. He discussed its value, and the conclusions to be drawn from its use, in the practical handling of human infertility problems.

Dr. Nancy Laughton (University of Birmingham) described the bacteriological findings in cervical swabs taken from two groups of women, one showing positive and the other negative post-coital tests. (This work was done in conjunction with a study, reported by Miss Dorothy N. Shotton (of the Women's Hospital, Birmingham), on the cervical factor in human fertility.) The most striking feature was the absence of pathogenic organisms in all except one case from each of the two groups (this was *B. coli* in both instances). She had isolated from several patients of both groups a hitherto undescribed organism which is a small Gram-positive pleomorphic bacillus, 0·7 μ in diameter and 1–3 μ in length. It is culturally delicate and shows a rudimentary branching habit. From its morphology and cultural characteristics, which she detailed, it was concluded that it belongs to the order Actinomycetales. She gave it the provisional name *Corynebacterium cervicis*.

Experiments on the effect of thyroid hormone and of thiouracil on spermatogenesis in mice, rabbits and rams were described by Dr. M. Maqsood (Cambridge). Thiouracil interferes with the development of the germinal epithelium and decreases the number of interstitial cells. Thyro-protein, on the other hand, speeds up maturation of the testis, so long as the dose remains within the physiological range. In rams, thyroxin-treatment prevents the usual summer decline in spermatogenesis and improves the seminal quality generally. Thyroxin given to rabbits with previously poor records of semen production improves the seminal quality in all cases. Administration for forty-four weeks had no deleterious effect on the testes, whereas administration of thiouracil for a similar period led to complete testicular atrophy.

Dr. B. P. Wiesner and Prof. John Yudkin (King's College of Household and Domestic Science, London) described their experiments on the results of feeding a purified diet containing the known vitamin supplements to rats. They found that the interval from pairing to parturition is, in general, lengthened as compared with that of the controls fed on a stock diet; but most striking was the almost invariable death of the new-born young, in an emaciated condition, within two days of birth. Adding whole liver, and, to a lesser extent, vitamin B_{12}, corrected this effect, but only partially. It seems possible that the necessary nutritional factor (which they call 'R') may also be present in yeast. A method for the drying of liver at low temperature *in vacuo*, to produce a stable powder still containing factor R, was described.

Dr. T. Mann (Molteno Institute, Cambridge) described chemical methods of use in the analysis of semen. These include the estimation of fructose and citric acid and the demonstration of cytochrome by means of the microspectrometer. He also directed attention to the recent discovery in his laboratory of the presence of ergothioneine in seminal fluid. He was followed by Mrs. Clare Harvey (Exeter), who described the results of fructose and citric acid estimations in human semen. There are wide ranges of values for both these constituents, and no clear correlation with other seminal characteristics; though high fertility seems, in general, to be associated with relatively low fructose and high citric acid contents.

Dr. John MacLeod (Cornell University, New York) compared the seminal findings in 1,000 men of proved fertility with those in the husbands of 1,000 infertile marriages. His main conclusions are that sperm density, provided it exceeds 20 millions per ml., is of little significance; but high proportions of motile forms, with vigorous activity, is characteristic of the fertile males. There is no evident association of seminal abnormalities with repeated miscarriages.

Other papers were read by Dr. S. Bender (University of London) on the outcome of pregnancy in women previously sterile; Dr. Raymond G. Cross (Dublin) on tuberculous endometritis; Mr. Donald Young (Warrington) on surgery of the vas deferens; Dr. B. Sandler (Manchester) on the relationship of cervical hostility and asthenozoospermia in human sterility; and Dr. A. C. Crooke (Birmingham) on the effects of various adrenergic and cholinergic drugs on the gonadotrophin excretion of women with amenorrhœa.

INDIAN VETERINARY RESEARCH INSTITUTE

DIAMOND JUBILEE CELEBRATIONS

THE celebration of the diamond jubilee of the Indian Veterinary Research Institute, which was founded at Poona in 1889 and was transferred, in 1893, to Mukteswar, was held on March 11, 1951. Distinguished by the attendance of many workers from the different States of India, the gathering was addressed by the Hon. Shri K. M. Munshi, Minister for Food and Agriculture, who inaugurated, at the same gathering, the ninth meeting of the Animal Husbandry Wing of the Indian Board of Agriculture and Animal Husbandry.

India, said the Minister, possesses a quarter of the world's bovine population and also millions of sheep, goats, poultry and other animals; yet her production and consumption of milk are, perhaps, the lowest in the world. A sustained and multi-pronged effort to remedy this state of affairs is required and is being planned. Breeding, proper management and feeding of all kinds of livestock, and control of diseases from which they suffer, must be studied in a unified and comprehensive scheme which should be linked with India's "Grow More Food" campaign. The largest scheme ever presented by the Research Institute is, the Minister said, that for the eradication of rinderpest, which takes the heaviest toll of the lives of cattle and, in addition, debilitates and reduces the production of those beasts which survive. Everyone will endorse the Minister's hope that this scheme, to be carried out in collaboration with the Food and Agriculture Organization of the United Nations, will be financed and implemented soon. Meanwhile, a pilot scheme, designed to prepare the ground for the larger scheme, has been sanctioned by the Indian Council of Agricultural Research.

Discussing further the immense task of upgrading the millions of Indian cattle, the Minister commended the utilization, as part of the task, of artificial insemination. The central organization for the study of artificial insemination is housed in the Indian Veterinary Research Institute, and the Minister expressed the hope that this organization would be used to the fullest extent and that it would train the many personnel required for the Key-Village scheme.

The Key-Village scheme, on which the Minister asked the Animal Husbandry Wing to concentrate, has been drawn up by the Indian Council for Veterinary Research. It seeks to establish, all over India, a network of key-villages, the key-village being defined as a compact area consisting of one village or of a group of them, containing a total bovine population of five hundred. Each key-village will be surveyed to find out the distribution of cattle in it, its present productive capacity, the existing arrangements for the production and distribution of milk, the local supply of feeding stuffs and kindred matters. Bulls available in each area are to be examined and, if they are not satisfactory, they are to be castrated or removed and approved bulls are to be supplied. When the initial information has been obtained, the second phase of the scheme will introduce control of breeding, recording of milk production and other measures necessary for the improvement of the cattle. Still later it is hoped that the key-villages will operate as Government breeding farms helped by Government subsidies and supervision. Because there is an acute shortage of approved bulls in India, the possibilities of artificial insemination are already being studied, and the pilot scheme sponsored by the Indian Council of Veterinary Research is examining these possibilities in ten selected villages near Delhi.

Continuing a speech distinguished by its wide outlook and grasp of essentials, the Minister for Food and Agriculture expressed the view that the aim of breeding should be to produce a type of animal that can flourish under the conditions peculiar to its locality. The animal, he said, is fashioned by the type of husbandry used, by the kind of food and pasture available, by the factors in the environment which favour the occurrence of disease and by the climatic conditions generally. All these factors must be given due consideration. His speech concluded with a tribute to the Indian Veterinary Institute, the history of which, during sixty years of vigorous work, was outlined in an instructive address given to the gathering by the Institute's present director, Dr. S. Datta.

In a special jubilee issue of *Indian Farming*, which replaces the issue for March 1951, Dr. Datta describes the history of the Institute in greater detail. In this article, in fact, he gives a history of the development of veterinary science in India. Tracing its origin back to the men imported by the John Company in 1774 to look after stud farms, Dr. Datta describes the work of Moorcroft, Hallen and Cook and the appointment, in or about 1889, of the medical man, Dr. Lingard, as microscopist—and, soon after, bacteriologist—to the Government of India. To Lingard's work in the isolated surroundings of Mukteswar, Dr. Datta pays high tribute. The Indian Veterinary Research Institute should, he says, really be called the 'Lingard Institute of Animal Science'. He goes on to describe the work of Lingard's successors, paying just tributes to Holmes, Sir Leonard Rogers, Shilston, who unhappily fell a victim to glanders, Sir Percival Hartley, Macalister, Sheather, Pool, Doyle, J. T. Edwards, Cooper, Sir Frank Ware, Haddow, Macdonald and the last British director, Minett, who left the Institute, when the era of Indian independence began in 1947, to become animal husbandry commissioner to Pakistan.

For those who wish to know what 'Mukteswar' is now doing, there are, in this jubilee issue of *Indian Farming*, articles which describe the work going on in the Institute's various sections. The departments of pathology, bacteriology, parasitology, animal nutrition, biological products, poultry research and animal genetics are all confronted with varied and difficult problems. The section concerned with the training of workers is also an important one, because, as Dr. Datta points out, many senior workers have left Mukteswar to fill important posts elsewhere, and the need is great for experienced workers to carry out the extensive schemes that the Indian Government has in mind.

The future, it is clear, provides great opportunities for the Institute, and the solution of some of the difficult problems that confront it will provide fundamental knowledge that will be valuable to veterinarians all over the world. There is great and beneficent work to be done and a strong will to do it effectively. The good wishes of everyone interested in the welfare of man and his domesticated animals will go out to all those who are grappling with the complex problems that India now presents to her people.

G. Lapage

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Relative Abundances of Oxygen and Carbon Isotopes in Carbonate Rocks

The relative differences in the ratios oxygen-18 to oxygen-16 and carbon-13 to carbon-12 of some hundred and fifty carbonate rocks, including fourteen sedimentary limestones, ninety metamorphic limestones, twenty 'intrusive' carbonatites, twelve calcite crystals from Alpine clefts[1] and seven calcareous sinters have been measured. The aim of this investigation, which is being extended to include other carbonate rocks, is the accumulation of data that might lead to an interpretation of the isotopic differentiation in the carbonates on the basis of their geological history.

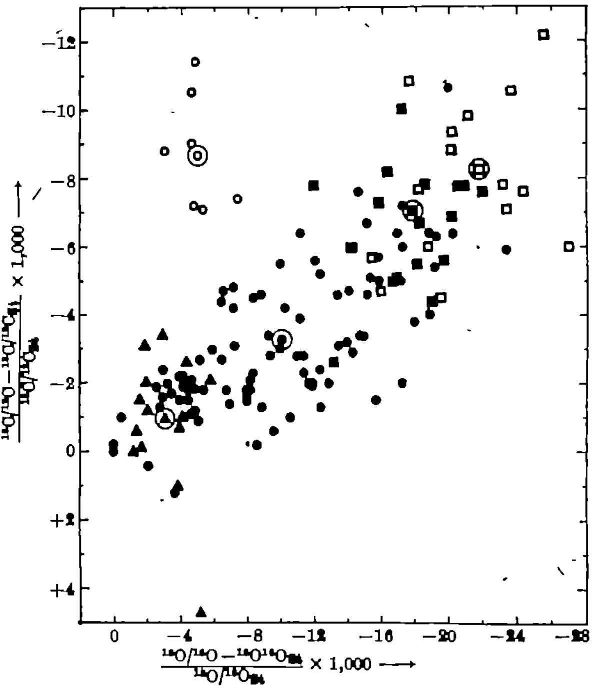
The determination of the relative abundances of the carbon and oxygen isotopes was carried out by means of a Consolidated–Nier double-collector mass spectrometer (type 21–201). The ratios oxygen-18 to oxygen-16 and carbon-13 to carbon-12 of each carbonate sample are reported relative to the corresponding quantities of an arbitrarily chosen standard limestone. The carbon dioxide samples necessary for this investigation were all prepared under the same conditions by decomposing the powdered rocks with 100 per cent phosphoric acid, according to a method developed by McCrea[2]. The results obtained in this manner are represented in the accompanying diagram. The deviations of the ratios oxygen-18 to oxygen-16 and carbon-13 to carbon-12 from those of the standard limestone (suffix St), given in parts per mille (°/₀₀), are used as x- and y-co-ordinates respectively. Negative figures thus indicate that there is less of the heavy isotope in the sample than in the standard. The carbon-13 to carbon-12 ratios are corrected for the variations in the oxygen-17 to oxygen-16 ratios, and the analyses were found to be consistent within about 1 per mille of the oxygen and carbon ratios.

The general character of the graph is at least partly explained by the fact that the isotopes of oxygen and carbon are fractionated in qualitatively the same way by most processes involving carbonate ions and carbon dioxide.

Considering the average isotopic composition of the different groups of carbonate rocks, it was found that the sedimentary limestones exhibit the highest abundances of the heavy isotopes. This can be understood from the low temperature of formation at which the oxygen-18 and carbon-13 in the carbonate are enriched by some 30 per mille and some 10 per mille respectively relative to the water containing carbon dioxide[3]. The scatter in the isotopic composition in this group may be attributed to local variations in temperature and isotopic composition of the water from which the carbonates were precipitated[3]. The calcareous sinters precipitated from fresh water are strikingly low in carbon-13. This is most probably due to the presence of dissolved carbon dioxide from decaying organic material. Such organic carbon is known to contain some 30 per mille less carbon-13 than the carbon dioxide in sea water[4].

On the other hand, since the isotopic fractionation between solid carbonate and its aqueous solution decreases with rising temperature of precipitation, we can see why the calcite crystals from Alpine clefts crystallized from hot solutions have the lowest abundances of heavy isotopes of all carbonates so far investigated. They contain, on the average, some 20 per mille less oxygen-18 than limestone precipitated from cold sea water. Since such limestone, as already mentioned, is enriched in oxygen-18 by some 30 per mille relative to sea water, one might conclude that the abundance of oxygen-18 in the solutions from rock pores from which the calcite crystals in the clefts were crystallized was some 10 per mille higher than that in sea water; always provided, however, that the temperature was 200° C. or more, conditions under which the fractionation of the oxygen isotopes becomes negligibly small. Similar conditions may be assumed to have prevailed in the formation of the 'intrusive' carbonatites which, according to the graph, are only slightly richer in heavy isotopes on the average than the calcite crystals from Alpine clefts. There is, in fact, strong evidence that the abundance of oxygen-18 in the water of rock pores increases with depth[5] and that magmatic water is some 10 per mille richer in oxygen-18 than sea water[6]. Though it is not possible as yet to account for the relatively large variations in the isotopic composition of the 'intrusive' carbonatites, it should be mentioned that these samples have a very similar oxygen-18 abundance to that of magmatic oxygen. It is reasonable to suppose that the corresponding ratio carbon-13 to carbon-12 is therefore significant for magmatic carbon.

The metamorphic limestones show a widespread variety in their isotopic compositions, ranging from those of the sedimentary limestones to those of the 'intrusive' carbonatites. No apparent relationships have yet been found between the isotopic composition



Relative abundances of oxygen and carbon isotopes in carbonate rocks.

▲, Sedimentary limestones; ●, metamorphic limestones (mainly from the Swiss Alps); ■, intrusive carbonatites (from Alno, Uganda, South Africa, Colorado); □, calcite crystals from Alpine clefts (all from the Simplon Tunnel); ○, calcareous sinters. Encircled points average isotopic composition of the different groups of the metamorphic carbonate rocks on one hand, and their physical and chemical properties or their age or geographical location on the other. It is most probable that the isotopic differentiation was caused by the different amounts of water and carbon dioxide passing through the carbonates at high temperatures during their metamorphic recrystallization. Limestones recrystallized with very small amounts of water had no opportunity of changing their original (sedimentary) isotopic composition, whereas carbonate rocks supplied with large quantities of ascending water and carbon dioxide finally attained the isotopic composition of the 'intrusive' carbonatites. In fact, such compositions were found only in crystalline limestones from contact zones with igneous or ultrametamorphic rocks where vast quantities of water and carbon dioxide were available. According to preliminary investigations, the abundance of the heavy isotopes generally decreases with increasing distance from the contact zones, and metamorphic carbonates having the isotopic composition of sedimentary limestones have been found mainly in the central regions of large limestone bodies. The distances over which a considerable change in isotopic composition may occur range from a few centimetres to several metres.

The results so far obtained suggest that the study of isotopic differentiation in metamorphic carbonate rocks might yield valuable information on the distribution and migration paths of the water and carbon dioxide during metamorphism.

Further investigations on the local distribution of the oxygen and carbon isotopes in well-known metamorphic areas are in progress and the results will be published elsewhere together with the details of this study.

I am indebted to Prof. A. Holmes (Edinburgh), Dr. E. Wenk and Dr. O. Grütter (Basel), for many helpful discussions and for furnishing the rock samples.

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May 25.

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Preparation of Uniform Solid Samples for Radioactive Assay

The preparation of uniform solid samples of radionuclides is of paramount importance in radiochemical assay, using end-window Geiger–Müller counters, especially for radionuclides emitting low-energy beta-radiation. For comparative measurements (using identically mounted samples), it is essential that all the deposits should be uniform and of the same dimensions, so that the factors due to absorption and scattering in the sample are constant.

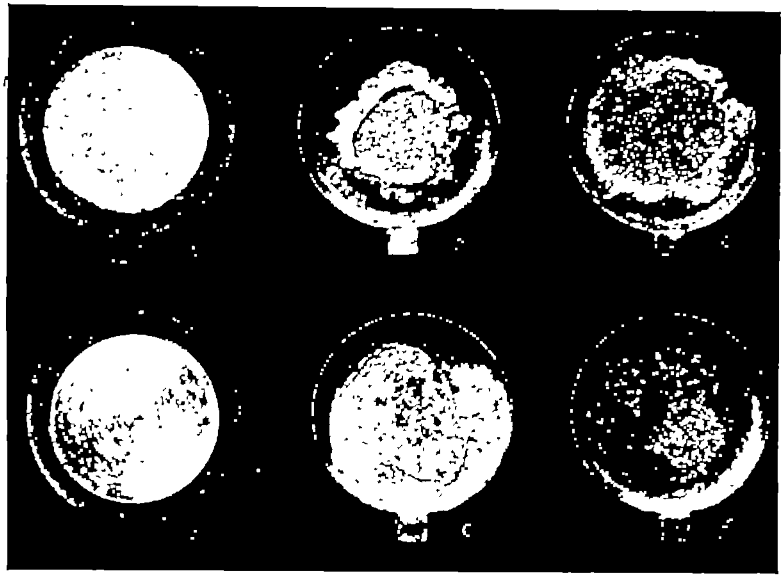
Many different methods for obtaining uniform deposits have been described[1] and these fall into two main categories: (1) those prepared by the evaporation of solutions; (2) those in which the deposition of a slurry of insoluble material is used.

The present method deals with the first case, that is, when the radionuclide compound is soluble. For routine work, a method often used is that of pipetting a small amount of the solution into a shallow metal dish and evaporating to dryness. Various devices have been used to induce uniform spreading and drying of the solution, as, for example, the addition of detergent or lens tissue or filter paper to the solution in the dish. It was found that methods involving the addition of a small amount of detergent did not give uniform deposits, and in some cases it caused the solution to creep over the edges of the dish. The present method, as well as giving a uniform deposit, accurately delineates the area of the active source, but requires no material to be added which would increase the absorption.

Circular stampings one inch in diameter with a protruding lug are made from 16-gauge aluminium sheet—the lug being used for ease of handling. The disk is held in a jig and the surface is 'turned-off' in the lathe from the centre outwards to a diameter of [illegible] in. to a depth of about 5×10^{-3} in., and a clean square-cut edge is left, care being taken not to touch the unturned part around the edge of the disk with the cutting tool. A known volume of the radionuclide solution is pipetted on to the centre of a disk and then rapidly evaporated beneath an infra-red heater in a current of hot air. The air stream is directed at the surface of the disk from all sides, through a series of holes drilled in a 5-in. diameter tubular brass ring. If the disk is placed at the centre of the ring, the air flow may be adjusted so that the liquid rotates. Thus, the solution is stirred until drying occurs, and the effects which usually cause uneven deposition are largely neutralized. When dry, the disks are fitted into a recessed metal plate which is then placed beneath the window of an end-window Geiger–Müller counter. (As the disks are flat, the active sample may be placed closer to the window than is possible with the usual type of shallow dish.)

The method has been tested using sodium bromide solutions containing either sodium-24 or bromine-82. When the deposit is of sufficient density to be observed, it appears as a matt finish of fine crystals uniformly distributed over the whole of the 'turned' surface. The present method is suitable for moderately heavy deposits; for example, it is found that the evaporated salt is confined to the 'turned' area even when 0·5 ml. of 1·0 *M* sodium bromide is used, whereas previously half this quantity evaporated in a shallow aluminium dish of similar size gave extremely non-uniform deposits. The best results are achieved when the disks are freshly turned.

A total of 10,000 counts was taken for each deposit and the results were corrected for decay; but corrections for resolving time were not made, as all the counting rates were of similar magnitude. Sources prepared with nominally equal volumes (checked by weight) from one active solution were used and all mounted in exactly the same manner, so that the geometry and the scattering effects of the mount and surroundings were constant. The effect of instrumental errors in counting was tested by counting one deposit ten times. The variation in counts was not significantly greater than that expected in a Poisson distribution; hence, instrumental errors could be considered to be negligible. The uniformity of deposition was tested by preparing ten disks of 0·2 ml. of 0·01 *M* sodium bromide containing sodium-24. The variation in counts was again not significantly greater than that expected in a Poisson



distribution ; that is, there was no experimental evidence of difference between the disks.

In the course of some other work, a large number of sodium bromide deposits containing either sodium-24 or bromine-82 have been tested using this method, taking three 0·2-ml. samples from each solution (from solutions of varying concentration up to 1·0 molar), and each set of three samples also gave results within the Poisson distribution.

Figs. *a* and *d* indicate clearly the uniform deposit obtained by this method, as compared with those obtained (*b*,*c*) by evaporating the solution in a dish, or those (*e*,*f*) when detergent is added to the solutions in the dish. In each case 0·2 ml. of sodium bromide has been used. Figs. *a*, *b* and *c* are for 1·0 *M* and Figs. *d*, *e* and *f* for 0·1 *M* solutions.

My thanks are due to Dr. A. Robson for discussion.

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April 27.

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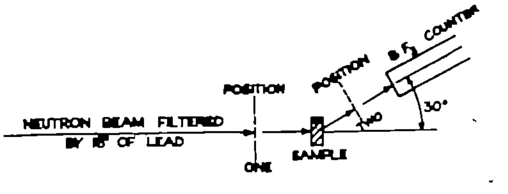
[1] For example, Kohman, T. P., *Anal. Chem.*, 21, 352 (1949).

Inelastic Scattering of Cold Neutrons

The gain of energy of cold neutrons on being scattered by crystalline materials has been investigated with a beam of lead-filtered neutrons from the Harwell pile. The maximum energy of the neutrons in the beam was 0·0026 eV. and the mean energy was 0·0017 eV. The experimental arrangement is shown in the accompanying diagram. The counter and sample were carefully shielded from stray neutrons, and the sample was enclosed in a vacuum chamber to eliminate air scattering. The angle of scattering was 30 ± 5°. The transmission of a lithium fluoride plate (0·14 gm./cm.^{2}) was measured in positions 1 and 2 for different scattering samples. The transmission of the plate had been measured as a function of energy with a mechanical spectrometer, so that a mean energy of the beam could be determined from these measurements. From the measurement in position 1 the mean energy of the neutrons which are scattered into the counter is determined *before* they are scattered, and from the measurement in position 2 the mean energy is determined after scattering. The results are shown in the accompanying table.



The cross-section (assuming the scattering to be isotropic) was determined by calculating the ratio of scattering to total cross-section of the sample, from the ratio of the counting rates obtained with the sample and the thin hydrogenous sample.

Element	Thickness in mean free paths	1 Initial energy*	2 Final energy*	Cross-section if isotropic	Cross-section determined from transmission data
H	0·81	1·75±0·10	1·75±0·10	—	—
H	1·4	1·60±0·10	2·85±0·25	—	—
H	3·4	1·75±0·10	9·3 ±1·8	—	—
Be	0·60	1·3 ±0·3	5·0 ±1·7	?	—
V	0·92	1·7 ±0·2	1·5 ±0·2	6±1	4·7
Se	1·06	—	—	2·5±1	4±2
Mo	1·00	—	—	<0·3	<0·3
Fe	0·98	1·65±0·25	9·8 ±1·8	1·5±0·5	1·4

* The energy is expressed in units of 10^{-3} eV.

In the case of hydrogenous media, the presence of inelastic scattering is only observable with the thicker samples. In crystalline materials, the scattering cross-section at neutron wave-lengths greater than the Bragg limit is made up of inelastic scattering due to thermal vibrations and elastic incoherent scattering due to spin and isotope effects. The result with beryllium confirms that the inelastic cross-section is much greater than the incoherent cross-section, although the value for the final energy is too low because the inelastically scattered neutrons are appreciably Bragg-scattered. The vanadium measurements verify that the scattering is largely incoherent. The measurements with selenium and molybdenum were made to confirm the order of magnitude of the inelastic and incoherent cross-sections which had been determined from the total cross-section.

The scattering cross-section of iron[1] is known to be greater than the thermal inelastic cross-section at long wave-lengths, and the present measurements verify directly that the difference is due to inelastic scattering. It is believed that this is magneto-thermal scattering[2].

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April 16.

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[1] Hughes, Burgy and Woolf, *Phys. Rev.*, 80, 481 (1950).

[2] Moorhouse, *Proc. Phys. Soc.*, 64, 207 (1951).

A New Method of Observing Compton and Other Incoherent X-Ray Scattering in Crystals

If a narrow cylindrical beam of copper K + white radiation is allowed to impinge on an iron foil of suitable thickness, placed in contact with a mosaic-type diamond (the foil being between the X-ray source and the diamond), an excellent divergent-beam pattern due to fluorescent iron K radiation can be obtained, superimposed on the Laue pattern of the diamond[1,2].

Even when the foil is removed, however, a weak divergent-beam pattern is still observed on sufficiently well-exposed Laue photographs, but it now corresponds to that expected for copper K wide-angle radiation. It was at first thought that this indicated the presence of copper as an impurity in the crystal, in sufficient quantity for a high proportion of fluorescent copper K radiation to be generated. This initial hypothesis was disproved by the following considerations and experiments.

(*a*) The effect is found for clear, colourless diamonds which would not be expected to contain copper as an impurity.

(*b*) Copper is a more unusual impurity than iron even in the opaque, coloured Belgian Congo diamonds which showed the copper K spontaneous pattern most clearly; yet, with an incident pencil of copper K radiation, for which the iron K fluorescence might be expected to be far more intense than any copper K fluorescence, no iron K spontaneous pattern was found.

(*c*) To check this reasoning, a spectrographic analysis of two Belgian Congo diamonds showing the effect was kindly undertaken by Miss Czapska, of Hilger and Watts, Ltd. This showed the presence of iron and silicon, but not of copper.

(*d*) A Laue photograph taken with cobalt K + white radiation showed a weak superimposed divergent-beam pattern due to cobalt K wide-angle radiation only.

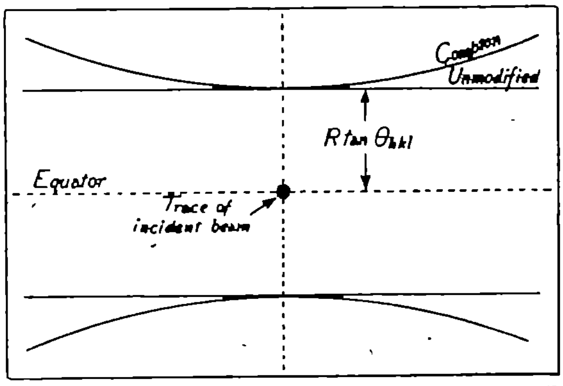
(*e*) Similar spontaneous wide-angle patterns were found for a mosaic benzophenone crystal using copper K and cobalt K incident beams respectively; and for a graphite crystal, using copper K radiation, when the incident beam was parallel to the basal plane.

Since the source of wide-angle radiation is within the crystal, and is not fluorescent radiation but of a kind similar to that in the incident beam, it must be either Compton scattering or imperfection scattering (including thermal scattering) or both.

This is confirmed by the observation that in the neighbourhood of the undeviated incident beam only reflexion conics, and no absorption conics, are recorded; which means, in effect, that the wide-angle source of radiation within the crystal has zero or low intensity near the incident beam direction, as would be expected for all such secondary radiation, but not for fluorescent radiation, or for low-angle scattering of any kind.

Owing to the difficulty of obtaining a pattern sufficiently intense for precise measurements of high-angle conics, it has not so far proved possible to distinguish between the effects due to the two types of incoherent scattering.

In principle, however, this could be done. In Compton scattering the wave-length of the scattered radiation is altered by up to 6 per cent, according to the incident radiation and the angle of scattering, whereas for imperfection scattering the wave-length change is only about 10^{-3} per cent. If the crystal is set with a plane (*hkl*) accurately perpendicular to the axis of a cylindrical camera, the divergent beam conics due to this plane will appear symmetrically on each side of the equator. If the pattern is due to the comparatively unmodified radiation, the conics will be a pair of lines parallel to the equator of the film; if it is due to Compton scattering the lines will diverge (appreciably for high-angle conics) as the angle of deviation from the incident beam increases (see diagram). Deviations from parallelism due to unwanted curvature of the film, etc., could be corrected for automatically by superimposing on the pattern a rotation photograph taken in the same orientation. In certain circumstances the nth-order conic will coincide with the nth rotation layer line, and any high-angle deviation could be observed. (For example, the deviation would be of the order of 2 mm. in the separation of the 220 copper $K\alpha$ conics for an angle of scattering of 140° for diamond with [110] parallel to the camera axis, using a cylindrical film of diameter 6·0 cm.).



Appearance of the *hkl* conic on a cylindrical film of radius R, when the planes (*hkl*) are perpendicular to the axis of the film. The curvature of the Compton conic is greatly exaggerated

The method is one which, if difficulties of technique are overcome, may be expected to give information about the relative amounts of Compton and imperfection scattering in various directions.

I wish to express my thanks to Prof. Kathleen Lonsdale for interest and advice during the course of this work.

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[1] Grenville-Wells, H. J., thesis, London (1951).

[2] Lonsdale, K., *Phil. Trans. Roy. Soc.*, A, **240**, 219 (1947).

Intensity Variation in Sunspots

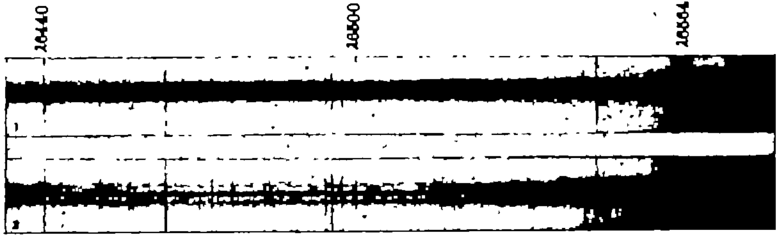
The most conspicuous and readily observed feature of a normal sunspot is a dark central umbra surrounded by a less dark penumbral fringe which, under good seeing conditions, appears to be composed of converging filaments directed radially inwards. Secchi[1] concluded from his visual observations that the penumbra is brighter at its inner edge, that is, towards the periphery of the umbra and darker at its outer edge. This feature is clearly shown in his drawings of sunspots.

Measurements of the variation of total energy across a sunspot with a thermocouple led Pettit and

Nicholson[2] to the conclusion that the total energy falls *continuously* from the photosphere throughout the penumbra to the umbra, where it remains fairly constant at about half the photospheric intensity. Wormell[3], who made similar measurements, arrived at the same result. He has remarked, however, that when allowance is made for scattered light, the observations can be accounted for by an umbra of constant intensity surrounded by a penumbra of constant higher intensity.

It is clear that these results do not support Secchi's observation that the penumbra is darkest at its outer edge and brightest towards the periphery of the umbra. Commenting on this, Pettit and Nicholson have remarked that "Secchi's observation is possibly an effect of contrast".

Recently, while taking spectrograms of the large sunspot of March 17–29, 1951, in the course of a study of the spectral intensity variation in sunspots, it was found that the umbral spectrum was bordered on either side by bright margins separating it from the penumbral spectra. The first observation of this was made on spectrograms taken in the H-alpha region of the first order of a 20-ft. grating spectrograph at 0430 hr. U.T. on March 24 (Fig. 1). The heliographic co-ordinates of the spot at that time were approximately latitude 12° N., longitude 15° W. The phenomenon was observed in a more striking manner on spectrograms taken at 0345 hr. U.T. on March 27 (Fig. 2). The heliographic co-ordinates of the spot at this time were latitude 12° N., longitude 55° W. Between March 24 and 27, the umbra of the spot had bifurcated and the bright bridge across the two halves of the umbra is clearly visible on the spectrogram of March 27.



Spectrograms of the sunspot of March 17–29, 1951. (1) March 24; (2) March 27

Visual examination of the photoheliogram of March 27 gives indications of a bright ring immediately surrounding the greater part of the umbra similar to that shown in Secchi's drawings. Examination of a number of old photoheliograms indicates that in the case of several spots the inner edge of the penumbra is brighter than its outer edge. A detailed microphotometric study of past photoheliograms taken at this Observatory is in hand.

Although several spot spectra have been taken on previous occasions, the phenomenon reproduced in the accompanying spectrograms has not been observed. The majority of the spectra do not show the sharp demarcation of intensity between the umbra, the penumbra and the photosphere which is so clearly visible on photoheliograms taken under good sky and seeing conditions, but show a continuous rise of intensity from the centre of the umbra through the penumbra towards the photosphere. This is presumably due to the wandering, owing to atmospheric unsteadiness, of the image on the slit of the spectrograph during the exposure. The two necessary conditions for accurate estimation of the intensity variation in sunspots are good sky and seeing and short exposure. A solar image of 60 mm. diameter formed by a 21-ft. photo-visual lens was employed in the present case and the exposures varied from 1 to 3 sec.

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April 25.

[1] Secchi, "Le Soleil", 1, 81 (1875). Young, "The Sun", 116 (1910). Russell, Dugan and Stewart, "Astronomy", 1, 200 (1945). Menzel D. H., "Our Sun", 125 (1949).

[2] Pettit, E., and Nicholson, S. B., *Astrophys. J.*, 71, 161 (1930).

[3] Wormell, T. W., *Mon. Not. Roy. Astro. Soc.*, 96, 736 (1936).

Effects of Ultrasonic Irradiation on the Coagulation of Cellulosic Solutions (Viscose)

The rate of coagulation of high polymeric colloidal solutions can be examined by a method devised by us, similar to that used for the study of the coagulation of recalcified blood plasma.

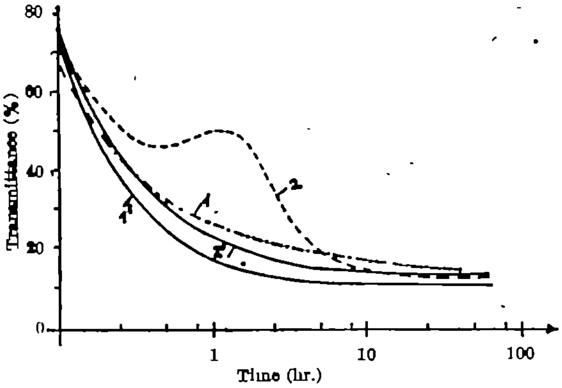
If the rates of coagulation and regeneration of a cellulosic gel are diminished by suitable means[1], it is possible to follow these phenomena spectrophotometrically. In this way a coagulation speed curve can be determined. The shape of this curve shows whether impurities are present or not, and also makes possible a study of the effect on coagulation of various chemical and physical agents (electromagnetic waves, ultra-violet radiations, etc.). We report here our first results concerning the effects of ultrasonic irradiation on the coagulation of cellulosic solutions and on the quality of the cellulosic lump obtained after regeneration.

Our method of slowing down the coagulation and regeneration rate consists in mixing drop by drop—contrary to industrial procedure—the diluted spinning-bath solution with the weakly diluted viscose (about 1 : 4) or cellulosic solution and stirring the mixture continuously in a regular manner. The process is stopped as soon as the coagulating reaction starts. In this way it is possible to initiate a low-speed coagulation and regeneration reaction which finally transforms the mixture into an optically homogeneous regenerated cellulosic lump, taking the shape of the vessel used. After achievement of this phase which lasts several hours, the lump begins to shrink and is transformed into a stiff and hard piece of cellulose; this transformation may last several days.

Three different types of ultrasonic apparatus were used. The first was an ultravibrator, frequency 800 kc./s., 50-watt total acoustic energy (maximum and 4·6 watt/cm.[2] maximal concentration, the second a Therasonel 015 (*ACEC*) with a frequency of 1,000 kc./s., 15-watt total acoustic energy, 1·8 watt/cm. maximal concentration, and the third a specially built experimental unit giving 50 watts total acoustic energy at a frequency of 3,200 kc./s. and an acoustic concentration of 5·5 watt/cm.[2].

The samples to be irradiated were placed in vessels of which the diameter was the same as the transmitting head. A cooling system using running cold water holds the sample at a constant temperature in spite of the heating effect of the ultrasonic radiation. Nevertheless, it was not possible to avoid specific thermal effects occurring in discrete points of a inhomogeneous medium which absorbs more or less energy than the surrounding liquid; microscopical temperature gradients are produced as during the treatment of inhomogeneous material with electromagnetic short-wave radiation[2]. Measurement of the ultrasonic dose (watt/cm.^{2}) is carried out by a differential thermocouple and that of the integral dose (watt. time) by insertion of small vials filled with an acidified solution of potassium iodide and starch[3]. Iodine is liberated by the action of ultrasonic radiation, and the depth of the blue colour—measured photometrically—gives the integral dose applied. In this manner the transmitted dose could be kept constant while using three different frequencies.

We have irradiated (*a*) the viscose before mixing with the coagulating solution and (*b*) the viscose after mixture with the coagulating solution. The three principal effects were: (1) outgassing by expulsion of included minute bubbles; (2) acceleration of the rate of coagulation and regeneration; (3) acceleration of dissolving and diffusing action of the spinning solution within the viscose.



Characteristic coagulation-speed behaviour of two different commercial viscoses (1 and 2). Curves 1′ and 2′ refer to the respective irradiated samples; their initial inclination (initial speed) is 2–3 times greater; however, the final transmittance is nearly the same in irradiated and non-irradiated samples. The abnormal behaviour (saddle form) of coagulation in sample 2 is not shown by the irradiated sample 2′

The cavitation effect occurring was positive and the speed of expelling hydrogen sulphide during the progress of regeneration was increased. The accompanying figure shows different photometric curves obtained under the influence of ultrasonic irradiation.

We have not found any remarkable differences due to change of frequency. Visible cavitation took place at about 0·65 watt/cm.^{2}. At that dose we had to irradiate for at least 15 min. to obtain a noticeable effect of acceleration on the rate of coagulation. The higher the dose the smaller was the time necessary to obtain an effect; however, there is not a linear relation between these factors. Macroscopic thermal effects do not seem to interfere with the process, because controls kept at 28° C., that is, 7° C. higher than the irradiated samples, showed no effect.

The acceleration of the dissolving and diffusing action of the spinning solution into the viscose and the outgassing of the mixture were clearly shown by the increase of light transmission through the sample at the beginning of coagulation when there is a nearly linear relation with the applied dose. The initial value of transmittance depends on the kind of viscose and coagulating solution, as well as on the quantities used.

As regards the structure of the regenerated lump of cellulose, we cannot be sure that the yield of the crystalline form and orientation are changed. However, the mechanical consistency of the lump is a little greater. Further work on this point is being carried out. The modification in the rate of the coagulation was only seen clearly when mixtures of viscose and spinning solution were irradiated.

I wish to thank the Director of Fabelta S.A., Brussels, for allowing me to publish parts of this work which were done in that laboratory.

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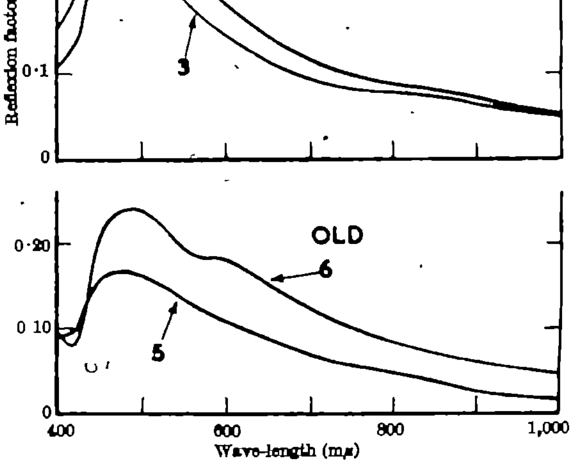
[1] Tomberg, V., Acta III Congr. Nat. Sci., Brussels (1950).

[2] Tomberg, V., *Acta Physiotherapica Belg.*, 4, 109 (1947); Acta Congr. Intern. Radiobiolog. (Venice, 1935).

[3] Prudhomme and Graber, *J. Chim. Phys.*, 5 (1950). Tomberg, V., *J. Radiologie*, 32, 358 (1951).

Spectral Reflexion Factor of the Cat's Tapetum

The physiological function of the tapetum in the eyes of animals of nocturnal habit is uncertain. However, it may fairly be assumed that by reflecting light incident on the retina back through the layer of end-organs, the tapetum reduces in some measure the absolute threshold for vision[1]. Since the tapetum is coloured, spectral sensitivities determined from absolute thresholds will also be modified. Murr[2], working on the light sense of the domestic cat, attributed differences in the wave-length of maximum visual sensitivity to differences in tapetum colour. In particular, he suggested that there occur changes of this kind during the life of the animal.



Reflexion factor of the tapetum from cats of different ages

To see whether tapetum reflexion was likely to be a factor in the current work of one of us (R. G.) on the cat's spectral luminosity curve, the spectral reflexion curves shown in the accompanying graphs were obtained. The tapeta of six freshly killed animals of different ages were dissected out, mounted in glycerine on 'black' glass, and measured on the G.E.C. recording spectrophotometer. Because of the rather small area of the tapetum—about 1·4 sq. cm.—it was necessary to use auxiliary lenses placed in the beam of the spectrophotometer in order to concentrate the light on the specimen. It was also necessary to apply a correction for light reflected not by the actual tapetum but by the surrounding black cardboard mask which exposed only the selected area of the specimen. The radiation specularly reflected at the glass–air surface of the cover glass falls on an absorbing surface in the instrument and is not included in the measured reflexion factor.

The corrected values given in the graphs show a main maximum reflexion factor at about 480 mμ and, in some cases, a rise as 400 mμ is approached and a rudimentary maximum at about 600 mμ. These last two features seem to occur together. It was obvious by direct inspection that the specimens were not uniform in colour. Probably at least two different pigments are playing a part. From the summary of the main features of the curves (Table 1), it appears that for the young cats the reflexion from the tapetum was weaker, and rather more to the blue than for the others, but the differences in this latter respect are not marked.

Table 1

Specimen No. and age of cat	Main maximum		Indications of secondary maxima	
	Wave-length	Reflexion at maximum	Below 400	Near 600
1 young	470	0·150	present	present
2 young	465	0·110	,,	,,
3 medium	470	0·254	absent	absent
4 medium	500	0·260	,,	,,
5 old	480	0·166	slight	,,
6 old	490	0·238	present	present

If the relative spectral sensitivity of the animal's eye would be V_λ if the tapetum were absent, some idea of the modification produced by the tapetum can be obtained by increasing V_λ by the factor $K(1 + \rho_\lambda)$. Here ρ_λ is the reflexion factor of the tapetum at λ and K is a constant introduced to restore the maximum sensitivity to the value unity. As an illustration, the changes in the photopic and scotopic spectral sensitivity curves of the human eye if a tapetum similar to specimen 1 or specimen 4 were introduced have been calculated in this way (Table 2). The changes are very slight.

Table 2

Photopic curve

λ (mμ)	460	480	500	520	540	560	580	600	620	640
V_λ	0·060	0·139	0·323	0·710	0·954	0·995	0·870	0·631	0·381	0·175
$V_\lambda(1+\rho_\lambda)K$ Tapetum 1	0·062	0·144	0·333	0·726	0·964	0·993	0·869	0·625	0·377	0·171
$V_\lambda(1+\rho_\lambda)K$ Tapetum 4	0·061	0·143	0·333	0·726	0·964	0·991	0·853	0·611	0·804	0·165

Scotopic curve

λ (mμ)	420	440	400	480	500	520	540	560	580	000
V_λ	0 097	0·313	0·570	0·796	0 962	0·933	0·597	0·318	0·124	0·036
$V_\lambda(1+\rho_\lambda)K$ Tapetum 1	0·093	0·309	0·577	0·807	0·970	0·933	0 589	0·310	0·120	0·035
$V_\lambda(1+\rho_\lambda)K$ Tapetum 4	0·088	0·301	0·564	0·798	0·968	0·933	0·589	0·309	0·119	0·034

It seems unlikely that the presence of a coloured tapetum can be modifying materially the observed spectral sensitivity curve of the cat's eye.

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April 5.

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[1] Gunter, R., *J. Physiol.* (in the press).

[2] Murr, E., *Zool. Anz.*, Supp. III and IV, 254 (1928–29).

Estimation of Volatile Fatty Acids and Ammonia in Silage by means of Paper Chromatography

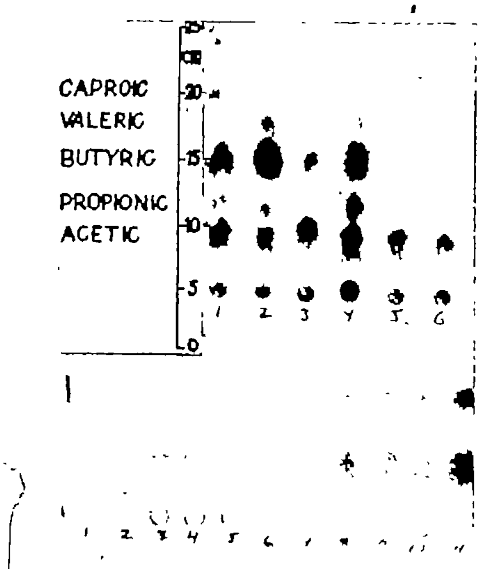
Silage-making is becoming more and more general in many countries, and it is necessary to pay more attention to its quality because the quality of milk and milk products suffers from a bad silage. The quality control of silage is therefore important. The simplest and quickest method of control is the determination of pH. In general, it can be said that when the pH of silage is between 3 and 4 (the AIV method) the decomposition processes (formation of carbon dioxide, ammonia and volatile acids) are slight in the silage and its quality is good. When the pH rises, the quality of the silage is lowered. Formation of butyric acid is then common, and ammonia is formed freely. Determination of these substances is of first importance in the control laboratories.

We have applied the chromatographic determination method of fatty acids developed by Hiscox and Berridge[1] to silage analysis, and have found that the analysis of butyric acid can be made directly from the effluent, which contains inorganic and organic ions. The spots have then frequently a slightly intenser colour than those produced by the corresponding amount of pure butyric acid in aqueous solution: this must be considered at estimation. Acetic acid cannot be determined in this way mainly owing to lactic acid, which proceeds almost at the same rate. If it is desired to determine acetic acid along with butyric acid, the acids must be distilled off from the effluent and the chromatographic determination made from the distillate.

The results of our determinations are illustrated by Fig. 1 and the accompanying table. Determination of butyric acid by paper chromatography is accurate enough for practical silage control.

Fig. 1 shows that silages of low quality may contain, in addition to butyric acid, also valeric acid (samples 2 and 4) and even caproic acid (sample 2). Propionic acid, too, often occurs.

Ammonia can be roughly determined by paper chromatography, also directly from the effluent (Fig. 2). Butanol–hydrochloric acid (2 vol. of n-butanol + 1 vol. of 6 N HCl) is used for the solvent, and the ammonia spot is developed by drawing the strip rapidly through



ig. 1. Paper chromatograms from six silage samples (raw fluents), with the following pH values (Nos. 1–6): 4·2, 4·3, ·0, 5·0, 3·8 (AIV), 3·9 (AIV) (upper paper) and from a control eries containing butyric acid 0·1, 0·2, . . . 1·1 per cent and acetic cid respectively 0·2, 0·4, . . . 2·2 per cent (lower paper). Solvent: -butanol saturated with water + ethylamine; paper. Whatman o. 1. Solvent frontier advanced in 18 hr. 28 cm. Acetic acid dvanced from the initial point 4–5 cm., butyric acid 10 cm.

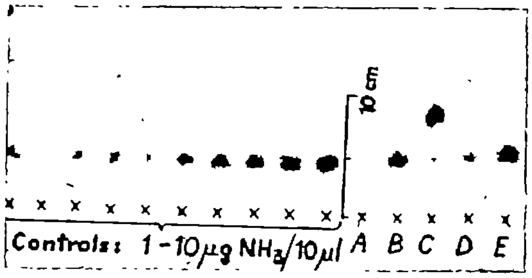


Fig. 2. Paper chromatogram from five silage samples (A–E) and from a control series with known amounts of ammonium sulphate

essler's reagent[2] and washing it in water. In ome silages a faster moving greenish spot is pro-uced by Nessler's reagent, in addition to an orange mmonia spot. This substance has not yet been dentified.

The optimum concentration region for ammonia n the paper chromatography is within 1 and 10 µgm., which means 0·1–1·0 mgm. NH_3/ml. when 10 µl. drops are used. The ammonia content of the effluents of good-quality silages is just within this region. Low-quality silages may contain considerably more ammonia and must be suitably diluted before the drop is placed on the paper. Since the salts contained in the effluent cause spreading of the spots, we have used about 1 per cent di-potassium phosphate in the reference solutions.

As the ammonia spot rapidly fades, the comparison of the spots must be made quickly, preferably when the paper is still in the wash-basin. Determination of ammonia by means of paper chromatography is not accurate (cf. the table); but it gives a rough idea of the ammonia content of silages. Distillation of an effluent made slightly alkaline to about half of its volume and titration of ammonia from the distillate gives, of course, a more exact result; but the paper chromatography may be useful in control laboratories as a work-saving method.

A detailed account will be published in *Ann. Acad. Sci. Fennicæ*.

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March 17.

[1] Hiscox and Berridge, *Nature*, 166, 522 (1950)

[2] Koch and McMeekin, *J. Amer. Chem. Soc*, 46, 2066 (1924).

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A Phosphate Ester of a Tricarboxylic Acid in Liver

We have found that the compound isolated from dog's liver and previously considered to be a phospho-trihydroxyglutaric acid[1] is instead the phosphate ester of a tricarboxylic acid. The data indicate that the compound is 2-phospho-4-hydroxy-4-carboxy-adipic acid. Since work had to be interrupted for external reasons, a preliminary report is being made at this time.

The most important evidence was derived from oxidative degradation of the phosphate-free compound, which was obtained from the parent substance by prolonged acid hydrolysis or, in a more satisfactory manner, by action of alkaline phosphatase. Oxidation with permanganate or dichromate at 100° C. in the presence of mercuric sulphate and sulphuric acid (Denigès reagent) yielded the char-

Analyses of Effluents from Five AIV-Silage Samples

pH		*A* 2·6*	*B* 4·3†	*C* 3·4	*D* 4·0	*E* 3·5
Volatile fatty acids: By paper chromatography (directly from effluent)	Propionic acid, per cent Butyric acid, per cent	0·0 0·0	0·1 0·7	0·0 0·0	traces 0·0	0·0 0·0
By quantitative distillation (Virtanen and Pulkki[3])	Acetic acid, per cent Butyric acid, per cent‡	0·44 0·00	1·10 0·81	0·39 0·04	0·81 0·00	0·32 0·00
Ammonia: By paper chromatography µgm./10 µl. (=mgm./10 ml.)		$\left.\begin{matrix}2\\3\\3\end{matrix}\right\}2·7$	$\left.\begin{matrix}10\\7\\9\end{matrix}\right\}8·7$	$\left.\begin{matrix}4\\3\\5\end{matrix}\right\}4·0$	$\left.\begin{matrix}3\\4\\4\end{matrix}\right\}3·7$	$\left.\begin{matrix}5\\4\\6\end{matrix}\right\}5·0$
By distillation (Pucher *et al.*[4]), mgm./10 ml.	–	2·04	9·64	2·50	4·56	3·39

* pH too low.
† pH too high.
‡ Distillation method gives somewhat too high values for butyric acid if the silage contains propionic acid and/or acids higher than butyric acid. Paper chromatogram makes possible identification of the acid.

acteristic precipitate of the mercury complex of acetone, which was further identified by distillation from the complex and by several characteristic reactions. Acid permanganate – bromine oxidation at 7° C. yielded 3·94 moles of carbon dioxide and pentabromacetone, which was identified by melting point, mixed melting point with an authentic preparation, and colour tests. The formation of pentabromacetone in nearly quantitative yield may be considered as a specific test for acetonedicarboxylic acid or for substances yielding it on oxidation[1-4]. Unlike compounds of the structure $R,R' = C = (COOH)_2$, which readily evolve carbon dioxide when heated in the dry state, the phosphate-free compound lost no carbon dioxide when heated up to 160° C. *in vacuo*. A stable, but hygroscopic, monolactone was formed easily, and there was some evidence of a second, weak, lactone linkage on the basis of titration in ice-cold solution. Analyses gave the following results:

	($C_7H_{10}O_8$) calc.	found
Equivalent weight of the phosphorus-free compound	74	71–78
" " " " " lactone	68	68
Molecular weight " " " " "	204	201

Elementary analysis of the barium salt of the phosphorus-free compound gave:

$C_7H_7O_8Ba_{1.5}$. Calculated, C, 19·8; H, 1·65; Ba, 48·5.
Found, C, 19·9; H, 1·54; Ba, 50·5.

With the phosphate ester, electrometric titrations gave 4·5–5·0 equivalents of hydrogen ion per mole of phosphate, and the equivalent weight was 66–69 (calculated for $C_7H_{11}O_{11}P$, 60·4). On oxidation with dilute permanganate solution, 2 moles of carbon dioxide were formed without hydrolysing the ester linkage. The oxidation product contained a carbonyl group, indicating the presence of a second hydroxyl group, other than that esterified with phosphate. It would appear that the carbonyl arose from the tertiary hydroxyl group by oxidative decarboxylation.

The following properties of the compound are of interest: (1) the phosphorus-free compound gives a dusty pinkish-red colour when heated with a mixture of pyridine and acetic anhydride (Fürth–Herrmann test[5]), similar to that of citric acid; (2) the phosphate ester shows only weak optical activity $[M]_{5461}^{23^\circ} = -3{\cdot}0^\circ$ (c, 0·26 M); (3) the phosphorus-free compound, when mixed with ammonium molybdate, was highly active $[M]_{5461}^{23^\circ} = +230^\circ$ (c, 0·003 M), a property shown by many hydroxypolycarboxylic acids; (4) acid periodate oxidation of the phosphorus-free compound for 10–60 min. gave 0·7 mole uptake of oxygen; (5) with hypoiodite, about six equivalents of iodine are consumed and iodoform is formed.

The possible biological role of the compound, which may be thought to arise from the condensation of phosphopyruvic and malic acids, appears of great interest.

We are indebted to Dr. G. Schmidt, Tufts Medical School, Boston, Mass., for a generous supply of intestinal alkaline phosphatase.

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Dietary Origin of Urinary Methyl-Histidine

THE variable occurrence in normal human urine of a substance giving a green colour with ninhydrin on paper chromatograms (R_F 0·86 in phenol, 0·28 in collidine–lutidine) has been described[1]. This substance has been identified as methyl-histidine[2].

Previous to the identification of this amino-acid as methyl-histidine, we had observed that it was constantly present in large quantities in the urines of domestic cats kept in this Laboratory, while it was absent from the urines of laboratory rats. The cats were fed on a diet consisting of raw beef 73 per cent, boiled liver 24 per cent, bone meal 0·5 per cent, cod liver oil 2 per cent, and 'Marmite' 0·5 per cent, whereas the rats were fed on rat cake (Diet No. 41 of the Associated Flour Millers, Ltd.) which contains 8 per cent skimmed milk, 8 per cent fish meal and 2 per cent cod liver oil as the only constituents of animal origin. These facts suggested that the excretion in the urine of methyl-histidine might be associated with the meat diet. We therefore examined the urines of a number of species of carnivores, rodents and herbivores, with the results shown in Table 1. These observations are consistent with the hypothesis that the urinary excretion of methyl histidine is correlated with a meat diet.

Table 1

Species	Diet	Urinary methyl histidine
Domestic cat	Meat	+ + + +
Lion	"	+ + +
Tiger	"	+ + +
Ocelot	"	+ + +
Puma	"	+ +
Kenya genet	"	+ +
Dog	"	+ + +
Rat	Mixed	–
Mouse	"	–
Golden hamster	"	–
Rabbit	Vegetarian	–
Guinea pig	"	–
Horse	"	–
Cow	"	–

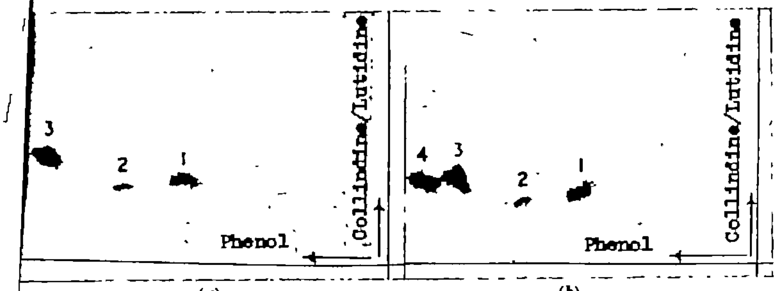
Our thanks are due to Dr. D. M. Walker for information about cows, and Mr. A. G. Searle about mice.

It might be reasonable to expect that the urinary methyl-histidine was derived from ingested anserine (beta-alanyl-methyl-histidine), which, as is well known, occurs in variable amounts in most vertebrate muscle. It should be noted that the urinary excretion of methyl-histidine is not correlated with the amounts of anserine present in the muscle of the species studied, as both the rabbit and the cat are known to contain relatively large and approximately similar concentrations of anserine in their muscles[3].

In order to explore the factor of ingested anserine, two human subjects were fed approximately 250 gm. roast rabbit meat, and their urine examined before

Table 2

Time (hr.)	Before hydrolysis		After hydrolysis	
	Methyl-histidine + anserine	beta-Alanine	Methyl-histidine	beta-Alanine
0	–	–	–	–
3	+ + +	–	+ + +	+ + +
12	+ + +	–	+ + +	+
21	+ + +	–	+ + +	trace



romatograms of urine (subject 1): (a) before ingestion of 250 gm. rabbit muscle; (b) 3 hr. afterwards.

each case 15 ml. of urine was applied to the paper in the right-hand corner. The individual ots were identified as: 1, glycine; 2, glutamine; 3, β-amino-isobutyric acid 4, anserine and methylhistidine

nd at different times after the meal. Rabbit muscle ontains between 200 and 500 mgm. anserine and 0–80 mgm. carnosine per 100 gm. wet weight[3]. s in our other experiments, the urine was run on 0 cm. squares of paper under conditions previously escribed[4]. Chromatograms were also prepared in ach case from the urines after hydrolysis with 5 *N* ydrochloric acid at 100° C. for 24 hr. The results were substantially the same for both subjects and he results for one of them are shown in Table 2 see also illustration).

We found that it was not possible to resolve nserine from methyl-histidine satisfactorily where me or other substance was present in relatively large concentrations. Consequently the increase in beta alanine after hydrolysis was taken as an index of the amount of anserine present in the urine. In no case was an increase in histidine noted after hydrolysis, which makes it reasonable to assume that most of the beta-alanine was derived from anserine and not from carnosine (beta-alanyl-histidine), which also moves to a position similar to anserine and methyl histidine on our chromatograms.

The results of this experiment support the view that a carnivorous diet can give rise to the urinary excretion of methyl-histidine. Furthermore, it indicates that the large variation of urinary concentrations of methyl-histidine encountered in human urines can be accounted for in part in terms of dietary variations. The findings also suggest that the peptide anserine may be absorbed intact from the gut and that during the first few hours after absorption it may be excreted unchanged in the urine.

After the heavy protein meal ingested in this experiment, there was relatively little increase in the urinary excretion of other amino-acids to be detected on the chromatograms compared with the anserine and methyl-histidine excretion. This suggests that the renal thresholds for these substances are relatively low. Some support for this view has also been obtained in the cat, where chromatograms of up to 500 micro litres of plasma (after ultra-filtration) have failed to reveal any appreciable quantity of methyl histidine, even though this substance was being excreted in relatively high concentrations in the urine.

These results raise the question of the site and mode of hydrolysis of anserine in the body. Enzymes which will hydrolyse anserine and carnosine have been described in liver, kidney, spleen, small intestine mucosa and intestinal juices of various animals. It is also interesting to note that Parshin found the carnosinase activity of the mucous membrane of the small intestine of man was lower than all but one of the animals examined[6]; his results also indicate that this enzyme is most active in carnivorous animals. Species differences of this sort may well play a part in our results in so far as they may explain the finding of methyl-histidine alone in the urine of carnivorous animals and a mixture of anserine and methyl-histidine in the urine of human subjects fed a high protein meal.

We are grateful to Dr. E. Hindle and the Zoological Society of London for specimens of urine from various animals.

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Kidney Citrate Levels in Nucleotide Shock

During recent studies on carbohydrate metabolism in shock, we have examined the citrate-level in the kidney of the fasting rat by Buffa and Peters's modification[1] of the method of Pucher, Sherman and Vickery[2], during the shock state produced by the parenteral injection of nucleotides. A marked increase ($P = 0 \cdot 01$) in the citrate content of the kidney occurred 1 hr. after the intraperitoneal injection of a lethal dose of adenosinetriphosphate (250 mgm. magnesium adenosinetriphosphate per 100 gm. body-weight in the strain of rat used, at an environmental temperature of 18–22° C.; see table). This increase was not maintained, and 4 hr. after the injection the level had returned to normal. In its time relationships this effect resembles that seen in fluoroacetate poisoning; but in the latter condition the increase in the citrate content of the rat kidney is much greater[1,3].

The kidney was chosen for study because it shows the most striking changes in fluoroacetate poisoning[1]. However, this effect of adenosinetriphosphate was not

Effect of the intraperitoneal injection of 250 mgm. magnesium adenosinetriphosphate per 100 gm. body-weight on the citrate concentration in the kidney of normal and medullectomized (40 days post-operative) fasting rats compared with the level in control rats given an equivalent amount of D-ribose

	No. in group	Citrate concentration in kidney (μgm. per gm. wet weight) Mean	Standard deviation
Controls	16	36	16·5
Normal rats:			
1 hr. after adenosinetriphosphate	11	93	44·3
4 hr. after adenosinetriphosphate	6	54	31·8
Medullectomized rats:			
1 hr. after adenosinetriphosphate	6	32	6·2

confined to that organ, for an elevated citrate-level was also found in the diaphragm. These results suggest some interference with carbohydrate oxidation during the shock state.

Little can be said, at the present time, concerning the mechanism of the effect. The magnesium salt of adenosinetriphosphate was used in these experiments; but there was no accumulation of citrate after the injection of molecular equivalent amounts of magnesium chloride. Nucleotide shock is accompanied by the liberation of adrenaline[4,5], and attempts were made to reproduce the effectby the subcutaneous injection of adrenaline hydrochloride (0·1 mgm. per 100 gm. body-weight). This had no effect on the citrate concentration in the kidney, examined 1 hr. after the injection, although the blood-levels of lactate and pyruvate at this time were of the same order as those found at a similar time after the injection of adenosinetriphosphate[5]. Although the adenosinetriphosphate effect could not be reproduced by injection of adrenaline, adenosinetriphosphate did not cause any increase in the citrate-level in the kidney when given to rats deprived of their adrenal medullæ (see table). Since the carbohydrate stores of the body are not mobilized in adenosinetriphosphate shock in the medullectomized rat, it would seem that the block in metabolism is only evident when large amounts of carbohydrate are passing through the metabolic cycle.

We think that these results may help to elucidate the mechanism of adenosinetriphosphate shock and, perhaps, of other forms as well; although striking changes in the concentration of citrate in the kidney have not, as yet, been found in tourniquet shock in rats.

Our thanks are due to the Medical Research Council for defraying the expenses of this investigation.

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Isolation of Octadecan-1 : 18-diol from Spanish Broom

An examination of the non-saponifiable fraction of the absolute from Spanish broom (*Spartium junceum* L.) by chromatography on alumina has led to the isolation of a fraction which is retained tenaciously by the adsorbent. The fraction was recovered by extraction of the alumina with hot ethanol. Purification readily gave octadecan-1 : 18-diol, melting point 99° (found: C, 75·5; H, 13·2; active H, 0·6; calc. for $C_{18}H_{38}O_2$: C, 75·5; H, 13·3; active H, 0·7 per cent). Octadecan-1 : 18-diol, melting point 99°, was synthesized by the reduction of diethyl octadecan-1 : 18-dioate with lithium aluminium hydride[1], and a comparison of the synthetic and natural diols and of the corresponding diacetates and *bis*dinitrobenzoates established their identity. Confirmation of the nature of the natural product was obtained by its oxidation with chromic acid, which gave octadecan-1 : 18-dioic acid.

A number of higher straight-chain aliphatic compounds in which the terminal carbon atoms carry functional groups have been isolated from natural sources. Several long-chain $\alpha\omega$-dicarboxylic acids have been obtained from Japan wax[2], and sabinic acid (12-hydroxylauric acid) and juniperic acid (16-hydroxypalmitic acid) have been isolated from conifer waxes[3]. The natural occurrence of long-chain aliphatic $\alpha\omega$-diols has not previously been reported.

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Ultra-violet Absorption of Reduced Phosphomolybdate

Estimation of phosphate with molybdate in the presence of a reducing agent is a well-established colorimetric method. Using excess of phosphomolybdate, reducing substances can also be estimated. This method was used by Briggs[1] for hydroquinone and by Neuberger[2] for homogentisic acid.

We have sought a quantitative micro method for the estimation of homogentisic acid. With Neuberger's method, the blue colour given by the small amounts handled was too faint to permit accurate estimation. However, these solutions were found to have a much higher absorption in the ultra-violet region. This is illustrated in Fig. 1, showing the absorption curve (*a*) for a solution (4 ml.) containing the following: homogentisic acid (50 μgm.); potassium dihydrogen phosphate (0·3 ml. 1 per cent) and ammonium molybdate (0·3 ml. of 5 per cent in 5 *N* sulphuric acid). Measurements were carried out in 1-cm. quartz cells in a Unicam spectrophotometer, Model *S.P.*500, and solutions were allowed to stand for one hour before measurement. The curve shows a maximum at 355 mμ, and absorptions measured at this wave-length were proportional to the quantity of homogentisic acid, as shown in Fig. 2 (curve *a*).

This method has been used successfully for the estimation of 20–50 μgm. homogentisic acid in urines, after chromatography on paper and extraction of the separated homogentisic acid[3]. No doubt the method is applicable to other substances which will reduce phosphomolybdate, provided that the oxidation

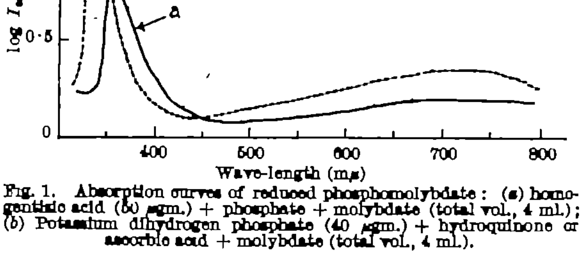

Fig. 1. Absorption curves of reduced phosphomolybdate: (*a*) homogentisic acid (50 μgm.) + phosphate + molybdate (total vol., 4 ml.); (*b*) Potassium dihydrogen phosphate (40 μgm.) + hydroquinone or ascorbic acid + molybdate (total vol., 4 ml.).

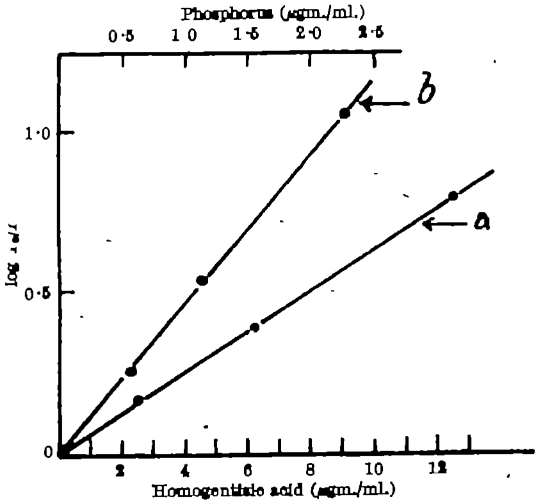

Fig. 2. Optical densities of various amounts of (a) homogentisic acid, measured at 355 mμ; (b) phosphate, measured at 335 mμ

products have negligible absorptions at 355 mμ. This is true for the oxidation product of homogentisic acid, *p*-benzoquinone-2-acetic acid[3]. Absorptions were also measured of a solution containing phosphate and excess of molybdate and a reducing agent. The latter was either hydroquinone or ascorbic acid; neither these nor their oxidation products have appreciable absorptions in the region of the observed maximum. Fig. 1 shows the curve (*b*) for a solution (4 ml.) containing potassium dihydrogen phosphate (40 μgm.), ammonium molybdate (0·3 ml. of 5 per cent in $5N$ sulphuric acid) and hydroquinone or ascorbic acid (0·3 ml. of 1 per cent in water). The curve was identical with either reducing agent. It will be seen that the absorption is again higher in the ultra-violet; but the maximum (335 mμ) is different from that of the homogentisic acid curve.

Measurements at this and lower wave-lengths necessitated rather large slit-widths for the control reagent solutions; but above 320 mμ, absorptions could be measured without decreasing the sensitivity. Absorptions at 335 mμ were proportional to the amount of phosphate (Fig. 2, curve *b*).

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Application of the Dische Diphenylamine Reaction to Pyrimidine Deoxynucleosides

THE Dische diphenylamine reaction[1], which is specific for 2-deoxysugars[2], is not suitable for the estimation of pyrimidine deoxynucleosides[3,4] because of the incompleteness of colour development.

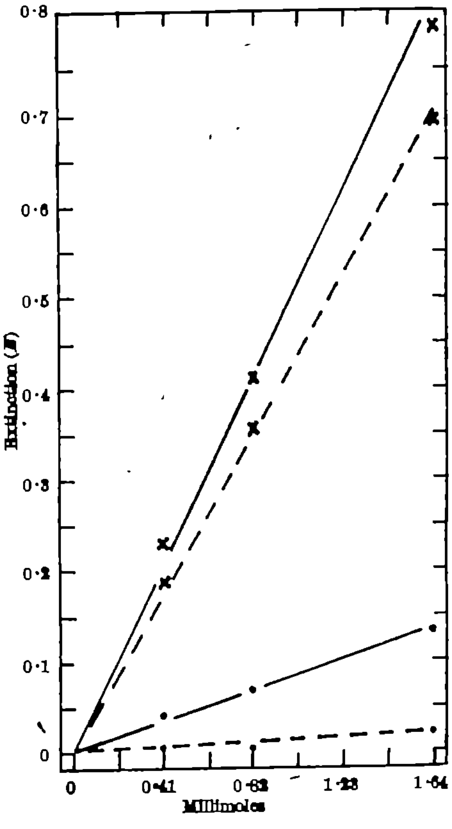
If, however, thymidine and deoxycytidine are given a preliminary treatment with bromine, there is a marked increase in colour development with thymidine, and a lesser increase with deoxycytidine.

As usually applied, the reactants in the diphenylamine test are heated in a water-bath for ten minutes or less. By extending the heating time to thirty minutes, there is no increase in colour intensity with either deoxyinosine or thymonucleic acid. As the colour development with brominated thymidine is more gradual than with purine deoxynucleosides, it is necessary, in the following experiments, to make comparisons after heating for thirty minutes.

Bromination is, with minor modifications, effected by the method of Massart and Hoste[5]. 2 ml. of the deoxynucleoside solution is heated with 0·01 ml. of bromine for five minutes in a boiling water-bath. Excess bromine is removed by aeration, and 4 ml. of the diphenylamine reagent is then immediately added.

The accompanying figure gives the extinctions at 600 mμ, obtained with equimolar solutions of brominated and untreated thymidine and deoxyinosine. Bromination causes a strong development of colour with thymidine, bringing it to a value approaching that of deoxyinosine. This is strong confirmatory evidence[6] for the assumption that there is a 2-deoxysugar residue in thymidine. Bromination of deoxyinosine under identical conditions leads to a complete suppression of colour development. This is consistent with the known lability of purine deoxyribosides in acid solutions.

A commercial sample of thymonucleic acid (from which the nucleosides used in this investigation were isolated) gives an extinction which shows that not only the purine deoxynucleosides, but also a portion of the pyrimidine deoxynucleosides fail to react with the diphenylamine reagent after treatment with



Effect of bromination on thymidine and deoxyinosine in diphenylamine reaction.

— — × — — ×, Brominated thymidine; —— ● —— ●, thymidine; — — ● — — ●, brominated deoxyinosine; —— × —— ×, deoxyinosine bromine. In contrast to this marked effect with diphenylamine, the total nucleoside concentration of such a sample of thymonucleic acid, when determined by the Mejbaum orcinol reaction[6], is only decreased by about 9 per cent. On the other hand, the free deoxynucleosides, with the exception of thymidine, do not develop any colour in the orcinol reaction after bromination.

It appears from these results that bromination causes a cleavage of the glycoside-N linkages of both purine and pyrimidine deoxynucleosides in thymonucleic acid. Further degradation of the deoxysugar is prevented by the phosphate attachments in position 3 or 5, which are not disrupted, as there is no release of organic phosphorus.

The fact that a proportion of the pyrimidine deoxynucleoside residues in thymonucleic acid fail to react with diphenylamine after bromination is evidence that the glycosidic attachment is less stable in these than in the isolated deoxynucleosides, and indicates that the C_1 of the deoxysugar of some of the pyrimidines in depolymerized thymonucleic acid are also engaged in "two distinct types of linkage (*a*) a form of polymeric linkage and (*b*) a glycofuranosidic attachment to the pyrimidine bases", as postulated for the deoxynucleosides of sperm deoxyribonucleic acid by Stacey and Overend[7].

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Dutch-type White-spotting in Rabbits

THE Dutch rabbit usually featured in books on domestic rabbit keeping is a parti-coloured animal; the posterior half being coloured, while the anterior is largely white except for the ears and two eye circles of coloured fur. This pattern, however, is not stable. The characteristic pattern ranges from almost complete white (with blue eyes) to animals with odd white marks on the muzzle and fore-feet[1,2].

The extremely low grades of Dutch spotting are represented by small areas of white fur on the toes of the forefeet and point of the nose, the remainder of the body being normal. The expression varies from an unpigmented claw or small tuft of white hairs to a white stocking on either or both feet. White-spotting of this nature frequently occurs among rabbit stocks, and it is desirable to know the probable cause. I have been able to observe the incidence of such a case among a herd of rabbits kept for meat and fur.

A buck possessing an inch or so of white on the left forefoot was mated to five females devoid of white marks so far as could be seen macroscopically. 100 offspring were recorded as 59 self and 41 white spotted. The spotting varied somewhat, from a white toe to two inches of white foot, or a small white nose-tip to a thin streak extending up the forehead. The simplest explanation is that the male is heterozygous for a gene inducing the spotting, and the data do not conflict with the suggestion (χ_1^2 = 3·24, P = 0·1–0·05). Seven females from the se group were backcrossed to the buck, yielding 42 self 35 white-spotted. By the same hypothesis, χ_1^2 = 0·4608, P = 0·5–0·3. Three females of the F_1 white spotted class were also backcrossed to the mal yielding 11 self : 16 white-spotted as previously 6 more extensively marked. In the latter, the white spotting was expressed as almost all-white forefee and an inverted V on the forehead. Assuming th segregation of a single gene, χ_1^2 = 1·848, P = 0·5–0·3 Combining the F_1 and first backcross, we have total of 177, which were classified for sex as follows 45 self ♂♂ : 55 self ♀♀ : 35 white-spotted ♂♂ : 4 white-spotted ♀♀. An analysis of the segregation gave :

Item	χ^2	n	P
Genic	3·23	1	0·1–0·05
Sex	1·43	1	0·3–0·2
Linkage	0·02	1	0·9–0·8
	4·08	3	0·2–0·1

There is no evidence of partial sex-linkage.

The small deficiencies of white-marked animals may plausibly be attributed to weak expressibility or lac of penetrance of the white-spotting gene. No sig of heterochromia iridis was noted in any animal but this is scarcely surprising since the condition is not usually manifested except in high-grade Dutch It is possible that the gene described is comparable to Castle's du^d or Punnett's s or t.

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Mygalomorph Spider in Samoa

MYGALOMORPH spiders are notoriously absent fro oceanic islands, owing to the fact that their youn do not habitually distribute themselves by sailing i the air on gossamer. It is interesting, therefore to record the occurrence in Samoa of *Idioctis helv* L. Koch, one of the Barychelidæ. This species wa recorded previously only from Fiji, and the Samoa specimens differ only in minor details from th descriptions of the Fijian ones. Mygalomorph spider of any kind are recorded in the south-west Pacifi only from New Zealand, Fiji, New Caledonia an the groups to the north. All these islands are situate in the relatively shallower part of the ocean. Mygalomorphs have not previously been recorded on th truly oceanic islands to the east.

Specimens of *Idioctis helva* were collected at tw widely separated localities on the island of Upolu in Western Samoa, and also on a minute uninhabite islet between Upolu and Savaii. From this distribution it seems unlikely that it was introduced at recent date. It inhabits a short, tough, silken tube provided with a trap-door, and all the specimens wer found within a few feet of high-water mark. Al were on rocks ; but if they also inhabit tree trunk they would be in a position to be transported acros the sea on floating timber or on canoes. Huma traffic between Fiji and Samoa cannot have a ver g history, so, if Fijian and Samoan specimens of *ootis* are really distinguishable, a longer separation the two populations and consequently natural onization would be indicated.

Two recent visits to Samoa devoted to collecting achnids have yielded a number of spiders belonging families not previously recorded in the Pacific, in ite of the fact that Samoa is one of the best-known alities so far as spiders are concerned. Members the Palpigradi and Schizomida were also obtained, d these orders do not appear to have been noticed fore in the area. Evidently considerable intensive ollecting must be done before much can be deduced om the geographical distribution of the more bscure invertebrate groups such as the arachnids.

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March 14.

Marsilea spp.: Materials for the Experimental Study of Morphogenesis

DURING recent years, improvements in the methods of sterile culture of organs and tissues have provided a valuable means of assessing the importance in morphogenesis of the various plant nutrients. It has been found that species of the heterosporous fern *Marsilea* grow well in sterile culture and show a sensitive response to changes in composition of the culture medium.

Sterile cultures are easily prepared from the resistant sporocarps, which, after treatment with absolute alcohol and bromine water, are washed once and opened in sterile water. Fertilization occurs overnight, and on the following day the young embryos may be transferred to tubes of the culture medium.

Much better growth is obtained in liquid culture than on agar media. The basic inorganic medium is a Knop's solution, supplemented by Berthelot's solution, as recommended by Gautheret[1]. The cultures are maintained at approximately 21° C., with a fairly low light intensity (100 foot-candles) which avoids any appearance of etiolation, but is inadequate for growth unless a suitable organic supply is present in the medium. Of the sugars investigated, sucrose supports the best growth, but adequate growth is also obtained with glucose or fructose. No other organic constituents are necessary, and in a medium containing sugar good growth continues even in complete darkness.

Fig. 1 illustrates a culture of *M. drummondii* A.Br. after five months of growth in a medium containing 5 per cent sucrose. Passing from the base towards the apex of the plant it will be noticed there is a gradual alteration in leaf form. The first acicular leaf (not shown) is followed by a spatulate leaf, then by bifid leaves, which in turn are succeeded by dorsiventral leaves, each with a quadrifid lamina, until finally the radially symmetrical 'four-leaf clover' type of the mature plant is obtained. Changes in the sugar concentration of the medium have a pronounced effect on this leaf succession and indeed on the entire morphology of the plant. Fuller details will be published elsewhere; but it may be indicated here that these effects are in part nutritional and in part osmotic. In this connexion, transfer experiments have yielded interesting results.

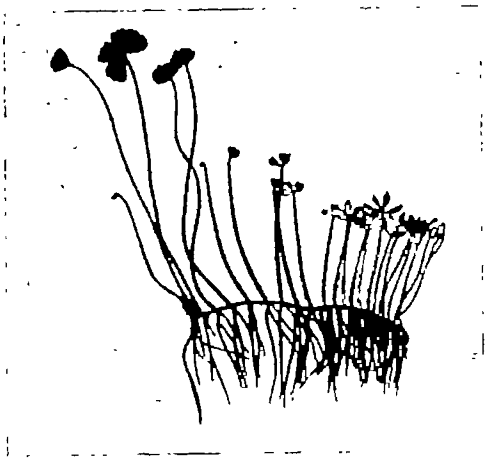

Fig. 1. *M. drummondii* after five months on medium containing 5 per cent sucrose. (Nat. size)

Isolated terminal growing points also grow well in the liquid medium: they afford excellent material for the investigation of the relation between nutrition and morphogenesis. Lateral growing points, one at the base of each leaf, begin active growth when the rhizome is divided up into separate nodes. The type of leaf produced by the laterals in part depends on the number of nodes from the base of the plant, and also on the previous nutritional history.

The sterile culture of pteridophytes is no new development[2]; but previous workers have not recorded the production of sporangia by their sporophytic plants. In the present work, which has been primarily concerned with the early stages of development, sporocarps were never obtained in cultures of *M. drummondii*. In *M. vestita* Hook and Grev., however, several plants produced sporocarps when cultured in a medium containing 5 per cent sucrose. The apical region of one of these plants is illustrated in Fig. 2. The sporocarps are quite normal in appearance; but since a dormant period is required, they have not yet been tested for viability. In Nature, strong light favours the formation of sporocarps, which are rarely produced on submerged plants[3,4]. It would seem from the present work that a high sugar concentration can take the place of the strong light normally required. Further work will be required

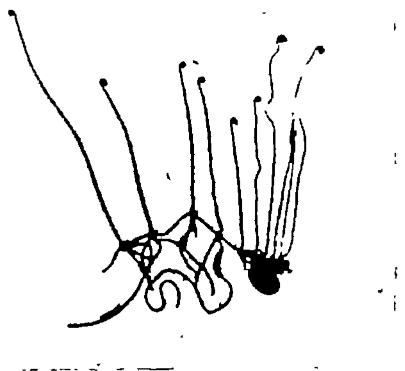

Fig. 2. *M. vestita*, after five months on medium containing 5 per cent sucrose. Apical region only. Some roots removed to reveal sporocarp. (Nat. size)

to establish this point; but it is significant that sporocarps were never produced on lower sugar concentrations.

I am indebted to Prof. Gilbert M. Smith, Stanford University, for the sporocarps of *M. vestita* and to Mr. Ernest Ashby for the two photographs.

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Invalidation of the Genus *Vaughaniella*

AN examination of specimens of an alga at first assigned to *Vaughaniella rupicola* Boergs. has led to the conclusion that the genus *Vaughaniella* Boergs.[1] represents the basal rhizomatous portion of the genus *Padina* Adans. In southern Queensland, these flattened rhizomes, often showing transition to fan-shaped thalli, are found at the base of plants of *Padina commersonii* Bory in both estuarine and exposed localities; but around the margins of shallow lower littoral pools, on exposed rock platforms, rhizome development may sometimes take place without any production of fan thalli.

A more complete account will be published elsewhere.

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An Insect Pest of Coconuts and its Relationship to Certain Ant Species

IN 1924 McDonald[1] and Welsford[2,3] reported the presence in Kenya, Tanganyika and Zanzibar of widespread damage of coconut fruits characterized by abortion of young female flowers, excessive dropping of young nuts and formation of necrotic lesions in those nuts which reached maturity. The damage was attributed to unfavourable soil conditions.

Present studies of the damage in Zanzibar have shown that it is caused by both nymphs and adults of a coreid bug which has been identified by the Commonwealth Institute of Entomology as a *Theraptus* sp. The feeding punctures of this insect are made through the calyx of the female flowers and into the young fruits, on which necrotic areas develop. Female flowers damaged in the bud stage, or when newly opened, are invariably destroyed; but if attack is delayed until after fertilization of the flower, the nuts may develop to maturity, the necrotic areas caused by the punctures developing into slit-like lesions in the husk. The damage appears similar to that caused by *Amblypelta cocophaga* China, in the Solomon Islands[4].

In the course of studies on the tree-nesting ant *Oecophylla longinoda* Latr. in connexion with clove diseases, it was noticed that damage by *Theraptus* sp. was absent or negligible in coconut palms occupied by this ant. The ant has been observed destroying *Theraptus* sp. nymphs on coconut palms, and it probably destroys or deters the adults. It is of interes that an *Oecophylla* species was apparently used as beneficial predator on citrus pests in China so fa back as the twelfth century[5]; and in the Far East Simmonds[6], Tothill[7] and Murray[8] have reported tha *O. smaragdina* is predatory on several coconut pests

Details of the yield of nuts from a single gatherin in a block of fifty-two coconut palms, of which sixteen were inhabited by *O. longinoda*, are shown i Table 1. The figures for yields shown in the tabl are approximately one-quarter of the annual yields

Table 1

	No. of nuts/tree	Percentage nuts showing lesions caused by *Theraptus* sp.	
		0–10 lesions/nut	More than 10 lesions/nut
O. longinoda present	21·2	16·5	6·2
O. longinoda absent	4·9	48·6	50·3

The figures show that, in the absence of *O. longinoda*, not only is the yield of nuts greatly reduced by *Theraptus* sp. attack, but also damage to the nut obtained is practically 100 per cent. Such damag results in reduction in size of nut and in yield o copra, as shown in Table 2.

Table 2

	Approximate No. of lesions/nut			
	None	0–10	10–20	>20
Wt. (lb.) of 100 unhusked nuts	286	264	229½	164
Wt. (lb.) of copra from above 100 nuts	47½	45½	36½	25½

Certain ground-nesting but tree-foraging ants, notably *Anoplolepis longipes* Jerd. and *Pheidol megacephala* F., ssp. *punctulata* Mayr., have replaced *O. longinoda* in many coconut areas of Zanzibar. The figures for coconut yields which have been obtained show that *Theraptus* sp. damage is not significantly reduced by the presence of the above two ant species. Observations on these ants in coconut palms show that they are not aggressive towards *Theraptus* sp.

Studies are in progress on the ecology of the various ant species with the object of determining conditions under which *O. longinoda* will replace the non-beneficial ants. Results of these and of studies of the problem on the coasts of Kenya and Tanganyika, as well as work on insecticidal control o *Theraptus* sp., will be reported later.

M. J. WAY

Clove Research Scheme,
Zanzibar.
(Seconded from
Rothamsted Experimental Station,
Harpenden, Herts.)
March 27.

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FORTHCOMING EVENT

Tuesday, August 21—Friday, August 24

ritish Institution of Radio Engineers (at King's College, bridge).—Radio Convention, Session 5: Television Engineering.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or fore the dates mentioned:

Demonstrator in Bacteriology—The Secretary, University llege Hospital Medical School, University Street, London, W.C.1 ugust 25).

Educational Psychologist—The Director of Education, 5 Port-bd Square, Carlisle (August 25).

Head of the Department of Engineering, South-East Essex chnical College and School of Art, Longbridge Road, Dagenham—he Chief Education Officer, County Offices, Chelmsford (August 25).

Mechanical and Electrical Engineers in the Works Department of the Air Ministry in connexion with the design, operation and aintenance of ground mechanical and electrical works services on .A.F. stations at home and overseas and on civil aviation stations—he Ministry of Labour and National Service, Technical and Scientific egister (K), York House, Kingsway, London, W.C.2, quoting .19/48A (Grade I) or D.370/50A (Grade II) (August 25).

Lecturer in Chemistry—The Principal, Wigan and District ining and Technical College, Wigan (August 27).

Assistant Lecturer (with a degree in zoology and botany) in iology—The Secretary, Royal Veterinary College and Hospital, oyal College Street, London, N.W.1 (August 31).

Chemist in the Insecticides and Fungicides Section at Long Ashton esearch Station, for work on the separation and characterization of he components of tar distillates—The Registrar and Secretary, The niversity, Bristol 8 (August 31).

Physical Chemist (Scientific Officer or Senior Scientific Officer rade) for work on boiler corrosion, with experience in high temperature orrosion (Ref. F.495/51A), a Physical Chemist (Scientific Officer or enior Scientific Officer grade) for work on soil corrosion, with experience and qualifications in electrochemistry (Ref. F.496/51A), Microbiologists (2, Scientific Officer grade) for work on sulphate-educing bacteria (Ref. G.255/51A), a Physical Chemist (Experimental Officer grade) for work on boiler corrosion, with experience in esearch on surface reactions (Ref. F.497/51A), a Microbiologist Experimental Officer grade) for curation of culture collection (Ref. .256/51A), and Microbiologists (3, Experimental Officer or Assistant xperimental Officer grade) for work on sulphate-reducing bacteria Ref. G.257/51A), at the Chemical Research Laboratory, Teddington—he Ministry of Labour and National Service, Technical and Scientific egister (K), York House, Kingsway, London, W.C.2, quoting the ppropriate Ref. No. (August 31).

Research Worker to take part in a programme of research in egeneration and tissue culture—The Secretary, University College, ower Street, London, W.C.1 (September 7).

Assistant Lecturer in Metallurgy in the Department of Coal as and Fuel Industries—The Registrar, The University, Leeds 2 September 10).

Engineers I at a Ministry of Supply establishment at Sevenoaks, ith experience appropriate to (a) development of optical instruents, including optical processing, and of drives for ultra high-speed ameras (Ref. C.461/51A), (b) development of radio communications nd monitoring equipment (Ref. D.343–4/51A)—The Ministry of abour and National Service, Technical and Scientific Register (K), ork House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 14).

Instrument and Radio Production Engineers in the Ministry f Supply in London, with extensive knowledge of airborne radio quipment, radio navigational aids, test and measuring equipment, ightweight and miniaturized electronic airborne equipment, quartz rystals, engine flight and navigational instruments, gyroscopic instruents, electric lamps—The Ministry of Labour and National Service, echnical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.338/51A (September 14).

Lecturer in the Department of Natural Philosophy—The ecretary, The University, Edinburgh (September 15).

Nuffield Research Fellowship in the Wheatstone Physics aboratory—Prof. J. T. Randall, F.R.S., King's College, Strand, ondon, W.C.2 (September 15).

Lecturer in Physiology (Cow and Gate Research Fellow)—The ean, Institute of Child Health, Hospital for Sick Children, Great rmond Street, London, W.C.1 (September 30).

Vice-Chancellor of the University of New Zealand—The ecretary, Association of Universities of the British Commonwealth, Gordon Square, London, W.C.1 (October 15).

Senior Lecturer or Lecturer in Botany at the University of Natal, Pietermaritzburg and Durban—The Secretary, Association of niversities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

Assistant Chief Mechanical Engineer to assist the Chief echanical Engineer in the general administration of the Mechanical ngineering Section of the Public Works Department, Sudan—The udan Government Office, Wellington House, Buckingham Gate, ondon, S.W.1, endorsed 'Assistant C.M.E.4/123'.

Insecticide Chemist in the West African Cacao Research Institute—The Director of Recruitment, Colonial Office, Great Smith Street, ondon, S.W.1, quoting 27106/39.

Physicists to supervise and undertake research work involving he application of physical methods to the study of metals and the ontrol of new metallurgical processes—The Ministry of Supply, ivision of Atomic Energy (Production), Risley, Warrington, Lancs.

Plant Pathologist in the Agricultural Department, Tanganyika—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting 27059/277.

Production Chemists for Royal Ordnance Factories in Irvine, Bishopton, Chorley, Swynnerton, Glascoed, Pembrey, Bridgwater and in headquarters, London, to assist in technical control of administration of explosives and acids manufacture or ammunition filling, including development work—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.542/51A.

Professors (2) and Associate Professors (2) in the Faculty of Electrical Engineering at the Technion (Institute of Technology), Haifa, Israel—The Secretary, The Technion Society of Great Britain, 13 Mansfield Street, London, W.1.

Research Assistant (with appropriate honours degree or equivalent) to take part in studies mostly concerned with the use of chicks in nutritional research—The Secretary, National Institute for Research in Dairying, Shinfield, Berks., quoting Ref. 51/5.

Technical Engineer to undertake fundamental technical work in the application of engineering principles to the design of nuclear reactors and allied atomic energy projects, and to predict the performance of such plants—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

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FREEDOM OF SPEECH AND THOUGHT

IN a recent lecture at the University of Manchester, Prof. W. Gellhorn, of the Columbia University School of Law, stated that there are now more physicists working on the atomic bomb project than existed in the United States a generation ago. The true significance of the position disclosed in his book "Security, Loyalty, and Science"[*] is only to be appreciated in the light of such a statement, at least so far as science is concerned. It is on the physicists, and especially on those concerned with nuclear physics, that the full impact of the security policies and the 'loyalty order' falls in the United States; and although Dr. Gellhorn addresses himself essentially to an American public, he has overseas readers in mind, and especially the effects of the situation on scientific advance generally. Other scientific workers, too, are obviously likely to be affected, especially by the loyalty order as at present administered; but in the main the security measures should chiefly affect physicists.

The book is one of a series of studies being made in the United States, under the general direction of Dr. R. E. Cushman of Cornell University, assisted by a grant from the Rockefeller Foundation, of the impact on civil liberties of the current measures taken by the United States Government to ensure internal security and to expose and control disloyal or subversive conduct. Much of the book is a factual summary of the way in which such measures are operated; but their effect on individuals and on scientific and national interests generally is assessed fairly on the assumption that national security may sometimes require restriction of some traditional liberties. Here Prof. Gellhorn's comments and conclusions have an interest that is not confined to the United States, and although there is little indeed in his book that has not already been expressed in discussions on freedom of science, security and loyalty in Great Britain during recent years, his argument may well prove as useful here as in the United States in a debate that is not yet concluded.

It is indeed a depressing reflexion that so much intellectual effort should be at this time diverted into the examination of such issues. This is not to doubt the justification for such an excellent statement of the real issues as Prof. Gellhorn has given us: indeed, if his argument achieves the revision of the loyalty programme and of the present personnel security procedures in the United States which he recommends, it should more than repay the time spent. There is no more striking feature in the book than the revelation of the appalling waste of administrative man-hours in such measures, with all the inquiries involved, to such little tangible purpose, even when we ignore what may be termed the secondary effects on recruitment and the quality of scientific work. As a demonstration of how not to seek security, this account of policy and practice in the United States deserves wide reading in Great Britain.

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[*] "Security, Loyalty, and Science." By Prof. Walter Gellhorn Pp. ix+300. (Ithaca, N.Y.: Cornell University Press, London: Oxford University Press, 1950.) 24s. net.

To the British reader the book is valuable particularly for the balanced survey it gives of the factors that should be taken into account in determining security policy or measures, and for the clear warning it gives of the price which may be paid for a security which in the end is illusory. Prof. Gellhorn makes two points very clear. Security is relative rather than absolute, and it is to be achieved by positive and not by negative means. Scientific and technical excellence is the foundation of national strength and security in this field, and if the measures by which it is sought to prevent a potential enemy from learning of developments impede scientific and industrial advance unduly, the price may be too high. Weaknesses and insecurity rather than security may result.

Prof. Gellhorn directs attention to a third characteristic of security measures. The indirect effects which may be the most far-reaching in their consequences are rarely immediately apparent. The effect on the quality of recruits for the fields of work affected, whether in Government service, in industry or in the universities, is cumulative and long-term rather than immediate. It may be a decade before there is decisive evidence that the most original and creative minds are reluctant to undertake work in such fields where their initiative is restricted and freedom of publication is limited; still more so if not only they but also those related to them are subject to searching inquiries of the type which Prof. Gellhorn describes as conducted either in 'security clearance' or under the 'loyalty programme'. The evidence offered in this book is sufficient to justify uneasiness on this count; the effect of restraint on freedom of publication on the quality of research and the rate of scientific advance had received impressive demonstration before the Second World War.

On the present scale of atomic energy research, the possibility, not to say probability, of wasted effort is considerably enhanced, and Prof. Gellhorn rightly directs attention to the importance of this factor now that even in the United States it is realized that the available scientific and technical man-power is limited. Though the scale of research is less in Great Britain, it would appear from the debate on Lord Cherwell's motion in the House of Lords on July 5 that misgivings as to the effective use of such resources are already entertained. Lord Cherwell was concerned primarily with the present administration under the Ministry of Supply, and argued that this is unsuited to the type of development work required: Civil Service methods are not adapted to the flexibility and the rapid decisions and assumption of responsibility which are necessary. Moreover, rightly or wrongly, many of the best engineers and scientific workers are not attracted by Civil Service conditions, and the present arrangements give the security officers an almost impossible task. Nothing that Lord Alexander said in his reply really met Lord Cherwell's arguments, and the admittedly weak Treasury control destroys the only substantial reason for continuing the present arrangement and not transferring the whole project to some special organization of the public corporation type outside the Civil Service system.

Lord Cherwell's motion was carried against the Government, but Lord Alexander's remarks on the security question indicate that in spite of his doubts as to the appropriateness of a special or semi-Government corporation for handling the atomic energy project in Great Britain, there is little risk that the Government will be stampeded into fresh security measures comparable with those in the United States. Prof. Gellhorn, indeed, goes so far as to suggest that the cost of security has proved so high that the time is ripe for considering whether the loyalty order should be expunged.

Prof. Gellhorn's chapters on the balance sheet of secrecy, the proper limits of secrecy and the universities and security searches, form the core of his book; but there is one further and wider aspect of which account should be taken. This is discussed in a chapter on the need for fair procedures, and more briefly in his concluding chapter. The problem of security cannot be dismissed without account of the issue, not simply of individual freedom but also of justice. It is part of that wider issue of our time, and for this reason Gellhorn's book may be appropriately placed by the side of a collection of essays by Mr. Charles Morgan which has been published under the title of "Liberties of the Mind"*.

The common thread running through Mr. Morgan's several essays is the theme of liberty, the threat to liberty and the techniques by which the tradition of liberty is undermined. As Prof. Gellhorn shows in his book, even if national policies on secrecy in scientific matters are intelligently formulated—as, in fact, he believes they have been in the United States—they are liable to be applied inflexibly and unintelligently, unless regard is paid to the wider issues involving simple human justice. No element is so liable to be disregarded as a result of popular pressures, and such popular pressure commonly arises from misconceptions as to the nature of scientific knowledge or the real issues at stake. Prof. J. L. Stocks once observed of social philosophy that when men do not know the faith by which they live, they will be apt inadvertently to betray it, and the remark is equally true in this matter of freedom of thought and utterance.

With the exception of the introductory essay on "Mind Control" Mr. Morgan's essays have appeared before; but the gist of the book is contained in that essay and in the Zaharoff Lecture on "The Liberty of Thought" which follows it. In the first, Mr. Morgan develops the theme that liberty is now endangered in the mind itself. He analyses frankly the implications of the Soviet, the Mindszenty and other trials with their inexplicable 'confessions'. He suggests that a new technique is emerging which will enable any unscrupulous totalitarian government to 'possess', in the scriptural sense of the word, the minds of their subjects. Mr. Morgan does not suggest that this is an entirely new development. He sees it foreshadowed in the mid-Victorian era, and detects in Tennyson's

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* "Liberties of the Mind." By Charles Morgan. Pp. viii+252. (London: Macmillan and Co., Ltd., 1950.) 12s. 6d. net.

'Sixty Years After'' a consciousness of what was happening. Nevertheless, although he notes the tendency of the mind to surrender more and more of ts liberties, Mr. Morgan seems inclined to attribute rather too much to overt attack, and attaches too ittle weight to the forces in contemporary life which, by weakening individuality and initiative and undermining the faith of the individual in the validity of his own mental processes, make him the easier prey of totalitarianism. We cannot continually, by precept and practice, contemn the virtues of individualism and extol the advantages of uniformity and conormity, and at the same time expect individuals to esist more effectively the attacks on their liberty, whether direct or indirect.

It has to be recognized that, in the welfare State, here is the danger that levelling down rather than evelling up standards may induce a uniformity and ack of enterprise which are fatal to creative work and the continuing advance of mankind. That danger was clearly recognized, for example, by Lord Beveridge, in his original report on social insurance as well as in the later one on "Voluntary Action". The preservation of the 'growing points', in science, art, technology, or indeed in government, is of vital mportance to a democracy, and both books direct attention to ways in which this is threatened.

In his essay on mind control, Mr. Morgan perhaps raises more fundamental issues, though he scarcely goes deep enough, and its value is rather as a chalenge or stimulus to thought than as an exposition of how to avoid the danger. Some of the issues he raises are of peculiar interest to the scientific worker: he makes clear, for example, how acute the question of the right use of science has become, and how mportant it is for men of science to address themselves to the questions of professional ethics, before their professional as well as individual influence is undermined. That in itself may involve questions of organization or the mechanics of government, which are discussed more fully by Mr. Morgan in his followng essay on the liberty of thought. Here, however, while fully as challenging, Mr. Morgan is inclined to overstate his case: he makes it plain that we can no onger take for granted much that we have been accustomed to accept from the days of Milton or earlier—we have now to be prepared to defend freedom at and from its source. But it does not follow that the dangers to democracy inherent in our present constitution are quite so serious as he suggests, or that the House of Commons is in the least likely to commit the excesses which are plainly within its power. He may underrate the restraining influence n Britain of the climate of opinion or the political tradition; but it is well that we should be reminded that the danger is there, that freedom is something to be safeguarded by our own efforts and determination. Liberty will perish, wrote Montesquieu, "when the legislature becomes more corrupt than the Executive", and we cannot watch without concern processes which weaken the sense of responsibility of either elected or elector.

In dealing with the mechanics of government, Mr. Morgan is, in fact, less convincing than Lord Justice Denning in his lectures "Freedom under the Law"; but none the less, the issues are made clear and some of his suggestions are parallel with those recommended by Prof. Gellhorn. He notes the questions involved in security against external attack, whether by armed forces or by enemy infiltrations which operate against the mind. He insists not only on the need for preventing intimidation of minorities, but also subversive intimidation by minorities. Liberty of thought, he suggests, has to be disengaged from the philosophical background of jurisprudence and made cognizable by positive law.

This challenge to intellectual leadership cannot be disregarded by scientific and other professional workers. The real danger to freedom of thought or utterance and all that Mr. Morgan understands by liberties of the mind lies really in just that indifference which enables the ill-disposed to seize institutions and prostitute them to evil purposes. Upon those liberties depend the functioning of every creative activity of mankind, in science, art and in every other field. Whether or not those dangers are exaggerated, the threat is real enough and Mr. Morgan sets it in the right context. Those who are concerned primarily with the advance of science must join forces with all who are concerned in safeguarding the liberties of men's minds and so strengthening the ramparts which defend such freedom. As Mr. Morgan writes: "There is no greater need than the world's need for a creative pause in which men shall have liberty to build and to preserve".

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THE STORY OF ENGLISH FARMING

English Husbandry

From the Earliest Times to the Present Day. By Robert Trow-Smith. Pp. 239+16 plates. (London: Faber and Faber, Ltd., 1951.) 18s. net.

IN spite of its extraordinary interest, the history of English agriculture has attracted little attention from professed historians. The great classic "English Farming" by Lord Ernle first appeared in 1912: it was last re-issued in 1936 when Sir Daniel Hall added a chapter; but it is now out of print. A revision is under consideration of the Royal Agricultural Society and the publishers and will, it is hoped, soon be undertaken; meanwhile, the advanced student has no big general treatise to work on. Dr. and Mrs. Orwin's short history is admirable for the general reader and their larger works for the advanced student, especially for those interested in the land usage. So far no similar histories have been available dealing with the development of farming technique.

The author sets out to supply this. He starts right at the beginning with the advent of the first agricultural colonists, the Neolithic peoples who about 2400 B.C. came to Britain, bringing with them the seeds of wheat (incidentally, apparently some of its associated weeds also) as well as cattle and sheep, descendants of which can still be found in outlying parts of the country. Then comes a short account of the Romano-British period, of the agriculture of which, however, little is known, though it must have been fairly efficient to maintain a relatively large population of military and towns-people. A chapter follows on the Saxon period in which the author revels—rightly so, as they were true sons of the soil: the vast majority of the villages in the central and southern parts of England have Saxon names and were presumably founded by them, being cut out from the primeval forest, though how exactly this was done is not known. By the time of the Domesday survey, however, English agriculture was already highly developed.

From Norman times onward the picture is much more complete: Mr. Trow-Smith has cast his net widely and has an eye for picturesque detail. He points out that in the Middle Ages more of the grain produced in England was drunk than was eaten. He recalls the story of the thirty canons of St. Paul's who, in 1286, were said to have drunk two-thirds of the brew from 175 quarters of barley, 175 quarters of wheat and 720 quarters of oats—apparently averaging 1,500 gallons of ale apiece in the year—33 pints a day. One can only add, adapting one of Mr. Churchill's crisp phrases: "Some canon, some thirst".

Written accounts of English agriculture begin in the early part of the thirteenth century with Walter of Henley's "Husbandry", two anonymous treatises, and Bishop Grosseteste's "Rules" of about 1240. They were published in 1890 with a translation by Elizabeth Lamond and a description by Mr. Cunningham, and are liberally drawn upon by the author. Then followed the time of plagues and pestilences culminating in the Black Death of 1348, which greatly reduced the numbers of farm workers: recovery, however, seems in many places to have been rapid, suggesting that there had previously been a good deal of redundant labour in the villages, as often happens in peasant communities. The changes resulting from the subsequent decay of the manorial system and the long series of enclosures are well described, and the author then deals with the great developments of the seventeenth century.

During the Civil Wars some Royalist landowners went as refugees to Flanders, where they saw agricultural practices much in advance of anything they had known in Britain—in particular the culture of clover, sown grasses and other fodder crops that enabled livestock husbandry to be fully integrated with arable husbandry: this forms the basis of some of our best modern systems. The author gives numerous quotations from contemporary writers and a good selection of illustrations showing the implements they used. He emphasizes the fact that ley farming, new to some of this generation, was introduced in Britain in the seventeenth century.

The author rather condemns the high farming of the mid-nineteenth century because it relied for its success on oil cakes and meals got from overseas countries "at the expense of the fertility of foreign soils, and many parts of an eroded world are to-day paying the piper for the tune played at the call of the English mid-Victorian yeoman". This is scarcely fair. The overseas farmer had not taken up land at the behest of the mid-Victorian yeoman but in order to live: not wishing for a low-level subsistence farming, he produced for the market. He was free to dispose of his produce however he liked. Great Britain offered the best terms and he sent it here. The erosion set in not because he sold the grain—which he had to do in any event—but because he was using in semi-arid conditions cultivation methods developed for humid regions, and it was long before appropriate methods were worked out. The English farmer acted rightly in buying extra feeding stuffs while he had the chance—the Danish and Dutch farmers later on did the same to their great advantage; he is equally right in producing more of his feeding-stuffs at home now that he cannot buy from abroad.

A few errors have slipped into the text. The Rothamsted dates are wrong. The Broadbalk experiments were started in 1843, three years after the publication of Liebig's book, not ten years as the author states; Lawes's experiments on superphosphate had been started about 1838. Liebig did not demonstrate the effect of chemical nutrients on crop growth; he used the results obtained by others. One would like to have seen John Andrews, the farm labourer of Debenham, given the credit for discovering Chevallier barley: it was he that found it and grew it first; but the local parson, the Rev. John Chevallier, multiplied it for distribution so it was called after him. Apart from these minor defects the book is very interesting and well worth reading.

E. John Russell

CONTRIBUTIONS TO MATHEMATICAL STATISTICS

Contributions to Mathematical Statistics

By Prof. R. A. Fisher. (Wiley Publications in Statistics.) Pp. xvii+658. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 60s. net.

This book consists of reproductions of a selection of forty-two of the author's more important scientific papers, together with a biography by Prof. P. C. Mahalanobis originally published in *Sankhya*. However, it differs in many ways from the ordinary volumes of 'collected works'. The papers have been selected by the author, and each paper has been prefaced by a short note indicating the circumstances which gave rise to it, and its relation to the common knowledge, or common misapprehensions, current at the time it was written. The papers are reproduced photographically, to the original size, with manuscript corrections and amendments. This produces a pleasing variety of text, and ensures that no new printing errors are introduced. The corrections that have been made are also apparent, a point which is of importance if the results have been used as a basis for subsequent work. Further, this method of reproduction has the very great advantage that it has enabled the book to be produced at a much lower cost, and with far less proof reading, than would otherwise have been possible. In this connexion, indeed, the generosity of the editors of the various scientific journals in permitting reproduction of their papers—only one journal, *Metron*, refused permission to republish—is to be warmly commended.

The selection of papers has been well done, though it is inevitable that there will be some disagreement as to what constitutes the perfect choice. One might, for example, have wished to see included the paper on "The Influence of Rainfall on the Yield of Wheat at Rothamsted" (*Phil. Trans. Roy. Soc.*, B, 213, 89; 1924), which contains a very elegant and original method of estimating the effect of rainfall at different times of the year, if necessary in preference to the earlier and less important paper on the variation in wheat yield from the same field ("Studies in Crop Variation. I. An Examination of the Yield of Dressed Grain from Broadbalk", *J. Agric. Sci.*, 11, 107; 1920). As an example of historical research, the paper on Mendel's work ("Has Mendel's Work been Rediscovered?", *Ann. Science*, 1 (2), 115; 1936), which is almost inaccessible in the original, is of lasting interest, while the relatively trivial paper on the half-drill strip method by Barbacki and Fisher ("A Test of the Supposed Precision of Systematic Arrangements", *Ann. Eugen.*, 7, 189; 1936) seems scarcely worth reproduction without at least a reference to 'Student's' subsequent and not wholly unjustified criticism of it.

The collection will be of immense value to all mathematical statisticians, particularly those of the younger generation who have not had direct contact with the original articles when they appeared. As Fisher himself stresses in the preface, reference to original sources of mathematical research tends to be neglected—indeed, it is only by publications such as the present one that the ordinary student can hope to make any comprehensive study of the works of a single author. In the present instance, the study is of interest and importance, not only in revealing how the subject has developed, but also because many of the results obtained and methods described are still only available in the original papers.

The book is also a worthy monument to Fisher's achievement in mathematical statistics. Even to those who are closely acquainted with his work, it brings fresh realization of its immense scope and the genius that marks so much of it.

From the point of view of a student, there are, of course, defects in the use of collected papers by a single author in the study of a subject, in that only one side of a controversial issue is presented. In such a case what is really required is a collection of papers by different authors dealing with the same subject. The same is true when a subject is developed concurrently by several authors. Perhaps if the method of reproducing scientific papers adopted in the volume is found to be generally acceptable, collections of this kind dealing with specific subjects might be attempted.

F. YATES

POLLEN ANALYSIS

Text-Book of Modern Pollen Analysis

By Knut Fægri and Johs. Iversen. Pp. 168. (Copenhagen: Ejnar Munksgaard, 1950.) 16 Danish cr.

TO quote from the preface of this little work: "Pollen analysis is still a very young science . . . and [it] has developed swiftly during the last 10 years". The aim of the authors, two well-known Scandinavian workers, has been to set forth, fairly exhaustively but simply, the technique in all its aspects and applications. This has been done in seventeen (unnumbered) chapters, which cover the subject thoroughly, from a short historical introduction to the latest suggested aid in pollen-grain identification—a perforated card key. The over-all result is an excellent book that cannot fail to be of very great help to everyone, mature worker or beginner, concerned with the science.

Some points, cf course, in my opinion at any rate, invite criticism. In the chapter dealing with the pollen diagram, for example, it would have been more convenient for the reader if the example of a typical diagram (Pl. IX) had been inserted here instead of at the end of the book. As to the merits of different types of diagram, I have always held the opinion that the 'dissolved' (unhappy word) diagram as used by Dr. Godwin and his co-workers has much to recommend it for clarity and directness of appeal. It would have been helpful if an example of this type of diagram covering the (mainly peat) zones of the Post-Glacial Period had been inserted. The omission of any illustration of these zones is indeed strange, since pollen analysis, as we know it, after all was founded on peat; perhaps the answer to this riddle is to be found in the statement on p. 84 of the book, which reads: "For ordinary work one should never analyse peat if any sediment is available". This statement is altogether too sweeping. The 'ordinary' work of pollen analysis dealt, and still deals, with peat. Are we to understand, for example, that the fine work of Jessen on the Irish bogs, so recently published, is of little value? Surely not.

The pollen keys provided are 'artificial' keys, and result in many strange bed-fellows. They deal mainly with the pollen species likely to be found in deposits in north-west Europe. They will doubtless serve their purpose—but, as the authors are at pains to impress on their readers, a pollen herbarium is a *sine qua non* for the pollen analyst.

The book is pleasingly printed, and the authors acknowledge indebtedness to Miss Jean Allison and Mr. Philip Tallantire for linguistic advice and help in proof-reading. A number of awkward words and phrases have passed uncorrected, but these are not likely to mislead the serious reader. When a second edition is called for, however, as it well may be, the opportunity should be taken of correcting these solecisms—and making a good book better.

J. B. SIMPSON

AMERICAN DECIDUOUS FORESTS

Deciduous Forests of Eastern North America

By Prof. E. Lucy Braun. Pp. xiv+596. (Philadelphia and Toronto: The Blakiston Company, 1950.) 10 dollars.

THE deciduous forests of eastern North America are treated in this book predominantly from the descriptive point of view, and Prof. E. Lucy Braun adopts as a basis the view that those forests which to-day appear to have been little modified by man can be regarded as indicative of the climax communities of the original forest cover.

The deciduous communities dealt with are considered by the author to comprise nine major forest regions based upon physiognomy and similarity of floristic composition. Historic factors are recognized as playing an important part. Thus, the mixed mesophytic forest region of the unglaciated Appalachian plateau is not only particularly the home of the chestnut, *Aesculus octandra*, and the white basswood, *Tilia heterophylla*, but is also perhaps significantly the habitat of the tulip tree, of ancient lineage. This region is by far the richest in species, with a number of kinds of trees constituting the canopy, usually more than thirteen even in a small sample area, together with a rich herbaceous vegetation some of the characteristic members of which have contributed to the beauty of gardens in England (for example, *Trillium grandiflorum*, *Erythronium americanum*, *Phlox divaricata* and *Tiarella cordifolia*). By contrast, the communities of the younger areas, where the forests are attributed to post-glacial immigration, exhibit only about half the number of arboreal species in the forest canopy, and the subordinate layers are floristically far less varied.

The mixed mesophytic forests occupy a relatively small area and are regarded as the lineal descendants of the Tertiary forests surviving in areas that have escaped glaciation, especially in the southern portion of the Appalachian plateau. The oak-hickory and oak-chestnut communities are held to represent local segregates from the mixed mesophytic type associated with more arid conditions. The communities occupying the largest areas are the hemlock-white pine northern hardwoods, covering a vast extent in the Great Lakes region, and the evergreen forests of the south-east, which are here included in the deciduous forest formation because their affinities are held to be closest with the other forest types dealt with.

For all the communities the author furnishes data from a number of sample areas respecting the woody constituents, and though reference is made from time to time to the herbaceous vegetation this is incidental rather than a feature of the main theme. The whole work is well illustrated by some eighty half-tone reproductions and nine maps, one of which is on a large scale, showing the limits of the forest regions as here defined.

The approach is essentially floristic rather than ecological, and habitat conditions are only briefly and generally treated; but within these limitations the work constitutes a valuable addition to the literature dealing with the arboreal vegetation of this area. E. J. Salisbury

CIVIL ADMINISTRATION IN GREAT BRITAIN

The Civil Service Today
By T. A. Critchley. With an Introduction by the Rt. Hon. Lord Beveridge. Pp. 150. (London: Victor Gollancz, Ltd., 1951.) 12*s*. 6*d*. net.

Mr. T. A. Critchley in this book has set out to give a factual and objective account of the Civil Service in Great Britain and the way it works, as well as to indicate in what respects it differs from the pre-war Service. This was done for the administrative class ten years ago by H. E. Dale; but Mr. Critchley covers a wider field and, it must be admitted, his book is by no means easy reading. He succeeds in conveying a clear picture of the way in which the Civil Service has grown with the increasing demands on government for positive rather than negative functions, and of the way in which certain of its inherent weaknesses are linked to such measures for obtaining public control and ministerial responsibility as the parliamentary question. But something much more vivid than the few flashes he gives of four or five Civil servants at their daily work will be required to hold the interest of the many whom he is trying to convince as to the necessity for a Civil Service and the way its size is determined by the public demand for services; and to any thoughtful reader the picture he presents of the complexities of administration is as frightening as that which he gives of the extent to which the Civil Service now touches, and sometimes paralyses, the whole of civil life.

This is not nearly as profound a book as either Mr. H. E. Dale's or the more recent studies of Dr. E. N. Gladden or Mr. H. R. G. Greaves, though it could easily have had a wider appeal. On the whole, Mr. Critchley is too much on the defensive, and what he does not say is sometimes more significant than what he actually writes. A working Civil servant could after all have scarcely been expected to write the obvious rider as to the effect on the Civil Service, not to mention on Parliament and ministers, of overloading Parliamentary sessions with legislation, however admirable individual measures may be and no matter how much public support they receive. Disregard of administrative limitations may be as disastrous as disregard of known chemical or physical properties in technical development.

Even where Mr. Critchley might be expected to be less inhibited he is too reserved. More should have been said of the Whitley Council system in the Civil Service, on the real weakness of which he merely touches. Further, though he admits that Civil servants are not infallible, he is inclined to lay the blame for defects entirely outside the Service. Of local government he says little and that little is disparaging, betraying no hint that in the revivification of local government might be found the way to a solution of the problem of complexity at the centre. He questions, in fact, the value of devolution, and when he writes of the necessity for a real spirit of public service he is plausible rather than persuasive in arguing that by this means deficiencies in organization would be corrected.

Unquestionably more mutual understanding between the Civil servant and the public is required —and, also it might be added, a clearer appreciation of the limitations of the Civil Service on the part of Parliament and Cabinet. Mr. Critchley's book may do something to further that understanding, but the dominant impression it leaves on the mind of the reader is the necessity for some very clear thinking about not so much the organization and functions of the Civil Service but rather the whole structure and organization of government, and the imperative necessity for grappling with that problem of local government reform which all political parties seem determined to ignore or avoid.

There are three other points that will strike the man of science who reads this book. Mr. Critchley clearly believes that there is room for the wider diffusion of scientific methods throughout the Service and that such a step would have a tonic effect. Nevertheless, he is sceptical as to the effect on a democratic system if the man of science once comes to dominate, and he becomes confused when he refers to the man of science or other expert as an administrator. Much more dangerous to democratic institutes, however, is the tendency for parliamentary democracy under the conditions depicted by Mr. Critchley to pass into tyranny of the executive. It is clear from this book, that that danger is yet to be removed.

The third point that emerges from the figures given by Mr. Critchley and the general picture he draws is of the extent of the demand which present conditions make upon Great Britain for trained man-power. Can the nation afford to devote to non-productive tasks its highly trained men and women in the numbers required to execute the tasks now placed upon the Civil Service? Can the educational system of Great Britain supply the necessary administrative talent, even if we draw freely on all possible reserves of it from science and technology? These are but a few of the questions raised by a book that, purporting to be descriptive, is highly suggestive to any thoughtful reader and, for all its limitations, covers the ground at least as well as any other. R. Brightman

Elements of Optical Mineralogy

An Introduction to Microscopic Petrography. By Prof. Alexander N. Winchell, with collaboration of Prof. Horace Winchell. Fourth edition. Part 2: Descriptions of Minerals, with Special Reference to their Optical and Microscopical Characters. Pp. xvi+551. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 100s. net.

THE fourth edition of Part 2 of A. N. and H. Winchell's "Elements of Optical Mineralogy" follows the third after an interval of eighteen years. During this period important developments in mineralogy have resulted from the intensified X-ray study of crystals, leading not only to increased knowledge of crystal structures, but also to a better understanding of variations in mineral composition, and to a revised classification.

As in previous editions, the book includes descriptions of all minerals the optical properties of which are sufficiently well known to permit diagnosis by means of a microscope. In bringing the work up to date, emphasis has been laid especially on the properties which serve this purpose; but details of the crystal structure of individual minerals as determined by X-rays are also given.

In the third edition, while the primary classification was chemical, the silicates were subdivided, so far as the knowledge of the time permitted, into groups on a structural basis. This system has been followed in the fourth edition; but the increased knowledge has permitted its extension to include within these groups all silicate minerals, with the proviso that the inclusion of certain minerals in particular groups is tentative. Opportunity has also been taken to bring into use the group names, tectosilicate, phyllosilicate, etc., proposed since the last edition.

This is a standard work, and it is regrettable that the increased cost of book production in the United States, and the current rate of exchange, necessitate a price that must put the book out of reach of many potential buyers.

Industrial Solvents

By Ibert Mellan. Second edition. Pp. x+758. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1950.) 96s. net.

IN the eleven years which have elapsed between the publication of the first and second editions of this work, many new solvents have been discovered or developed for commercial use, and measurements of physical properties have multiplied. It is not surprising, therefore, to find that the size of the volume has increased by more than 50 per cent.

The first 200 pages deal with solution and general properties of solvents in a manner which may appear unorthodox to physical chemists, unless they realize that the subject-matter is concerned mainly with solvents and their uses in the paint and varnish industry. A bad fault occurring here and throughout the book is the presentation of data on solubility, viscosity and rates of evaporation without any mention of temperature. Many figures given in this part are repeated later, and it is suggested that a great improvement would result from a thorough revision and drastic curtailment.

The remainder of the book contains a vast amount of information of most diverse nature regarding the properties and uses of some four hundred liquids and their mixtures. Numerous commercial solvents are included and their composition indicated. Some of the data recorded appear to be of little value, while an item of real interest, the price of the solvents, has been omitted. Minor criticisms apart, however, there is no doubt that this volume, with its wealth of information collected from sources which are in many cases inaccessible to the average reader, must be regarded as indispensable to all those whose work involves the use of organic liquids. H. E. WATSON

The Technology and Chemistry of Alkaloids

By Frank E. Hamerslag. Pp. viii+319. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1950.) 48s. 6d. net.

THIS book is primarily intended to assist those engaged in the manufacture of alkaloids. It is therefore principally, but far from exclusively, concerned with processes of isolation (or synthesis) and purification. Following a brief description of general procedures and technical equipment, the commercially practicable alkaloids are discussed in turn, either as individuals or as related groups, in eighteen chapters. Each chapter contains some discussion of the structural chemistry, the natural sources, the pharmacological properties and the means of identification of the appropriate alkaloids, in addition to a description of the manufacturing methods used. It is probably in this last respect that the main value of the book emerges, for the author is able to draw upon his personal experience in order to evaluate procedures, to give practical advice and to make specific recommendations. The detailed descriptions given of the methods of isolating individual alkaloids certainly merit the attention of all who have occasion to undertake these operations. The book is equipped with a comprehensive index and the text is liberally supplied with references to the original literature.

The Thought of C. S. Peirce

By Prof. Thomas A. Goudge. Pp. xiv+360. (Toronto: University of Toronto Press; London: Oxford University Press, 1950.) 40s. net.

THE life of Charles Sanders Peirce (1839–1914) presents the world of scholarship with a problem at once profound and fascinating. Prof. Goudge, in writing this distinguished book, sets out to explain why this should be, and what can be learnt from it. Essentially, Peirce was an example of ambivalence; he was capable of an enviable analytic power at times (perhaps mostly) overwhelmingly naturalistic, at other times completely transcendental. If a conclusion is permissible regarding a life so fruitful and yet lived so dangerously, it is that his naturalism triumphed in his mind, his transcendentalism in his heart. This entailed a certain rigidity of partition between theory and practice, exemplified by the extremely abstract character of his thought when functioning as a philosopher or logician, alongside a thoroughly competent, almost mundane, affection for experimental chemistry, in which subject he graduated *summa cum laude*. When to all this is added more than a touch of the poet and the mystic (making him accord to æsthetics, for example, an exalted place in his hierarchy), it is clear with what a unique mind we are confronted.

Prof. Goudge shows a sure touch: he lets the restless intellect of Peirce shine through, without the interposition of a biographical screen. An excellent memoir is the result, full without being repetitious, understanding yet critical. F. I. G. RAWLINS

A HUNDRED YEARS OF PLANT MORPHOLOGY*

By Dr. H. HAMSHAW THOMAS, F.R.S.

IN 1851 British botanists were still mainly occupied with the description and classification of plants, studies which were very similar to those which had been carried on since the days of William Turner in the sixteenth century. The work of men like Grew, Hales, Bradley and Knight, who realized the interest of plant physiology and plant biology, had exerted little influence on the main current of botanical thought; in fact, these men were not generally regarded as botanists. Botany was studied only in the field, the garden and the herbarium; botanical laboratories did not exist, and teachers like Henfrey and John Hutton Balfour (known to his students as "old woody fibre"), who attempted to develop anatomical study with the aid of the microscope, had met with little success.

At the time of the Exhibition of 1851, many of the outstanding botanists of the early nineteenth century were still living. Robert Brown, in his seventy-eighth year, was president of the Linnean Society; Sir William Hooker was director of the Royal Botanic Gardens, Kew; John Lindley was professor in University College, London; J. S. Henslow, Darwin's teacher, still held the chair of botany at Cambridge but was also rector of Hitchin and only resided in Cambridge during the Easter term; Sir Joseph Hooker had just returned home from his Himalayan journey, and Charles Darwin was quietly working at Downe on Cirripedes and brooding over the 'species question'. Modern botany was being actively developed in Germany by von Mohl, Nägeli, Hofmeister and others who had been stimulated by Schleiden; but it had very little influence in Britain. It is remarkable that there is no reference in the "Origin of Species", the letters of Charles Darwin or the published letters of Sir Joseph Hooker, to Hofmeister's "Comparative Researches on the Higher Cryptogams and Gymnosperms" which was published in 1851, and demonstrated the existence of an alternation of generations in these two groups—a powerful argument for the idea of evolution. This work was, however, translated into English and published by the Ray Society in 1862.

The outlook on plant structure in 1851 was that commonly held before the coming of the doctrine of evolution. Each species was believed to be the result of a separate act of creation; it had a form and structure which distinguished it from other plants. But among the great diversity of form it was possible by the exercise of the mind to recognize certain unifying principles. A mental picture of an ideal plant might be formed to serve as a standard with which all actual living forms could be compared. Goethe and the German Nature philosophers of the early nineteenth century formulated different concepts of the ideal plant, but Goethe's was the only one of lasting value. This was an imaginary organism consisting of a stem bearing a series of leaves showing various types of metamorphosis, or conceptual change, and having roots below the ground. Goethe's new science of morphology made considerable progress. We find Lindley expounding it in 1832 in his "Introduction to Botany". In 1857 Henfrey, in his "Elementary Course of Botany", writes: "the study of the metamorphosis of the organs of the flower is now advanced far enough to set all general questions at rest". Although his treatment of morphology and comparative anatomy is mainly descriptive, Henfrey defined this branch of botany as having the object of ascertaining what are the elements of plant organs, and of tracing out the laws under which they acquire the different forms presented in fully developed plants.

The publication of "The Origin of Species" in 1859 gave a new impetus and a change of direction to the comparative study of plant form. While Darwin himself did not claim that the parts of flowers had arisen in evolution from leaves of a uniform type, he mentioned that "almost everyone is familiar with the view that the floral parts are metamorphosed leaves". At first there seems to have been no change in botanical studies; but a great revolution in the outlook of botanists took place between 1870 and 1880.

The leaven of the concepts of evolution, the work of the great German plant scientists, the genius and energy of Prof. T. H. Huxley, the Education Bill of 1870 passed by Gladstone's Liberal Government, all combined to produce far-reaching results. Huxley had been teaching in South Kensington in buildings resulting from the 1851 Exhibition, and he undertook the organization of classes in biology to train teachers in science for the new public elementary schools. These classes included adequate practical work, an innovation in Britain at the time. Studies of a taxonomic kind were subordinated to the teaching of anatomy, physiology and the life-histories of plants. Thiselton-Dyer gave the first course in botany in 1873, assisted by Lawson of Oxford, Vines came from Cambridge as an assistant in 1875, and later Hillhouse, Daniel Morris and Bower took part in the teaching. Before long, teaching with laboratory work on the same pattern was begun in several British universities. Lawson began at Oxford, Vines, although not holding the chair, organized classes at Cambridge, Hillhouse went to Birmingham, and Bower to Glasgow. Dyer played a large part in the foundation of the Jodrell Laboratory at Kew, where much important work in plant morphology and physiology has been carried out.

The establishment of the Normal College of Science, which later became the Imperial College of Science and Technology, was a very important event in the history of botany in Britain. It produced a small band of enthusiastic teachers and investigators, two of them responsible for my own interest in botany, and it led to considerable activity in the investigation of plant form and structure.

At the outset, the exponents of the new botany concentrated on the objective study of all aspects of plant life. The great text-book by Sachs was translated into English and published in 1875. It contained little morphological theory; but plant structure was treated in some detail with frequent reference to the development of organs and their physiological implications. This book aided the new movement. But very soon the minds of biologists began to be influenced more and more by the ideas of evolution, and the establishment of phyletic relationships became one of the chief endeavours of many British botanists.

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* Substance of a paper entitled "Changes in the Outlook on Plant Structure during the Past Hundred Years" read on August 9 before Section K (Botany) at the Edinburgh meeting of the British Association.

Between the years 1880 and 1910 the study of plant structure was dominated by the belief that it held the key to the problems of phylogeny. Attention was mainly paid to the Pteridophyta and Gymnosperms, the possible connexion of which had been indicated by the work of Hofmeister. This climate of thought was intensified by the striking discoveries in Britain of fossil plants with well-preserved structure. These were especially due to W. C. Williamson, who was appointed professor of natural history in Owen's College, Manchester, on its foundation in 1851. Between 1868 and 1895 he described the structural details of many interesting and novel forms from the nodules of the coal measures of Lancashire and Yorkshire, and showed how some ancient pteridophytes were trees with secondary thickening. This and other contemporary work directed attention to the importance of this group in the vegetation of ancient times, while the structure of the stems called *Lyginopteris* and *Heterangium* suggested a connexion between the ferns and cycads.

All this historical evidence of evolution based on anatomical structure made a profound impression on the younger botanists of the time and many of them became active investigators. D. H. Scott, who was keeper of the Jodrell Laboratory, became associated with Williamson and afterwards continued to describe the structure of fossil plants; Kidston as an amateur began his detailed investigation of the Carboniferous plants of Scotland; Seward studied with Williamson at Manchester, and then specialized on the plants of the Mesozoic period; Oliver, working with Scott, established the characteristics of the Pteridosperms, and later added greatly to our knowledge of fossil gymnosperm seeds. At the same time, our knowledge of the living pteridophytes was being greatly extended, especially by Bower, who devoted his long life to the investigation of this group.

It would be difficult to exaggerate the importance of this period in the acquisition of factual knowledge, though the general trend of thought of the time is open to criticism from the philosophical aspect. For some twenty-five years it was assumed that Goethe's morphology could be forced into an evolutionary frame. As Dr. Agnes Arber so aptly writes, "by a feat of legerdemain, which seems to have passed almost unnoticed, the Ancestral Plant was substituted for the Archetypal Plant and those characters which had, with reason, been attributed to the mental conception of the archetype were, without further justification, assumed to have been proven for an actual historically existent ancestor". This point of view was encouraged among botanical students in Britain by the earlier translations of Strasburger's "Text-book of Botany". For a long time it proved a real stumbling block to the understanding of the fossil record, as well as creating an unbridgeable gulf between the Thallophyta and the Cormophyta.

The preoccupation of British botanists with the cryptogams and gymnosperms led to the realization of the value of anatomical characters in the study of plant morphology, a view that was regarded as heretical by the German botanists. It resulted, however, in considerable neglect of the flowering plants. Before 1920 almost the only extensive series of investigations in this group was the study of seedling structure under the leadership of Dr. Ethel Sargant. At first the aim of this work seems to have been mainly phylogenetic, but as it progressed Hill and De Fraine, and also Compton, were led to recognize the importance of physiological and ecological considerations.

The growth of the study of ecology, genetics and cytology towards the end of the first decade of this century diverted the attention of many young botanists from the pursuit of phyletic morphology. These subjects, as well as physiology and physiological anatomy, caused the problems of plant structure to appear in a new light. Bower's great book on "The Origin of a Land Flora" (1908) introduced biological considerations into morphological discussion and thus initiated a break with tradition; hitherto plant anatomy and morphology had been completely separated from physiological considerations.

From this time onwards there was in Britain a steady weakening of the view, expressed in Strasburger's text-book, that phylogeny is the only real basis of morphological study. This dictum was severely handled by Prof. W. H. Lang in his address to Section K of the British Association in 1915. He advocated a wider view of the significance of plant structure gained from the study of parallel developments, the methods of advance in different groups and in different generations of the life-cycle, the changes observable during development and the results of experimental treatment. Though this causal outlook is essentially different from the historical outlook, there is no opposition between causal and phyletic morphology. It has to be recognized that "there has been an evolution, not of mature plants, but of specific substances exhibiting development". Owing to the First World War, this admirable address probably received less attention than it deserved. A few years later Kidston and Lang published their full account of the plants of the Rhynie Chert, and opened up new lines of thought on plant evolution. They described very early plants which were completely different from the *Urform* of Goethe; and Lang's later work on the Silurian and early Devonian forms, together with that of Halle, Krausel and Weyland, showed that these forms were typical of the early cormophytes.

At the meeting of the British Association in Edinburgh in 1921, Dr. D. H. Scott as president discussed the phyletic implications of the recent discoveries in the Rhynie Chert, while Prof. Bower developed the causal side by a very interesting paper on size and form. Some of us who were present felt that, from these two aspects of morphology, real progress was being made; but the great problem was the bearing of this new knowledge on the morphological study of the flowering plants.

It seemed to me in 1932 that we should make no progress until we recognized clearly that Goethe's concept of metamorphosis had no evolutionary significance: for this reason I suggested that a fundamental distinction existed between the old morphology and the new. But this opinion has gained adherents very slowly. In the period between 1925 and 1939 Miss E. R. Saunders carried out a series of researches on the vascular structure of angiosperm flowers with the view of elucidating the evolution of carpels. While adding considerably to our factual knowledge, the value of her conclusions depends on the validity of her premises, and it seems doubtful if her basic suppositions were justified from a historical point of view. On the other hand, the work of Dr. Agnes Arber shows that most valuable results are forthcoming by strict adherence to the philosophical system of the old morphology. Many people now find this approach to the study of form difficult to understand owing to our changed outlook on natural objects. They may have read papers like the admirable address on the interpretation of plant structure delivered to Section K of the British Association in 1939 by Prof. D. Thoday, and cannot envisage a system of thought from which biological and physiological considerations are excluded.

A survey of the changes in outlook since 1851 seems to show that form and structure can be viewed from three separate aspects: the old, abstract and purely intellectual approach; the causal and developmental point of view; the objective and historical study of plant evolution, which is, perhaps, still undeveloped as a logical system of thought. While these three branches of study will probably be best developed as separate disciplines, I believe that their results will eventually contribute to a synthesis of far-reaching importance.

GEOGRAPHY IN THE SERVICE OF MANKIND*

By E. O. GIFFARD, M.B.E.

A LAYMAN is not the right person to review the academic evolution of geography or to put forward detailed proposals for its further development as a scientific study: such matters must be left to those properly qualified to deal with them. A layman, however, may quite properly examine the record of the services of geography to the common people, and, indeed, may also be a proper person to urge that geographical knowledge shall be more frequently and widely applied in the conduct of both national and international affairs.

It is commonly said that 'pure' scientists are not concerned with or about the use made of the knowledge which they accumulate. Results, in their case, are said to be sufficient if it can be proved that something has been added to the store of human knowledge. This familiar argument is, of course, basically sound; but it appears to overlook the fact that, in the last analysis, a man of science is a specialist or expert employed in the service of his fellow-men. That is to say, he is, directly or indirectly, a servant of the public. Now the public is accustomed to assess the value of any study or activity by an analysis of its observed or deduced results. If the results appear to be good, then the study or activity in question continues to command respect and support and the specialists and experts concerned enjoy a high reputation. If, on the other hand, the results appear to be unsatisfactory or if, after a reasonable time, no results can be seen or deduced, then the value of the particular study or activity becomes suspect and the support accorded to its practitioners is liable to be diminished. For these reasons it is submitted that men of science and particularly geographers cannot afford to remain entirely disinterested in the use made of their knowledge and ought to do whatever they can to encourage its useful application.

As has been said, the public tends to evaluate a study or activity by its visible, demonstrable or deducible results. In this connexion the words 'visible and demonstrable' are particularly important. Remember the wisdom of those who insisted that justice must not only be done but must "manifestly be done". If public respect for scientific work is to be maintained at a high level and if financial support is to be forthcoming on an adequate scale, then the results of such work must be manifest. In this connexion the increasing dependence of our universities upon the public purse is not to be forgotten.

Results sufficient for the purpose need not, however, be directly produced by those who accumulate the required knowledge. It will serve well enough if they are usually produced by laymen who know how to use the knowledge or the techniques supplied by the professional experts, provided always that the experts receive adequate credit for the vital part they have played.

Compared with many other scientific workers or experts, the geographer is somewhat handicapped in the matter of producing visible or demonstrable results. The physicist, for example, lacks no publicity for the results of his labours, nor does the chemist or the engineer. The geographer, however, like the economist or the psychologist, deals largely in ideas which can rarely, if ever, be translated into anything which can be seen except upon paper. Perhaps he is a little better off than the economist and certainly he is better off than the psychologist, because the geographer at least has the solid earth as the subject of his study, whereas the psychologist is concerned with the invisible and intangible thought processes of the human brain. Nevertheless, the geographer creates few visible evidences of his work and it is not often possible for the layman to pause and point and say "that was done by a geographer".

Since geographers are not, in the ordinary sense of the words, either producers or administrators, since they do not till the soil, fish the seas, labour directly in industry, engage in trade or direct the energies of those who do these things, their contribution to the common effort and the common weal has to consist, on one hand, of learning and recording things about the earth as the home of man and, on the other, of teaching and advising. For visible results the layman has to be content with books and maps and things on paper: for other results he must rely on deduction rather than sight. In other words, he must look for abstract rather than concrete evidence. Naturally enough, he thinks of the geographer (when he thinks of him at all) as the informer, teacher or adviser, and he thinks he ought to be able to detect the influence of the geographer in many departments of human affairs. Nor is it unreasonable that he should do so. As practitioners of a subject which can claim no less than twenty-one academic chairs in Great Britain alone, as intellectuals equipped with special knowledge about the home of man, geographers ought surely to be found exerting a profound influence on the conduct of both national and international affairs. What are the facts?

Outside the universities and the schools, geographers are held to be of small account. In the departments of State, in local government, in industry and commerce and in the Fighting Services they are almost unknown. That surely must be very disappointing, if not humiliating, to professional geographers. Certainly it is a thought-provoking fact to laymen. Admittedly geographers have served on one Royal Commission (the Royal Commission on the Geographical Distribution of Industry) and may have served on others though not specifically as geographers. Some have served on the staff of the

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* Substance of a paper read on August 10 before Section E (Geography) at the Edinburgh meeting of the British Association.

Ministry of Town and Country Planning (now known by another name, but, like the rose, retaining the same odour), and a few have been appointed to similar posts in local government. A few may be serving in administrative posts in the Dominions and Colonies, and it is possible that one or two are to be found as advisers in industry and commerce. Some there are, of course, serving with distinction in the Fighting Services, but few of these serve as geographers. In truth, the number of qualified geographers employed as such in any sphere of administration or in any public service may fairly be described as negligible. Only as teachers in the universities and schools may the qualified geographer be found in fair numbers, and sometimes, even in such places, he still has difficulty in maintaining his status and dignity as an important specialist.

It is clear, therefore, that, if geographical influence has been brought to bear on problems of the day, it has been largely exerted by laymen. We know, of course, that laymen do apply geographical knowledge daily in matters great and small; but there must be very few laymen in positions of authority whose knowledge and appreciation of geographical principles are equal to the requirement. Unfortunately, also, laymen making use of geographical knowledge are often not very sure what sort of knowledge it is that they are using, and very few of them ever pay tribute to the people from whom they obtained it. Thus the professional geographer rarely gets any credit and, unless he is a school teacher, he remains in the background—a vague, shadowy figure whose function remains largely a mystery to the layman.

Are things any better elsewhere? Let us see what those who ought to know say about the state of affairs in France. M. Georges Chabot, professor of geography in the Sorbonne, agrees with M. Louis François, inspector-general of public education in France, that "The Public is largely ignorant of Geography and the Press is in the same state": and that in France, which has produced some of the greatest geographers of all time. In Germany, where geography was once held in the highest esteem, the subject is making progress towards revival but has had to pay heavily for having allowed itself prior to 1939 to become the tool of political gangsters. In the United States geography is alive, and geographers are more vocal than in Britain; but convincing evidence of intelligent application is lacking or difficult to find. As for American politicians, they pay lip service to geography but their actions sometimes justify doubts as to whether they fully understand what they praise. In other parts of the world the situation seems to be the same or not so good. The truth is that, although geography has marched forward in the universities and the schools of a great many countries, it remains barely noticed by statesmen and administrators and is largely ignored by the average, adult citizen.

In the British Commonwealth great problems arise almost weekly which demand the assistance of the best brains and the wisest heads; but though quite a number of these problems lie well within the legitimate field of the professional geographer, he is seldom consulted. What, perhaps, is more deplorable is that geographers themselves do not seem to exert themselves to make their influence felt. Far-reaching political and economic proposals are widely debated in Britain in connexion with which the qualified geographer could render signal services by contributing his knowledge and stating his convictions, and yet never, or scarcely ever, is his voice raised loud enough or in time to affect the issue. Charged with indifference or sloth in these matters, some geographers have said that it is not consistent with their position or their dignity to join in political or other public controversies. It is here submitted that such an attitude is wrong. To remain aloof, withholding vital information or advice merely because no one has thought of asking for it, is equivalent to issuing an invitation to be ignored. Unfortunately, there are many who, for one reason or another or for no reason at all, fail to seize the opportunities for service which offer themselves. We may find in that fact one of the reasons why geography lacks its fair measure of public esteem and support and why so few geographers are to be found in positions of influence outside the academic field.

It is one hundred years since Section E of the British Association was established. By now geographers should be able to point with proper pride to the achievements of their kind in administration and public affairs. There should be trained geographers employed, at least as advisers, wherever geographical knowledge is essential to wise decisions and intelligent action. The simple fact that geographers are so rarely to be found occupying such posts is evidence enough that geography has not yet become the force which it ought to be. Geographers have knowledge which contains the seeds of a great power for good. Wisely disseminated and applied, that knowledge might yet do much for mankind and for the peace of the world. It is time that that knowledge became more widely known and used, and it is more than time that geographers took action to make it so.

That the study of geography has done good and has accomplished much would not and could not be denied by any intelligent person who cared to give the matter careful thought. The great wealth of information which has been so patiently collected, analysed and recorded in the forms of books, papers and maps is irrefutable evidence of the skill and industry of practitioners of the subject. In the practical sphere the record of exploration and of research work in the field is a record of which geographers may justly be proud. In the schools of Great Britain the teaching of the subject has been revolutionized, and slowly but surely it has gained status and respect despite many handicaps and a good deal of unreasoning opposition. In the universities, as we all know, the subject has advanced beyond the most sanguine hopes of those who laboured fifty or more years ago to obtain for it a bare foothold. Yet, despite these achievements we cannot pretend that things are satisfactory. The authors of the Unesco pamphlet entitled "Towards World Understanding" have felt obliged to write ". . . in spite of the progress of geography in methods of research and dissemination, the efforts of geography teachers produce disappointing results". Again, in the same pamphlet they go on to say, ". . . actually less is known of geography to-day than formerly". We may question the accuracy of these statements; but it is impossible to deny that the mere fact that a number of distinguished geographers and teachers can agree to make them is alarming.

Another thing which is disquieting is that, despite the brilliance of many of the teachers and the interesting manner in which the subject is presented in so many schools, pupils are not generally enthusiastic about geography. It is safe to say that, in most cases, geography is the subject which promising pupils want to drop when they are approaching the period in school-life when something has to be given up to allow for more intensive study of other subjects. In this readiness to drop geography towards the culmination of the school course and in the desire to avoid taking it in the examinations, the more brilliant pupils are all too often encouraged by head teachers, who seem prone to share the pupils' lack of interest in the subject. What can be the explanation of this? It is submitted that the explanation is the same as that already suggested as being the cause of apathy in the adult citizen, namely, lack of evidence that geography is something applicable to life. Children can see daily evidence of the application of physics, chemistry, mathematics, biology and engineering, but they rarely see or hear anything in the world outside school which would lead them to believe that geography is something that really matters. As we have already said, geographers create few if any visible monuments, are rarely heard, seldom reported and are not often seen at work in a way which renders them recognizable to laymen as geographers. As more than one senior pupil has said to me: "You never hear of anybody *doing* anything with geography: it's just a school subject". Those pupils had the wrong idea, of course, but can we blame them? Geographers rarely speak in Parliament or in the local council chamber. Comparatively few of them give lectures to the general public on the problems of the day: very few are heard on the wireless, and then, as a rule, only on the Third Programme. They are practically never alluded to in films, even incidentally, and they almost certainly occupy less space in the newspapers than other scientific workers. Thus there is little indeed to indicate either to the adult or the adolescent citizen that geographers exert any influence or do any notable service.

To no one would this sorry state of affairs give greater distress than to that great geographer and public servant, Sir Halford Mackinder, were he alive to-day. Mackinder, perhaps more than any other great geographer, believed in the application of geography to world affairs; that is to say, he believed in it being not only studied but also used for helping to solve some of the problems of mankind. He saw it as a power for good and believed that, properly applied, it could help the statesmen of the nations to agree on wise and practical territorial arrangements which would remove some of the more potent causes of war. He saw it as at once both a science and a philosophy and also as a technique which could be applied to a great variety of human problems—local, national and international. Had geography been so used it could not now appear to so many ordinary people as the purposeless and almost barren study which to too many of them it seems to be to-day.

Fortunately, signs are not altogether wanting that some geographers of standing have at long last sensed the need to explain their purpose and demonstrate their techniques to educated laymen. Some also seem to be awakening to a more proper appreciation of their responsibilities as workers in the social and political fields. Even since the first draft of this paper was written there have been some significant developments in this direction, and they are to be welcomed. Unesco has done a service to geography by indicating its possible application to the problems of world understanding and by exposing the failure, up to the present, of geographers generally to gras their opportunities in this connexion. Finally mention must be made of the Land Utilizatio Survey which, whatever criticisms may be justl levelled against it, represents a gallant and largel successful attempt to apply a geographical techniqu to a social purpose.

In regard to the application of geography, let u contemplate only a few of the things geographer could do now. They might, for example, turn thei minds to some of the pressing territorial problems which threaten the peace of the world instead o concentrating their studies upon areas or regions which, however interesting academically or useful as subject for an exercise, are not in the minds of the public and are not storm centres of the day. They might usefully express views on the great problem of the production and distribution of raw materials. They might put forward a constructive scheme, based on sound geographical principles, for the amendment of the areas or regions of local government in Britain. They might give us soil maps. Other things in which we are all interested are (to take only a few instances at random): better plans than exist at present for the re-distribution of the urban population; the better development of Commonwealth resources; the future of Africa and particularly of parts of that continent; and the great problems of world over-population. Indeed, there are a score or more of golden opportunities for the geographer to make his mark and prove his worth in contemporary affairs. Cannot some of them be taken? Perhaps the answer will be given that they have been taken. If so, then the work which has been done must be hiding in the pages of some professional journal or in the archives of some university or learned society and has not yet been brought to the notice of the world at large.

As to the employment of geographers in the departments of State and in the public services, we cannot hope for much improvement in the present position until geographers have succeeded in establishing themselves more securely in public esteem; and they can only hope to do this by making themselves useful and by letting the world see or hear about their good works. In this connexion it would be helpful both to geographers and laymen if the great daily newspapers would appoint qualified geographers as special correspondents. If that were done, the views of geographers would be more often quoted and the value of their special knowledge would be more widely appreciated.

These latter years have witnessed the development of a number of geographical sects—each sect preoccupied with one particular aspect of geography and each sect waging a kind of cold war against the others. Indeed, not infrequently of late, it has seemed that sectarian interests have been allowed to rise superior to the good of geography as a whole. That there should be some workers in the field who are more interested in one part than in the other parts is natural, necessary and good; but it is not good for such persons to be allowed to proclaim that the part in which they happen to be most interested is the part which matters most. Nor is it good that such persons should be allowed to pour contempt on the special work of others. The part cannot be greater than the whole, and when anything is compounded of parts, as geography is compounded, every part is essential, for, missing a single part, the whole cannot exist.

It is submitted that the professors, who are the academic leaders, would be wise to bring all their influence to bear against those who, either with intent or inadvertently, would break up the synthesis into its component parts and, this done, would seek to proclaim themselves the high priests of their particularly favoured mysteries. That way lies disintegration and disaster. Let there be controversy by all means; but let it be conducted in an atmosphere of mutual respect and always with the main object of furthering the study of geography as a whole, rather than of any one part of it. Let the elder statesmen of geography exhibit a unity of fundamental ideas and a determination to maintain an essential discipline.

In 1931 Mackinder forecast that, towards the middle of the twentieth century, geographers would have their golden opportunity. He said: ". . . then will be the opportunity of the geographer-statesman, for geography must underlie the strategy of peace if you would not have it subserve the strategy of war". Unheeded by too many, that hour has struck! The geographer, that is to say the person trained to think geographically, is better equipped than most other people to see through the fog of political propaganda and the mists of emotional nationalism and to discern the real, underlying causes of discontent and disturbance. Could the geographer but bring his influence fully to bear in the counsel of the nations, could he but gain for his knowledge and skill the respect which both so richly deserve, there would be at his command a power which might do much to ensure fair and just territorial settlements, bring about a more equitable distribution of the world's natural wealth, promote better understanding between peoples and remove some of the more potent causes of wars. That, indeed, would be service to mankind. That power, however, will not be granted to geographers until they have given more abundant proof of their qualities and capabilities and of the usefulness of their special knowledge.

VARIATIONS IN BROOD-STRENGTH IN THE NORTH SEA HADDOCK, IN THE LIGHT OF RELEVANT WIND CONDITIONS

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MANY years of research into the biology of the haddock (*Gadus æglefinus*) in the North Sea have shown that one of the major factors contributing to the short-term fluctuations in the fortunes of the commercial fishery for this species is the varying numbers of recruits entering the fishable stock from year to year. The importance of this phenomenon was firmly established during the early inter-war years by Thompson[1] (then of the Marine Laboratory, Aberdeen), who, from the results of extensive research vessel trawling surveys in the North Sea, was able to relate the fluctuating yields from the fishery to this cause. These surveys, which were afterwards extended by Raitt and later by Parrish (of the same Laboratory), gave estimates of the distribution and relative density of each brood of haddock throughout its demersal life and thus gave measures of the relative stock strengths from year to year, and provided a means for forecasting, a year in advance, the relative success of the commercial fishery. The magnitude of the fluctuations in brood-strength over the period 1920–49, exclusive of the war years 1939–44, are illustrated in Fig. 1. This gives the mean annual catch per hour of fishing relative to that in 1923, rated as 10, taken with the trawl of the research vessel for each successive brood in its second year of life, by which time its members have become demersal.

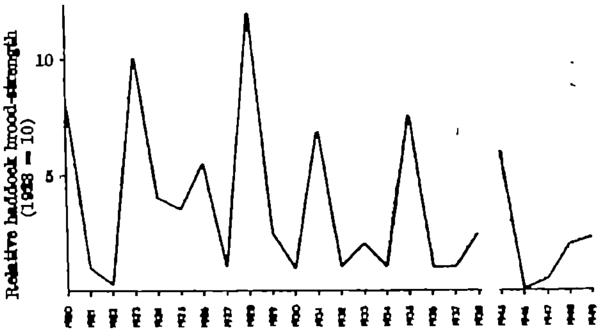

Fig. 1. Fluctuations in haddock brood-strengths in the North Sea, 1920–49

In an attempt to assess the factors causing these fluctuations, the first step which had to be taken was to determine that critical stage in the haddock's development, up to the end of its second year of life, during which the observed fluctuations in abundance may be experienced. The possibilities may be summarized as follows: (1) variations in egg production from year to year; (2) annual changes in the survival-rates of eggs, larvæ and young fish during the pelagic phase; (3) annual changes in survival-rate after the demersal stage has been reached.

In a paper read before the Challenger Society in 1949 (now in preparation for publication in detail) an analysis was made of the large volume of data of the distribution and density of each brood in its first and second years of life, and of the egg production potential of the spawning shoals from year to year during the period 1920 to 1949. This has yielded the following results: (1) variations in abundance of successive haddock broods cannot be properly attributed to corresponding variations in egg production potential of the spawning shoals; (2) no large-scale differential mortality can be traced after the haddock become demersal and before they reach trawlable size.

These results lead to the important conclusion that the factors determining the level of recruitment are operative during the pelagic phase of the haddock's life-history. These factors must, therefore, be sought among the complexity of physical, chemical and biological features of the pelagic environment in which the eggs and larvæ develop, and for most of which no serial observations over a wide enough area are available.

Of these features, one which has received much attention in the marine field and has been considered to be critical for the survival of many species of organisms is the current system of the upper-water layers, within which the spawning products develop and are distributed by its changing speed and direction into areas favourable or unfavourable for subsequent development. The possible importance of such changes to the survival of haddock in the North Sea is apparent from a knowledge of the disposition of the spawning area in relation to the surrounding water masses. Spawning takes place in the northern North Sea basin, chiefly within the boundaries of the large elliptical eddy system described by Tait[2], which to the north and east is bounded by deep-water masses, the movements of which are northerly or north-easterly in direction. Any spawning products driven into these waters will, therefore, be swept away from the North Sea along the Norwegian coast. Those driven to the west and south, on the other hand, will be distributed over the main body of the North Sea, which constitutes the main haddock nursery area.

Unfortunately, in the absence of precise year-to-year measures of the direction and speed of mass water transport in the northern North Sea during the spawning season, the importance of this phenomenon to haddock-brood survival cannot be assessed directly. An indirect approach is possible, however, from a consideration of the variations in the direction and speed of the local winds over the spawning area, the importance of which in influencing the direction and speed of local surface water movements has been demonstrated by Carruthers[3] and Carruthers, Lawford and Veley in a series of papers recently published. Striking preliminary results were obtained in 1938 by Carruthers[4] from an analysis of variations in haddock-brood strength and variations in the wind component from the south-east quadrant as deduced from barometric pressure data.

A more complete analysis of this relationship was made possible following the preparation by Dr. G. Dietrich, of the German Hydrographic Institute (Hamburg), of monthly wind resultants of a high degree of accuracy for the northern North Sea, covering the years 1900–49. Relative haddock brood-strengths for the years 1920–49 (exclusive of the war years 1939–44) have been used and, for each year, the wind values for the four months February to May have been taken. An account of the analysis was prepared by us and read before the International Council for the Exploration of the Sea in October 1950; on that occasion a full exposé of the underlying ideas was given, and these have now been presented in a paper, "An Attitude on Fishery Hydrography", due to appear in the United States shortly[5].

An initial analysis of these data showed that, in general, high haddock values occurred during years when southerly and easterly wind components were large, and northerly and westerly small, whereas low haddock values were accompanied by reversed conditions. In view of these results, a wind function, $H = \sqrt{S^2 + E^2} \sim \sqrt{N^2 + W^2}$ (where S, E, N, W, are the four wind components), was developed by Veley and was used in the subsequent analysis. The values of H, derived in this way, are plotted against the relative haddock values in Fig. 2. The value for $\sqrt{S_2 + E^2} > \sqrt{N^2 + W^2}$ and vice versa are plotted separately.

The conclusions to be drawn from these results are as follows:

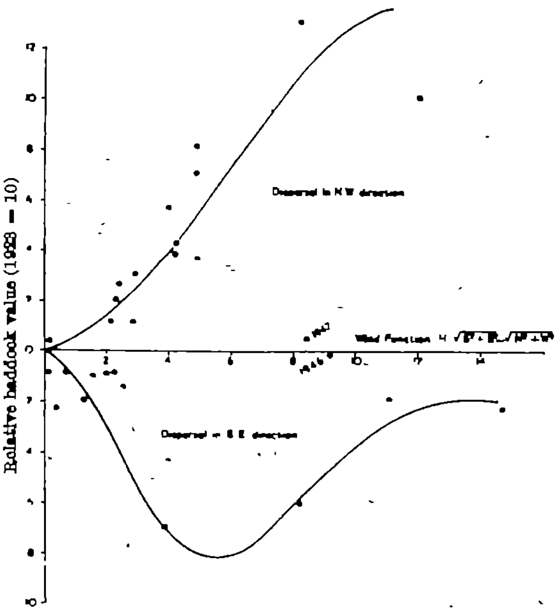

Fig. 2. Relationship between relative haddock value and wind function

(1) When the $S\ E$ term is large compared with the $N\ W$ term, dispersal of the spawning products is in a north-westerly direction. This appears to be the most favourable to brood survival.

(2) When the $S\ E$ term is small compared with the $N\ W$ term, dispersal is in a south-easterly direction. This is also favourable to brood survival, but to a lesser extent.

(3) A small value for H might arise either from a north-easterly or a south-westerly dispersal, or from no dispersal. Such a small value for H has always been found to be unfavourable to haddock survival so far, but, over the period of years investigated, a small value of H proved always to be due to south-westerly winds causing north-easterly dispersal.

The importance of these results is evident when they are considered in relation to the movements of the water masses surrounding the spawning area as outlined above. Thus, distribution in a north-westerly direction will dispose the spawning products within the eddy or, if out of it, into the southerly running stream entering the north-western North Sea from the Atlantic; this will distribute them over the main body of the North Sea, which is the main nursery area for adolescent haddock. Similarly, dispersal in a south-easterly direction is favourable unless the spawning products are driven beyond the boundaries of the eddy, when they will enter the north-going stream along the Norwegian coast and will be lost to the North Sea. Calculation shows that this is likely to take place for values of H greater than 6, which is the value at which the maximum occurs in the $S\ E$ dispersal curve in Fig. 2. Dispersal to the north-east will also drive the spawning products into the northerly-going current which runs along the eastern and northern boundaries of the eddy.

These results can, therefore, be explained in terms of the wind-induced movements of the water masses in the spawning area, and of the prevailing current systems of the surrounding waters. In the absence of precise data of the distribution of the spawning products, the validity of this interpretation has yet to be substantiated. The close relationship of the success of haddock-brood survival to the prevailing local winds during the spawning and post-spawning periods is, however, clearly demonstrated for all but two out of the twenty-four years investigated. In the years 1946 and 1947, some over-riding factor or factors must have dominated the haddock development. This may have been, for example, temperature, and it is interesting that the 1947 spawning followed one of the coldest winters in recent years. Nevertheless, it is considered that a knowledge of the wind conditions over the spawning area may lead to accurate predictions of future haddock-brood strengths, at least a year in advance of data obtainable at present, either with a research vessel or from commercial statistics, that is, two years in advance of the entry of these fish into the commercial fishing.

A fuller account of this work will be published elsewhere (Scientific Investigations, Fisheries Division, Scottish Home Department).

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[1] Thompson, H., *Rapp. et Proc.-Verb. Cons. Perm. Int. Exp. Mer*, 68, (1930).

[2] Tait, J. B., Fish Scot. Sci. Invest., No. 1 (1937).

[3] Carruthers, J. N., Min. of Agric. and Fish. Fish Invest., Ser. II, 14, No. 4 (1935).

[4] Carruthers, J. N., *Rapp. et Proc.-Verb. Cons. Perm. Int. Exp. Mer*, 107 (1938).

[5] Carruthers, J. N., *J. Mar. Res*, 10, No. 1 (1951).

NEWS and VIEWS

Chemistry at Queen Mary College, London : Prof. J. R. Partington, M.B.E.

PROF. J. R. PARTINGTON retires this summer from the chair of chemistry at Queen Mary College, University of London, which he has held since 1919, and has been appointed emeritus-professor in the University. After graduating at Manchester, where he won the highest academic honours, he worked first with Dixon, and then with Nernst at Berlin, and so founded his lifelong interest in inorganic chemistry and in the physical methods for the study of chemical problems then being newly developed. During the First World War he served in the Army, and later did research work in applied chemistry for the Inventions Department of the Ministry of Munitions, before succeeding Prof. Hewitt at Queen Mary College. To his colleagues in London his outstanding characteristics are, perhaps, first his wide and scholarly knowledge of chemistry, secondly the integrity, precision and good sense with which he has always discharged his University duties, whether as examiner or as member or chairman of University boards and committees, and thirdly his lively and ever-growing interest in the teaching and exposition of chemistry.

Prof. Partington is, of course, well known for his researches on the reactions and constitution of many inorganic compounds, on the properties of gases, on electrochemical problems, on dipole moments of organic liquids, on solubility and various other subjects ; many of them are models of critical thought combined with great experimental skill. His greatest contribution to the development and spread of chemical knowledge probably lies, however, in the books he has written and is writing. Prof. Partington's interest in the history and literature of science, based largely on his own extensive library, is apparent in all his works, and as an authority in this field he is president of the British History of Science Society and a member of the committee of the London Library. Since he intends to continue writing, chemists generally will be happy to know that they are likely for many years to come to have the benefit of his encyclopædic knowledge presented to them with the meticulous clarity and precision they have learned to expect from him.

Dr. M. J. S. Dewar

DR. M. J. S. DEWAR, who succeeds Prof. Partington at Queen Mary College, was educated at Winchester and Balliol College, Oxford. For the past six years he has been working at Messrs. Courtaulds Research Laboratories at Maidenhead. Dr. Dewar has become prominent mainly for his theoretical work in applying wave mechanics to problems of organic chemistry, though in recent years he has also made interesting kinetic studies of polymerization and oxidation processes. His book on "The Electronic Theory of Organic Chemistry" has been one of the most stimulating and controversial contributions to organic chemistry of recent years. In it he has elaborated applications of the wave concept of the probable behaviour of the reactive 'π-electrons' of unsaturated and aromatic systems in the interpretation of the mechanisms of organic reactions, and has shown how these theories can be extended in consideration of the transition states of reacting systems. Undoubtedly the most notable advance in organic chemistry which has resulted from these concepts is the recognition of the aromatic character of the seven-membered ring in tropolone, and of its existence in several natural products, as, for example, colchicine. As yet, few accurate experimental results are available for testing the more quantitative implications of Dr. Dewar's many computations, but it now appears that the modern analytical techniques of isotope analysis and infra-red spectroscopy should facilitate the rapid growth of the more quantitative aspects of organic chemistry to which wave mechanics will provide an essential theoretical background.

Industrial Research in East Africa : Mr. H. B. Stent

MR. H. B. STENT has been appointed director of industrial research in East Africa. This step results from discussion between the East Africa High Commission and the Standing Committee on Finance of the Central Legislative Assembly on ways of speeding up the establishment of an industrial and research organization to provide adequate scientific background for the existing industries in East Africa and to encourage new industrial development. It had first been envisaged that an organization should be established with functions similar to those carried out by the Department of Scientific and Industrial Research in Great Britain. Detailed consideration indicated, however, that it would be more effective to set up an organization mainly confined to matters having a high priority in relation to development in East Africa. Mr. Stent has acted as chairman of the East African Research Board since 1946.

It has also been agreed by the Governments of the three High Commission territories that the present Industrial Research Board should be reconstituted as a Scientific and Advisory Committee under the chairmanship of the director. It will consist of scientific and technical representatives of the three territories, together with a panel (also nominated by them) of persons specially qualified in particular branches of science and technical matters. This new Committee will be advisory to a new and smaller Board comprising representatives of the High Commission and the three territories, which will be under the chairmanship of the Administrator to the High Commission. The new Board's duties will be, principally, the maintenance of full liaison between the organization and the Governments, determination, with the consent and backing of Governments, of priorities, etc., affecting research, and the review of progress in research. It is expected that the new Board will be constituted shortly. The laboratories operating under the old Industrial Research Board have, during the past few years, carried out research into a large number of matters concerning industrial development in East Africa, in addition to analytical work. These matters include investigations on phosphatic fertilizer production; refractories and ceramics, including bricks and roofing tiles and drain pipes as well as domestic pottery; cement production; charcoal production with by-products; soda production from Lake Nakuru; and the extraction and treatment of fresh pyrethrum flowers.

Statistics at the Australian National University, Canberra: Prof. P. A. P. Moran

A CHAIR of statistics has recently been created in the Research School of Social Sciences in the Australian National University, Canberra, and Dr. P. A. P. Moran has been elected as its first occupant. Dr. Moran, who is thirty-four, was born in Sydney and educated at St. Stanislaus' College, Bathurst, at the University of Sydney, and at St. John's College, Cambridge. During the Second World War, he served as an experimental officer in the Ministry of Supply and (later) as Australian scientific liaison officer for physics and operational research. Since the War, he has been lecturer in mathematics at Trinity College, Oxford, University lecturer in mathematics, and a senior member of the Oxford Institute of Statistics. He is a Fellow of the Royal Statistical Society and has played a prominent part in the post-war development of the Society's Research Section, and in the creation of a school of mathematical statistics in Oxford. Apart from earlier work on the pure mathematics of measure, Dr. Moran is chiefly known for his papers on the statistical theory of ranking, and on the theory of stationary time-series. He has collaborated with Prof. A. S. C. Ross on the dating of manuscripts by the statistical analysis of philological data, and with the Oxford Bureau of Animal Population on some problems of population dynamics. At the present he is interested in the problems of estimation arising out of the theory of stochastic processes.

American Scientific Mission to West Germany

AN American scientific mission, headed by Dr. Harold Vagtborg, president of the Southwest Research Institute, San Antonio, Texas, is undertaking a survey of West Germany's scientific research resources under the sponsorship of the Economic Co-operation Administration. In addition to staff members from the Southwest Research Institute, the group, which is spending a month in Europe with headquarters at Bonn and Paris, includes research officers from the Armour Research Foundation of Chicago, the Battelle Memorial Institute of Columbus, and the Stanford Research Institute of Palo Alto. The primary object is to determine whether a need exists for the establishment of applied research institutes to serve small and medium-sized manufacturers and processors in West Germany in the interest of national security and, if it does, how best to set up such laboratories. The West German Government itself asked for this survey to be made. The same group has already given assistance in establishing similar industrial research laboratories in Norway, and in the development of a programme leading to the inauguration of a scientific institute in Brazil. It is hoped to carry out similar surveys in other countries of Western Europe.

Advisory Committee on Metals Economy

THE Minister of Supply, in conjunction with the Lord Privy Seal as Minister of Materials, has appointed an Advisory Committee on Metals Economy to help him to ensure the most economical use of metals in the engineering industry and in the defence programme. The terms of reference of the committee are: "To bring under review in consultation with the various Government and industrial authorities concerned ways of economizing in the use of scarce metals in the design, specification, and the manufacturing process of metal goods for both rearmament and civil purposes, and to advise the Government how it can best assist in promoting such developments".

The committee will be under the chairmanship of Mr. D. A. Oliver, director of research at the Birmingham Small Arms Co., Ltd. The other members are drawn from industry and Government departments. The industrial members are: Dr. G. L. Bailey, British Non-Ferrous Metals Research Association; Mr. H. A. R. Binney, British Standards Institution; Mr. H. H. Burton, English Steel Corporation, Ltd.; Mr. W. C. F. Hessenberg, British Iron and Steel Research Association; Mr. E. W. Grinham, Standard Motor Company, Ltd.; Dr. Ivor Jenkins, General Electric Co., Ltd.; Dr. L. B. Pfeil, Mond Nickel Co., Ltd.; and Dr. C. J. Smithells, British Aluminium Co., Ltd. The secretary is Mr. K. M. McLeod, of the Engineering Industries Division of the Ministry of Supply.

Student Health Services

THE sixteenth issue of *Communication*, the organ of the International Association of University Professors and Lecturers, contains the Association's report upon the provision made in the universities of many countries for the health of their students. Some time ago a questionnaire was addressed to university authorities in all countries, thirty-six of which replied. In these thirty-six countries the great majority of universities accept the principle that they have some responsibility for the health of their students as well as for the way in which services should be organized and paid for. From the replies received it is clear that in the health examinations of the ordinary student at entrance to the university and on subsequent occasions very real importance is attached to the X-ray examination of the lungs. There is a general consensus of opinion that there should not be any exacting psychological examination of the ordinary student's mental health, although in some cases the help of a psychiatrist has been sought. The Association recommends that, in assessing the menta health of a student, the indirect approach is the most suitable, although a counselling psychological service is advised for the universities of countries which have suffered most from the War. The report also contains sections setting out the Association's views on the provision of some form of health instruction, the inspection of the student's environment, the treatment of minor ailments of the sick student and the treatment of students who are seriously ill.

Pests of Ornamental Plants

The late G. Fox Wilson performed a great service to horticulture in his studies of insect and other pests which attack flowers and shrubs, and a compendium of these studies was first published by the Ministry of Agriculture and Fisheries in 1937. This has long been out of print, so that a second edition, enlarged and modernized, is very welcome (Bulletin No. 97, Pests of Flowers and Shrubs; 105 pp.+117 pl.; London: H.M. Stationery Office, 1950; 4*s*. 6*d*. net). A short general introduction is followed by fairly detailed consideration of measures of control. The more ubiquitous pests such as slugs, millepedes, aphids, wireworms and leatherjackets are described in a general section, and thereafter localized pests on lawns, borders, bulbs and corms, rock gardens and glasshouses receive consideration. Such a horticultural arrangement necessitates a more adequate index than is provided, for it is not always easy to make rapid reference to a particular pest. This slight criticism must not, however, be allowed to detract from the value of the bulletin, which is a sound book of reference, thoroughly informative and very well illustrated. It should appeal to the gardener and equally to the advisory officer. One useful feature is that the results of future work with modern sprays, like HETP and TEPP, or modern soil treatments like benzene hexachloride, will be readily applicable to the text, for control measures have been considered as principles rather than mere specific remedies.

St. Andrews Mathematical Colloquium, 1951

Many mathematicians will remember with pleasure the colloquia held at the University of St. Andrews under the sponsorship of the Edinburgh Mathematical Society in 1926, 1930, 1934 and 1938. It was intended to hold such meetings every four years, but the War and the difficult post-war conditions made this impossible until now. The fifth St. Andrews Colloquium took place during July 18–28, and proved even more successful than its predecessors. There were 110 people present at University Hall, St. Andrews, including overseas representatives from Australia, Belgium, Canada, Egypt, Eire, Holland, India, Switzerland and the United States. The inaugural address was given by Prof. H. W. Turnbull, who gave an account of the fascinating historical researches arising from the preparation for publication by the Royal Society of the letters of Isaac Newton. There were five sets of formal lectures: (1) Prof. H. S. M. Coxeter (Toronto) on kaleidoscopes and quadratic forms; (2) Prof. A. Erdélyi (Pasadena, California) on the analytic theory of systems of partial differential equations; (3) Mr. A. E. Ingham (Cambridge) on the analytic theory of numbers; (4) Prof. J. L. Synge (Dublin) on the geometry of function-space and its applications to mathematical physics; (5) Prof. G. Temple (London) on mathematical problems of supersonic aerodynamics. In addition, single lectures were given by Prof. Sophie Piccard (Neuchâtel) on the theory of groups and by Prof. L. E. J. Brouwer (Amsterdam) on the influence of mathematics on logic. At the concluding meeting, Prof. Temple expressed the thanks of all present to those responsible for the successful organization of the colloquium, in particular to Dr. D. E. Rutherford (St. Andrews). It is hoped that the sixth St. Andrews Colloquium will be held during 1955.

Society of Dairy Technology

The Council of the Society of Dairy Technology has established a medal, to be known as the Society of Dairy Technology Gold Medal, which will be awarded to anyone from any part of the world who, in the view of the Council, has rendered particularly distinguished service to the industry. The award will be made not more than three times in ten years. The first award, to be presented at the Society's annual general meeting in London on October 22, is being made to Dr. Richard Seligman, who has been responsible for many developments of outstanding and world-wide importance in the dairy industry.

The Council of the Society has elected Mr. James Mackintosh, lately principal livestock husbandry officer, South-Eastern Provinces, National Agricultural Advisory Service, and formerly head of the Dairy Husbandry Department of the National Institute for Research in Dairying, and Mr. E. B. Anderson, lately chief chemist of United Dairies, Ltd., to be honorary members of the Society of Dairy Technology, in recognition of their services to the dairy industry and to the Society.

Announcements

Applications are invited for the Gabriella Zuccar research grant of 250,000 lire for work at the Zoological Station of Naples for at least six months during 1952. The grant may be renewed for a maximum of three years. Applications, including an outline of the proposed investigation, should reach the Rector, University of Padua, by October 31.

The twenty-sixth annual conference of Aslib will be held at Ashorne Hill, near Leamington Spa, during October 5–8. The programme will include such subjects as the training and organization of staff, including voluntary workers and students; what can be learnt from industrial efficiency methods, such as job analysis, time and motion study, etc.; and practical bibliographical and documentary projects in operation in the international field, with special reference to the part of Unesco in them. Opportunities will be provided for groups to discuss subjects in their particular field of interest. Further details can be obtained from Aslib at 4 Palace Gate, London, W.8.

The United Nations Department of Public Information has now issued a 36-page pamphlet, "World Facts and Figures" (New York: United Nations; London: H.M. Stationery Office, 1951. 25 cents; 1*s*. 9*d*.), giving some cogent facts about population, production, including coal and petroleum, electrical energy, steel, strategic metals, cement, rubber, sulphuric acid, transport and communications, medical facilities and newspapers. These are taken from second editions of the "United Nations Statistical Year Book" and "Demographic Yearbook". The facts included are sufficiently comprehensive for the pamphlet to provide the ordinary man or woman with a convenient means of keeping some current discussions on a factual basis.

EGG-SHELL FORMATION IN TREMATODES AND CESTODES AS DEMONSTRATED BY THE METHYL OR MALACHITE GREEN TECHNIQUES

By Dr. J. D. SMYTH
Department of Zoology, Trinity College, Dublin

DURING recent work on cestode physiology, it was observed that two chemically related dyes —methyl green and malachite green—showed a very marked affinity for the material which formed the egg-shell in certain Diphyllobothriidae. Further observations revealed that the egg-shell in trematodes possessed a similar affinity.

The essentials of the method, which have been published in detail elsewhere[1], involve fixation of worms in 5 per cent formol-saline and staining of sections in 0·5 per cent aqueous methyl or malachite green, combined with a red nuclear counterstain where necessary. It is stressed that these stains are made up in pure aqueous solution, free from acetic acid—the latter converting them into precise nuclear stains, in which form they are usually used in animal cytology.

These stains have been found to be absolutely specific for shell material, and stain it a brilliant green (malachite green) or greenish-blue (methyl green). Thus, any gland, tube or duct containing shell material may be readily identified in sections.

The method greatly simplifies investigation of the mechanism of egg-shell formation in these groups, as the egg-shell material may be traced from its origin to its final moulding into a typical shaped egg in the lower part of the uterus.

Egg-shell formation in Trematodes. It has long been realized that in trematodes the shell material is produced not in the 'shell' gland (Mehlis's gland), but in the so-called 'vitelline' glands ('vitellaria'). The evidence for this view has been ably summarized by Stephenson[2], who has also shown that the egg-shell material is an ortho-dihydroxyphenol-protein complex. The function of the Mehlis gland remains obscure and a number of views have been put forward; the most recent—that of Stephenson[2]—suggests that the main function of the gland is to produce a fluid which increases spermatozoan activity.

Application of the methyl or malachite green techniques confirms and demonstrates clearly the origin of the shell material in cells of the 'vitelline' glands, as spherical globules (*S*, Fig. 3) which stain specifically and intensely in these stains. Not all the cells produce shell at the same time, but in each acini inactive cells free from shell occur (*I*, Fig. 3). Due to the presence of the shell globules in the 'vitelline' glands, these glands stand out clearly in sections from the surrounding tissue (*VG*, Fig. 1). The 'vitelline' cells, loaded with shell globules, may easily be traced along the 'vitelline' ducts and into the lower uterus where, on meeting the ova, they release the contained shell globules, which fuse, to become moulded into typical shaped eggs.

Egg-shell formation in Cestodes. The pseudophyllidean cestodes are characterized by possessing shelled eggs similar to those of digenetic trematodes and, also, numerous 'vitelline' glands. The general arrangement of both male and female genitalia also closely resembles that of digenetic trematodes. It might be speculated, therefore, that the eggs in this group of cestodes would be formed in a manner similar to that in the trematodes. Due, no doubt, to the fact that the genitalia in cestodes are smaller and more compressed—being confined to the limits of a proglottid, whereas a fluke of much larger size contains only one set of genitalia—the mechanism of egg-shell formation in this group of cestodes has never been worked out.

Nevertheless, evidence from recent physiological work has strongly suggested that the egg-shell in pseudophyllidean cestodes originates in the 'vitelline' glands. Thus, when such worms are removed from the host gut, they appear colourless; but on exposure to air, the eggs darken rapidly (as in trematodes) and the 'vitelline' glands likewise take on a brown colour. Again, when the pseudophyllidean cestode, *Schistocephalus solidus*, is cultured to maturity *in vitro* under aerobic conditions (that is, with a stream of air passing through the culture medium), the 'vitelline' glands darken rapidly as maturation approaches and only a few shell-less or very abnormal eggs are produced[3,4]. Such phenomena could be

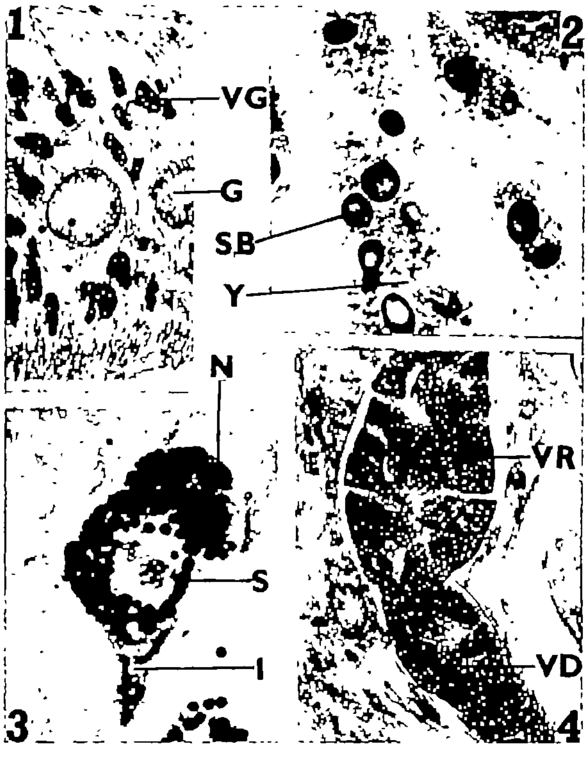

Fig. 1. T.S. *Fasciola* (methyl green)
Fig. 2. T.S. Lower uterus of *Diphyllobothrium* (methyl green)
Fig. 3. 'Vitelline' cells of *Fasciola* in 'vitelline' glands (malachite green)
Fig. 4. 'Vitelline' reservoir and duct of *Schistocephalus* (methyl green). All material fixed formol-saline. *G*, gut; *I*, inactive cell; *N*, nucleus; *S*, shell globules; *SB*, shell blebs; *Y*, yolk; other letters as in Fig. 5

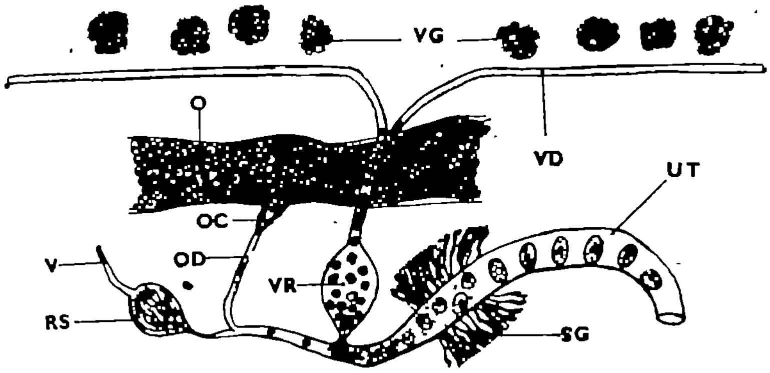

Fig. 5. Diagram of female genitalia in proglottid of *Schistocephalus* to illustrate method of egg-shell formation. *O*, ovary; *OC*, oöcapt; *OD*, oviduct; *RS*, receptaculum seminis; *SG*, 'shell' gland (Mehlis's gland); *UT*, uterus; *V*, vagina; *VD*, 'vitelline' ducts; *VG*, 'vitelline' glands; *VR*, 'vitelline' reservoir

explained by the supposition that the shell material is being produced in the 'vitelline' glands; but due to the high oxygen tension it becomes prematurely tanned and hardened so that the shell globules are unable to fuse together to form proper shaped egg-shells. Although such experimental evidence was highly suggestive, it was not previously possible to confirm such speculations by histological methods.

Application of the methyl and malachite green techniques has enabled the egg-shell formation in three members of the Diphyllobothriidæ—*Schistocephalus solidus*, *Ligula intestinalis and Diphyllobothrium* sp.—to be demonstrated histologically with little difficulty.

After staining, the presence of large, bright green globules in the cells of the 'vitelline' glands may be immediately recognized. As these cells pass down the 'vitelline' ducts (*VD*, Figs. 4 and 5) through the 'vitelline' reservoir (*VR*, Figs. 4 and 5) and into the lower uterus, they release the contained shell globules which here fuse together to form the typical oval egg-shell which encloses a fertilized ovum and some 'yolk' (the remains of the 'vitelline' cells which now only contain nuclei and small pink-staining granules). The 'vitelline' glands thus provide both shell and yolk material to the fertilized ovum. In *Ligula*, the process of egg-shell formation is identical with that in *Schistocephalus*. In *Diphyllobothrium*, the shell globules fuse to form larger globules (*SB*, Fig. 2) before finally forming a moulded egg-shell, and these large globules stand out clearly from the yolk in the lower uterus. It may be remarked that I had been attempting to work out the mode of egg-shell formation in the *Diphyllobothriidæ* for the past five years without success. From sections stained in methyl green, it was possible to trace out the entire process in a matter of a few hours.

Position of cyclophyllidean cestodes. The cyclophyllidean cestodes differ from the pseudophyllidean cestodes in that their eggs lack an external egg-shell —the so-called 'egg-shell' being, in fact, merely a thickened embryophore. This lack of an external egg-shell is clearly correlated with the absence of a free-swimming larval stage—such as occurs in the pseudophyllidean cestodes and trematodes—from the cyclophyllidean life-cycle.

On theoretical grounds, therefore, it was speculated that the 'vitelline' glands in cyclophyllidean cestodes would be free from globules of shell material and concerned only with the production of yolk material. Investigation of the histology of the 'vitelline' glands of *Tænia saginata* by the methyl green technique has confirmed this hypothesis—the 'vitelline' cells being quite free from shell material and acting as yolk producers only.

There is thus a marked distinction between the 'vitelline' glands of these two groups of cestodes—one type producing yolk alone, the other both shell and yolk. To retain the term 'vitelline' glands for both only introduces confusion. With the present terminology, students are informed that the 'vitelline' glands produce shell, and the 'shell' gland does not—an unfortunate and confusing state of affairs. In order to clarify this position, it is proposed that the use of the term 'vitelline glands' or 'vitellaria' should be restricted to glands that produce only yolk (that is, in the Cyclophyllidea). For glands that produce both yolk and shell (that is, in the trematodes and pseudophyllidean cestodes) it is suggested that a new term—*vitellocalycal* glands—be introduced. The term 'shell gland' should be dropped entirely and replaced by 'Mehlis's' gland—as, indeed, is the increasing tendency in recent text-books of helminthology—until its function has been established.

I am indebted to the Medical Research Council of Ireland for financial assistance towards the expenses of this work. [April 2.

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EFFECTS OF A PROTEIN-FREE DIET ON THE ALKALINE AND ACID PHOSPHATASE ACTIVITY OF THE LIVER OF THE RAT

By J. O. ELY and M. H. ROSS

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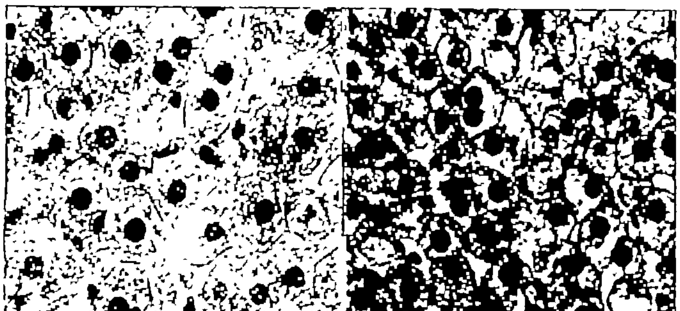
PROTEINS, phospholipids and ribonucleic acids are lost rapidly from the livers when rats are fasted[1,2] or fed a protein-free diet[3]. It was suggested by Perlmann and Ferry[4] that acid phosphatase is a water-soluble protein, and alkaline phosphatase is a water-insoluble, salt-soluble globulin. Loss of protein from the liver because of a restricted dietary protein intake from any cause might alter the phosphatase activity. If this be true, any experiments on the effects of various agents on phosphatase activity should take into consideration the effect of the experimental regime on the food intake of the animals.

The effects of a protein-free diet, in contrast to an adequate diet, on the alkaline and acid phosphatase activity of the liver of rats have been investigated by chemical and by cytochemical methods.

Experimental. Male rats of the Wistar strain, 150 gm. initial weight, were maintained on (1) a protein-free diet (dextrose, 89 gm.; corn oil, 5·0 gm.; salt mixture, 4·0 gm.; rice bran extract ('Vitab'), 2·0 gm.; riboflavin, 0·2 mgm.) and (2) Fox Food Blox diet (Allied Mills). At intervals of from five to forty-nine days, rats from each group were de-



Phosphatase activity in sections of livers of rats. The photographs for each phosphatase were prepared under identical treatment, exposure and development time. Magnification × 580. (*a*) Alkaline phosphatase activity in section from liver of rat fed Fox Food Blox diet for 49 days. (*b*) Alkaline phosphatase activity in section from liver of rat fed protein-free diet for 49 days. (*c*) Acid phosphatase activity in section from liver of rat fed Fox Food Blox diet for 49 days. (*d*) Acid phosphatase activity in section from liver of rat fed protein-free diet for 49 days

capitated, and samples of liver weighing 0·1–0·2 gm. were removed and were ground with sand and distilled water. After standing for 30 min. at 15° C. in 5 c.c. of distilled water the suspension was filtered through No. 1 Whatman filter paper; the filtrate was used for the chemical estimation of phosphatase. Chemical determinations of alkaline phosphatase activity were made by the method of King and Armstrong[5] and of acid phosphatase activity by the method of King and Armstrong as modified by Gutman and Gutman[6].

Cytochemical determinations of alkaline and acid phosphatase activity were made by the methods of Gomori[7,8]. For alkaline phosphatase activity determinations thin pieces of liver from the rats of each dietary group were treated alike during the process of fixation (80 per cent ethyl alcohol) and dehydration. For acid phosphatase activity determinations the tissues were fixed in acetone for two hours, and were then dehydrated and embedded in paraffin; the whole process was completed in seven hours. A specimen from each dietary group was embedded in the same block of medium so that sections to be compared were cut at the same stroke of the microtome knife and were mounted on the same microscopic slide.

Results. The filtrates prepared from the livers of rats fed the protein-free diet exhibited per unit of nitrogen approximately twice as much alkaline phosphatase activity, and approximately the same acid phosphatase activity as did the filtrates prepared from the livers of the rats fed the Fox Food Blox diet (see accompanying table).

The cytochemical demonstration of phosphatase activity in microscopic sections of tissue showed that the alkaline phosphatase activity was much greater in both nuclei and cytoplasm of the livers of the rats fed the protein-free diet than in the livers of the rats fed the Fox Food Blox diet (Figs. *a* and *b*). Acid phosphatase activity, however, was much less in the nuclei and cytoplasm of the livers of the protein-free diet fed rats than in the livers of the rats fed the Fox Food Blox diet (Figs. *c* and *d*). The photographs show also that the nuclei are more numerous in equal areas of the sections, and, therefore, in equal volumes of tissue, from the livers of the rats fed the protein-free diet than from the livers of the rats fed the Fox Food Blox diet.

Discussion. The results of the chemical and cytochemical estimations of alkaline phosphatase activity are in agreement; that is, both methods showed greater enzyme activity in the livers of the rats fed the protein free diet. The results of the acid phosphatase determinations are not in agreement; cytochemically, there was less acid phosphatase activity in the sections from the livers of the rats fed the protein-free diet and no significant difference in the activities per unit of nitrogen in the filtrates. It appears, therefore, that in the filtrates from the livers of the rats fed the protein-free diet a greater amount of enzyme was associated with a unit amount of nitrogen than in the filtrates from the livers of the rats fed the Fox Food Blox diet. This, it seems, indicates that during protein depletion rat liver loses less non-enzyme nitrogen than enzyme nitrogen (acid phosphatase).

It is of interest that the alkaline phosphatase activity in the nuclei of the livers of the rats fed the protein-free diet was greater than in the nuclei of the livers of rats fed the Fox Food Blox. It was shown recently[9] that under similar conditions the feeding of a protein-free diet was followed by an increase in the deoxyribonucleic acid content of the nuclei of rat livers. Brachet and Jeener[10] and Brachet[11] state that a direct parallel exists between

PHOSPHATASE ACTIVITY OF EXTRACTS OF LIVERS OF RATS FED DIFFERENT DIETS

No. of rats	Days on diets	King–Armstrong units of alkaline phosphatase per 100 mgm. of nitrogen		Units described by Gutman and Gutman) of acid phosphatase per 100 mgm. of nitrogen	
		Protein-free diet	Fox Food Blox diet	Protein-free diet	Fox Food Blox diet
19	5–32	54 ± 5·7*	25 ± 3 4	243 ± 29·4	263 ± 38 0

* Standard error of mean.

the rate of turnover of the phosphate in deoxyribonucleic acid and the amount of alkaline phosphatase of the nuclei. The experiments reported here seem to indicate a parallelism between the alkaline phosphatase activity and deoxyribonucleic acid content in nuclei of rat-liver; the rate of phosphorus turnover, however, is not known.

The changes in phosphatase activity found in these experiments apparently are much greater than those previously reported for rat livers. Wachstein[12] found a slight decrease in acid phosphatase activity during protein depletion, and a moderate increase in alkaline phosphatase after 6–18 days on a protein-free diet.

Both the alkaline and acid phosphatase contents of the liver appear to be significantly influenced by protein intake. It would seem important to take this fact into consideration in both the planning and the interpretation of experimental work.

Summary. Alkaline phosphatase has been shown chemically and cytochemically to be increased in both nucleus and cytoplasm during protein depletion produced in rats by the feeding of a protein-free diet. Acid phosphatase, on the other hand, has been shown cytochemically to be reduced in both nucleus and cytoplasm. Other proteins of the liver are apparently reduced to a greater extent than acid phosphatase.

[April 2.

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OPTICAL ROTATION AND CHAIN FOLDING IN SYNTHETIC POLYPEPTIDES AND GELATIN

By Dr. CONMAR ROBINSON and M. J. BOTT
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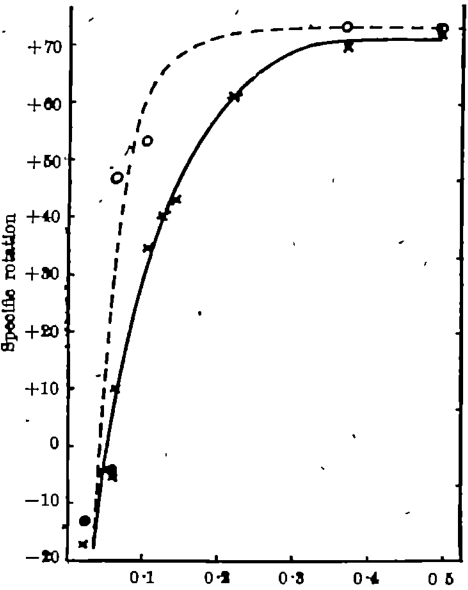
IN a chain of atoms containing asymmetric carbon atoms, movements of groups of atoms in the chain relative to those asymmetric carbon atoms would be expected to affect the magnitude and even the sign of the optical rotatory power. Further, if such movements involved in a change of configuration result in ring formation, the consequent reduction of free rotation may also be expected to increase greatly the optical rotation. Recent work in this Laboratory has indicated that the 'α-keratin' configuration of the polypeptide chain is produced by folding the extended β-form into seven-membered rings, held together by intra-chain hydrogen bonds[1,2]. It follows that the $\alpha \rightleftarrows \beta$ transformation would be expected to be accompanied by a change in the specific rotation.

We have recently made some experiments with a synthetic polypeptide (γ-methyl-L-glutamate D-L phenylalanine copolymer). If the molecular weight is not too low, films prepared by evaporating *m*-cresol solutions of this polymer are found to be in the α-form; but as the molecular weight is decreased, there is an increasing tendency to form the β-configuration (compare the similar tendency found for small polypeptides by Bamford, Hanby and Happey[3]). Samples having different molecular weights were prepared and their specific rotations in *meta*-cresol were measured. A rough estimate of the percentage α-fold in the films obtained by evaporation of the solutions was obtained by making use of the fact that the CO-stretching frequency has a characteristic value for both the α- and β-configurations. The results, together with the specific viscosities of the 1 per cent solutions, are shown in the accompanying figure. It will be seen that there is a striking relationship between the specific rotation of the solutions and the percentage of the α-configuration in the films prepared from them. That the differences in specific rotation are not a *direct* effect of molecular weight can be seen by examining solutions of the same polypeptides in formic acid. Here the specific rotations fall between −14° and −18° for the whole range of molecular weights, while the films prepared from these formic acid solutions all show between 60 and 75 per cent of the β-fold. It seems, therefore, reasonable to assume that the changes in specific rotation in *meta*-cresol solutions are largely determined by changes in the proportions of the α- and β-configuration.

The results suggested that it would be possible to use the optical rotatory power as an indication of the change of configuration in protein solutions. Some interesting results have been obtained with gelatin. As is well known, on cooling a gelatin solution from above 35° C. to room temperature, the specific rotation approximately doubles in value. This mutarotation is closely connected with the gelling properties, and it has been suggested more than once that there are two forms of gelatin, one stable above approximately 35° C. and one which is only found below this temperature. Collagen, and gelatin in a film obtained by cold evaporation, have a characteristic configuration which is neither the α- nor the β-fold. This is shown not only by the X-ray diagrams but also by polarized infra-red absorption by oriented specimens. Ambrose and Elliott have proposed a configuration which is in conformity with these data, in which the fold is held together by *inter*-chain hydrogen bonds[4]. The collagen fold has a characteristically high N—H stretching frequency of 3,330 cm.$^{-1}$ as compared to 3,305–3,310 cm.$^{-1}$ for the α- and β-folds in other proteins, and this may be used to identify it in unoriented specimens.

Two 5 per cent solutions of gelatin (*p*H 6·8) were prepared and kept at room temperature and 40° C. respectively. After three days the specific rotation of the cold solution had become almost steady at −262°. The hot solution, which reaches equilibrium rapidly, had a specific rotation of −128°. The specific rotation of a film prepared by evaporation of the hot solution had almost the same value as the hot solution and did not change within twenty-four hours after cooling. On the other hand, a film prepared from the cold solution by evaporation at room temperature showed a rotation (*c*. −1,000°) which was very much higher than that of the corresponding cold solution. These results indicate that we have succeeded in obtaining the hot form of the gelatin in a 'frozen' state which was suitable for studying at room temperature. The N—H stretching frequencies of the



× - - -, specific rotation ; ○ - - -, per cent α-fold

hot and cold evaporated films were found to be at 3,310 cm.$^{-1}$ and 3,330 cm.$^{-1}$ respectively.

These values suggest that the collagen fold is not present in the hot evaporated film; but unfortunately the data do not allow us to decide whether this film is in the α- or the β-configuration. The results, however, allow us to put forward a tentative picture of the gelling mechanism. Above 35° C. gelatin would appear to exist in a form which does not allow hydrogen bonds to exist between the molecules. This condition would be satisfied either by the α-fold or by a β-fold preferentially forming hydrogen bonds with the water. On concentrating such a hot solution there is little change in the optical rotation, which strongly suggests that it is in the α- rather than in the β-configuration. Below 35° C. the existence of the collagen fold becomes possible where lengths of parallel chain come into contact; a three-dimensional network is built up consisting of lengths of single molecules joined together by small regions of parallel chains in the collagen configuration (the presence of more than 20 per cent proline and hydroxy-proline means, however, that there will be many residues which cannot be hydrogen-bonded in the α-fold). Where the concentration and number of collagen folds cross-linked are sufficiently high, the network will permeate the whole solution, which will then set to a gel. On ageing, the organized regions in the collagen fold increase; this will continue until steric restrictions prevent the further growth of the organized regions. The ageing is accompanied by an increase in specific rotation and rigidity. On concentrating the gel there is a further large increase in the proportion of collagen fold, as indicated by the further marked increase in the optical rotation.

In attributing the origin of the gel formation to the formation of the collagen fold, we are assuming that any contribution from side-chain interaction will be of secondary importance. This is in accordance with the observation that the optical rotation[5] as well as the melting point[6] and rigidity[7] of the gel are little dependent on pH.

If increasing quantities of certain salts (for example, lithium bromide, iodide or thiocyanate) are added to a cold gelatin solution, the specific rotation falls to a limiting value which is very near that for the hot solution, while at the same time gel formation is prevented[8]. It would seem that high concentrations of such salts convert cold gelatin from the inter-chain-hydrogen-bonded form to the intra-chain-hydrogen-bonded α-form. It is significant that lithium bromide, as Ambrose, Bamford, Elliott and Hanby[9] have shown, converts silk from the inter-chain-hydrogen-bonded β-form to the water-soluble α-form.

Our thanks are due to Mr. E. J. Ambrose for having first directed our attention to the fact that a correlation between optical rotation and the chain configuration in polypeptides was to be expected from theories of optical rotatory power, to Dr. A. Elliott for obtaining the infra-red radiation data on gelatin, and to Mr. N. B. Abbott for that on polypeptides. We also wish to thank Mr. W. E. Hanby for preparing the range of polypeptide specimens.

[March 7.

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A HUNDRED YEARS OF ORGANIC CHEMISTRY (1851–1951)*

THE century 1851–1951 has been an eventful one for organic chemistry. Indeed, it has seen the science grow from a rather confusing and empirical body of facts into one of the most systematic and fascinating of the sciences, and one on the progress of which many of the amenities of our modern civilization depend.

1851 might almost be regarded as a turning point in organic chemistry, for major developments destined to shape the whole course of the science were at hand. It will be recalled that early in the nineteenth century Berzelius had defined organic chemistry as the chemistry of substances produced by living matter, in contradistinction to the inorganic substances of mineral origin. There were certain striking differences between the two types, and in Berzelius's mind, as in those of his contemporaries, these were associated with the vital force concept. Wöhler's laboratory synthesis of urea in 1828 is generally believed to have sounded the death knell of the vital force theory; but, in fact, it survived for long after that and it still rears its head in the famous text-book of Gmelin (1854). In the years that followed Wöhler's discovery, however, Liebig and others had shown that the organic compounds all contained carbon and that carbon compounds with similar properties could be obtained from non-living sources, for example, coal tar. So it gradually came to be recognized that organic chemistry was, in effect, synonymous with the chemistry of the carbon compounds, and attention was directed to the understanding of carbon chemistry, since it was clear that

* Substance of a paper read by Prof. A. R. Todd, F.R.S., before Section B (Chemistry) of the British Association on August 9.

until such an understanding was obtained little progress was to be expected in studying the chemistry of living matter.

By 1851 the efforts of many chemists had produced a substantial body of factual knowledge ; but despite type theories and radical theories, there was no really satisfactory theory of valency which could correlate the facts and establish the interrelationships of organic compounds. In 1852 E. Frankland made the first clear statement of the idea of valency or fixed combining power of an element. This was a great step forward, and it was followed in 1858 by the work of Kekulé and Couper, who independently put forward a theory of molecular structure based on the quadrivalency of carbon and the capacity of carbon atoms for joining together in chains ; they showed how molecular constitution could be represented diagrammatically in graphic formulæ and could predict the existence of isomers. That more isomers did, in fact, exist than were allowed for by this theory was, however, clear from the earlier work of Pasteur, who had shown that two optically active tartaric acids exist. This was clarified in 1874 by van 't Hoff and Le Bel, who added to the Kekulé–Couper ideas the concept of the tetrahedral carbon atom and thereby introduced the idea of space- or stereo-isomerism. With this the whole subject was placed on a firm basis, and on these theories virtually the whole of the modern science arose. Only in comparatively recent years have alterations in basic ideas of molecular structure come from physics through knowledge of the electronic structures of atoms, but even these new ideas have not altered the essential applicability of theory laid down between 1850 and 1874.

Armed with this understanding of structure, the study of the carbon compounds flourished exceedingly, and by the early twentieth century a vast number of such compounds were known and methods of synthesis and analysis had been developed in great variety. During this period, too, began the rise of the great organic chemical industry—producing dyestuffs, starting from the initial aniline dye of Perkin, explosives, etc. This rise of an industry notable for its closeness to the advancing front of a science has continued, until to-day it produces not only dyes and explosives, but also plastics, detergents, photographic materials, drugs, fabrics and a multitude of other things which we accept without question as part of everyday life—there are indeed few of the material comforts of life which do not owe something to organic chemical industry.

The twentieth century has seen, however, a remarkable development in our knowledge of chemistry in relation to living matter. During the latter half of the nineteenth century organic chemists paid scant attention to this side of their subject, and even biochemists—those concerned primarily with the nature of the processes going on in living matter—were relatively few. It is only in this century that great strides in biochemistry have been made.

From the organic chemist's point of view, this was inevitable. The materials found in living matter were too complex for him to study with success until he had mastered the groundwork and developed methods for studying carbon compounds in general. This mastery came from the work of the late nineteenth century, and as the twentieth begins we can see the beginnings of a move towards the goal of the early organic chemists in the work of Fischer, Willstätter and others on the proteins, purines, sugars, natural colouring matters and enzymes. This movement has grown continuously, receiving enormous impetus through the development of microtechniques enabling work to be done with tiny quantities of material ; and in the past twenty-five years it has given most of the spectacular achievement of organic chemistry in the structural elucidation and synthesis of hormones, vitamins, alkaloids, natural colouring matters, etc., and indirectly of the synthetic drugs. Parallel with it have come the developments in the understanding of the finer details of molecular structure and reactivity associated with the names of Lapworth, Robinson, Pauling and Ingold. The welding together of the results and ideas emerging from these two fields of endeavour promise still more striking triumphs for organic chemistry in a future which should be as fascinating as its past.

VERTICAL MIGRATION OF PLANKTON ANIMALS*

MANY of the small plankton animals in the sea which are important as the food of fish such as herring, sprat and mackerel swim upwards towards the surface in the evening and down again to deeper levels after dawn. It is of interest from a purely biological point of view to find out what are the factors which govern these movements, and may also be useful in reaching a better understanding of the shoaling of the herring. The plankton consists of small animals of many different kinds, small jellyfish, worms and molluscs, hosts of small crustaceans and many others ; they nearly all show this nightly vertical migration upwards. Since it has been developed in so many different groups of animals and must use up so much energy every day—some of them climbing more than a hundred feet—it must clearly be of profound significance in their lives. We do not yet understand its meaning and are still only in the stages of studying the actual movements of the animals in relation to different conditions of light, temperature, pressure, etc.

Hitherto it has not been possible to see animals making extensive vertical migrations in the laboratory or to experiment with them while doing so. Now apparatus has been devised which allows this to be done. A curved transparent tube of 'Perspex', of 2 in. by 1¼ in. cross-section, is made to form a complete circle of 4-ft. diameter and is then mounted as a wheel ; a small opening, which may be sealed up, allows it to be filled with water and the experimental animal added. The wheel is now turned so that the animal is half-way up one side ; it can now swim up or down according to the varying conditions of light, etc., which may be controlled ; but as it does so the wheel is turned so that it is actually kept stationary in relation to the observer. It is seen that the animal is swimming in an endless tube ; it can swim up and up, or down and down for hundreds of feet, and the wheel, which is turned all the time, automatically records its speed of swimming on a recording drum. Inside the tube are small doors, some with weights and some with floats, which automatically open and close as the wheel goes round ; they are always wide open at the side at which the animal is swimming and so do not interfere with it, but closed on the other side to ensure that the water turns exactly with the wheel.

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*Substance of a paper read by Prof. A. C. Hardy, F.R.S., and R. Bainbridge before Section D (Zoology) of the British Association on August 10.

A parallel tube fitted with a photo-electric cell records the light intensity at a point beside where the animal is swimming. The experiments are performed with the wheel in a small glass greenhouse and the intensity of the light varied from bright daylight to complete darkness by a series of white, grey and black screens which can be drawn over the top.

Tracings from the recording drum of the swimming up and down of different animals under different conditions were shown and discussed. *Calanus*, a crustacean, almost the size of a grain of rice and the principal food of the herring, is shown to be able to climb 50 ft. in one hour, and another larger crustacean, *Meganyctiphanes*, almost an inch long, can climb as much as 305 ft. in the same time.

APPLICATIONS OF PLASTICS

AT the British Plastics Convention and Exhibition held in Olympia, London, during June 6–16, the plastics industry was given full opportunity for displaying its products and discussing the technical and practical aspects in the Convention Hall. The industry can claim considerable credit for the display. This relatively new and virile industry is one which uses its chemical raw materials in a careful and efficient manner to produce a very wide range of products and articles which are proving of much benefit to many industries to-day. They enable new assessments to be made of many old problems and processes; new values of durability, resistance to chemical attack or corrosion under atmospheric conditions, beauty and often lower-cost production resulting from their adoption. There is a large range of plastics materials available, and each one of the materials has itself an almost limitless range of applications best suited to its chemical and physical properties. There is in the lighter industries a very considerable scope for their adoption for very many uses.

The various plastics raw materials will be described first, and a few of their chemical and physical properties named. Then some of the outstanding applications for each plastic dealt with in the Exhibition and the Convention will be mentioned. Plastics materials are either moulded or otherwise fabricated into the many articles or other finished products used by the consumer, who may be the public, or the manufacturer of other products used in another industry. It should be stated here that the plastics materials referred to are the organic plastics only, but by common consent in the industry, rubber is excluded from the range.

Celluloid (or Nitrocellulose), discovered in 1865. This is the recognized pioneer material. It is thermoplastic, which means that after it has been shaped while it is hot, it is rigid when cold. But it will soften again on reheating and it can then be reshaped. Although it is the oldest plastic, it still has many uses which would not be improved upon by more modern materials, for example, table tennis balls, covering stretched over metals, such as automobile steering wheels and omnibus rails, hairbrush backs and toothbrush handles, etc. Its inflammability, however, necessitates its use with caution. In its sheet or rod form it is remarkably tough, while, of course, it is unaffected to a large degree by water and many chemicals.

Cellulose Acetate, discovered in 1865. This non-inflammable grade of plastic replaced celluloid for some uses where inflammability was feared. It is a thermoplastic. It came into prominence during the First World War as an aeroplane 'dope'. After that War ended, large stocks were available for utilization, when the process of converting the white powdered cellulose acetate into sheet and rod was developed. A new and relatively safe plastic was available for use in such things as lamp-shades, ornamental articles (for personal decoration, such as brooches, etc.), transparent sheet for packaging, astraldomes for aircraft, fountain-pen barrels, moulding powders, etc.

This material is extremely tough in all its forms and can be made in both rod and sheet form and as moulding material, clear, opaque or translucent (for example, tortoiseshell). Among numerous articles for consumer use made from cellulose acetate are fancy goods, door beading, drawer pulls and handles, spectacle frames, ciné non-flam film, packaging, showcards, protective eyeware.

Cellulose acetate is used to quite a large degree as the raw material for cellulose lacquers, extensively used for general decorative applied finishes. It is also used on ships' fittings, such as covering metal handrails, door furniture, etc.

Casein Plastics, first produced in 1885. This class of plastics is gradually giving way to more modern materials. It is available in sheet or rod form principally, and its present use is mainly for ornamental buttons for the garment industry, which articles are fabricated by machines from rod or sheet. It is not waterproof in the generally accepted sense of the word.

In addition to buttons, many fancy goods are made from it, such as barrels for pencils and fountain-pens, and insulators and articles for resisting low-tension electric currents. Other applications are shoe buckles, knitting pins, umbrella handles, furniture handles, combs, etc., by machining from rod or sheet.

Phenolic Plastics, developed in 1907. This type of plastics is the most extensively used range of materials at present. Phenolic plastics are thermosetting, which means that while hot they may be shaped; but during shaping a chemical reaction takes place which hardens the material in the mould. Further heating does not soften the moulding or shaped piece as in the case of thermoplastic materials. Thus, the finished articles or products made in phenolic plastics may be used for purposes where some resistance to heat is required. Phenolic plastics is only one type of thermosetting material, others being urea-formaldehyde and melamine-formaldehyde plastics (aminoplastics) as described later. The finished articles are extremely hard and, in addition to being resistant to heat, they are also resistant to a wide range of chemicals, but not to alkalis or strong oxidizing agents.

From the resins are made a wide range of products, such as moulding materials, paper and fabric laminated sheets, the more durable types of paints, and varnishes for electrical insulation, units of chemical plant as a structural material, acid-resisting floors, tanks, vats, pipework, etc. Large quantities are used for the manufacture of high-speed grinding wheels, brake and clutch linings for cars, adhesives for plywood manufacture, electric lamp capping cements, metal foundry core binders, etc.

Moulding powders are used to produce large television and radio cabinets in one piece, clock cases, rotary pump impellors, stud-welding pistol grips, car facia boards, Topham spinning boxes and spools for the rayon industry, vacuum cleaner bodies, shop counter drawers, ventilator fan cases and rotors and radio and electrical accessories. In addition, a large range of fancy goods such as cigarette caskets, desk calendars, etc., are produced. The present trend is for larger and larger mouldings to be made.

In its laminated form, using paper or fabric as the interlayer, phenolic plastic is used for plywood facing for furniture, wall panelling for ships and railway carriages, silent gear wheels to transmit both low and high powers, plating barrels, fish plates for railways, stern tubes for the propellor shafts of ships, roller bearings in steel rolling mills, aircraft propellors and structures (for example, the 'Mosquito'), moulded dinghy hulls, etc.

Amino-Plastics—Urea and Melamine, developed in 1920 *and onward.* These are thermosetting. Mouldings with a high degree of beauty can be made, and thus they are used for fancy goods to a large extent. Urea resins are used for plywood adhesives, foundry sand-core binders, surface coatings, treatment of textiles to render them resistant to creasing, increasing the wet strength of papers, permanently stiffened finishes for textiles in admixture with starches or dextrins, controlling shrinkage of fabrics.

Urea and melamine resin mouldings are non-tracking, and thus are widely used for certain electrical insulators where resistance to electrical surface leakage is essential.

Amino materials capable of being made in light colours and delicate pastel shades are used extensively for surface layers of laminated sheet for wall panelling and light-coloured materials for furniture finishing, for example, table and bar counter tops, etc.

Polyvinyl Plastics, developed during 1920–30. These are thermoplastics made as polyvinyl chloride or acetate or copolymers of chloride and acetate. They are also produced as the acetals, butyrals, etc. They are easily worked into sheets and are now extensively used for shower curtains, window furnishings, flooring tiles and raincoats (either as sheet or as coated fabric). They can be made with a high degree of decoration, either clear or opaque and with printed patterns. They are also used for upholstery (leather-cloth), shoe uppers, ladies' handbags, transparent packaging, etc. In the chemical industry, polyvinyl chloride sheet (known as p.v.c.) is used for tank linings, protective clothing, filter cloths. Other applications are: safety glass for motor-car windscreens, yarns for weaving hosiery, fishing nets, etc., 'cocoon' casing for armaments in storage or being shipped to the East. Very large quantities are used for covering electrical cable instead of rubber, and for the manufacture of highly successful primers and other surface coatings.

Polyethylene Plastics, developed 1937–43. They are thermoplastic and possess a very high degree of both chemical and electrical resistance. They are wax-like to the feel and in appearance. They can be used for many items of chemical plant and utensils, such as pipes for conveying many chemicals, and for lining the interior of chemical tanks and vats, containers and utensils for hydrofluoric acid.

The evolution and use of polyethylene contributed substantially to the development of radar during the Second World War, on account of its very low power factor.

It is extensively used as the interior core of undersea cables to reduce electrical losses. It is also used in transparent film form as a packaging material for foodstuffs, drugs (like 'Mepacrin' tablets), flexible bottles by the Plax extrusion blow technique, pharmaceutical tubes, cosmetic containers, etc. Balloons for high-altitude meteorological and other observations can be made of polyethylene. Tubing for cold-water plumbing is also made of polyethylene.

Nylon, developed during 1928–38. This is a polyamide plastic and is a thermoplastic. It is best known for its use in hosiery and specialized garments. Industrial applications include tow ropes for gliders and gear wheels for impellor pumps. As a filler for phenolic moulding materials, it imparts great strength and resistance to alkalis and acids in mouldings. It is used extensively for surgical dressings where 'breathing' outwards only is required.

Methyl Methacrylate, developed in 1938. This is an ethenoid type of plastic and is thermoplastic. Some of its applications are for use in aircraft as radomes from transparent sheet, transparent models or housings for working parts for use in exhibitions, for example, motor-car engines, gear-box casings, etc. It is also used for artificial teeth and dentures, some types of transparent mouldings, camera lenses, spectacle lenses, sculpture or highly ornamental carvings, and rods for transmitting artificial light round bends. It is a material of considerable beauty and consequently is used for a wide range of fancy goods for machining.

Polyethylene Glycol Terephthalate ('Terylene'), developed in 1939 *and onwards.* This is a true synthetic fibre, either silk-like or wool-like in properties. It can be made unshrinkable. It can be easily printed and is probably the most successful synthetic fibre for the textile industry to date. Its tenacity when wet is the same as when dry. It has good drape and handle, and has been used so far for lightweight suits. It is also used for filter cloth and laundry bags, ropes, cord, thread, corset cloth, brassière cloth, industrial overalls and sailcloth. It is expected to follow the pattern laid down by nylon.

The above is a brief outline of the state of the industry up to date; but new products are emerging rapidly and what is new to-day may be old to-morrow.

H. V. POTTER

LIBRARY SERVICE IN GREAT BRITAIN

ANNUAL CONFERENCE OF THE LIBRARY ASSOCIATION

AS one of the means by which scientific and technical knowledge is made more readily available to industry and to the community generally, the public library service must always be of some general interest to the man of science. While his own needs will be met in general by the libraries maintained by his professional institutions, or of the universities, research institutes or industrial organizations or firms with which he is associated, as well as by such national libraries as those of the Patent Office or the Science Museum, they are already to some extent served by the larger public libraries which offer a type of regional service. If the regional libraries or services envisaged by the Panel on Technical Information Services of the Committee on Industrial Productivity ever mature, the public libraries are likely to play an important part in the development.

Little hint of such developments was given at the annual conference held in Edinburgh during June 5–8 by the Library Association; but papers presented at the Conference possess rather more than usual interest for the scientific worker. The presidential address of Mr. James Wilkie, for example, dealt largely with the challenge which the impact of science and technology on everyday life as well as on industry make to the librarian, not only to meet the needs of science and technology but also to assist the citizen to adapt himself to changing conditions. These opportunities of service to all sections of the community were indicated with the vision and sure touch to be expected from the secretary of the Carnegie United Kingdom Trust. The same qualities characterize the general report of the Public Library Inquiry conducted in the United States by the Social Science Research Council, with assistance from the Carnegie Corporation, at a request made by the American Library Association in 1948. The findings of this report were summarized for the Library Association Conference by Mr. W. A. Munford, Cambridge city librarian, and it is clear from his summary that, apart from its bearing on public library service in Great Britain, the report deserves attention in regard to adult education and the extramural work of the universities, at least as indicating some of the questions that should be answered before determining university policy in that field.

Mr. Munford's paper was presented at a session at which the Association looked to its future problems, and another paper contributed to that session, by Miss Gwenda Jones, dealt with the practical issue of the place of reference and technical libraries in the county library system. This is an aspect of the regional problem which has scarcely yet been faced, largely for reasons of space, staff and of money; but it is one which the distribution or dispersal of industry would render ever more important. Decentralization of industry itself explodes the idea that the county library system is a purely rural service completely divorced from industry and science. Miss Jones herself recognizes that the pattern of a county library technical service may be decentralization to the towns where the main industries operate, and that this would necessitate strengthening the branch staffs with technical librarians, possibly joint appointments with that of reference librarian. It is interesting to note also in this paper the suggestion that the county library system should provide employment for more persons with scientific qualifications of the calibre who at present find a place only in the big municipal libraries or the industrial libraries. Doubtless it will not be easy to implement any such suggestion without considerable improvement in the status and salaries which the county library system can offer at present, but the freer movement of men and women both from the public library system into industrial libraries and in the reverse direction is desirable. It could be an important factor in encouraging that mutual understanding of problems and conditions which is a prerequisite in developing the co-operation between libraries to which a whole session of the Conference was devoted.

The paper on reference libraries presented by Mr. Hargreaves, reference librarian of Leeds, at that session, and the papers at the symposium on library service to industry are possibly those of most interest to the scientific worker. Mr. Hargreaves's paper presented a sane and balanced view of the whole problem of inter-library co-operation in which the point of view of the industrial librarian is very fairly reflected. Mr. Hargreaves sees clearly enough the advantages of building up a co-ordinated system, as well as the practical difficulties in doing so, and no one could have indicated more clearly the way in which any such system can be prejudiced or even wrecked by thoughtlessness in the way it is put to use. Some of his suggestions should be at least as useful to the librarian in industry as to the public reference librarian, and his paper gives also a hint of the extent to which inquiry is still required before any attempt is made to set up a system of regional reference libraries in Great Britain.

The Earl of Elgin and Kincardine, vice-president of the Scottish Council for Development in Industry, who opened the symposium on library service to industry, was concerned to provide a national background for the discussion, and, like Mr. Wilkie, stressed the dominant part of science in industrial production and expansion and the need for efficient library service to enable the scientific worker—and indeed the administrator—to do the best work of which they are capable. He gave, moreover, just a hint of the contribution which library service can make to the task of adult education and the bearing of this not merely upon industrial productivity but also upon the social satisfactions which, as Dr. Elton Mayo emphasized, go so far to determine productivity. That point was also stressed by Mr. L. R. McColvin in his final reference to the importance of preventing the devaluation of man.

Mr. McColvin was referring to the part which the public library can play in providing the real incentive to use our technical powers to improve productivity by helping to make life interesting; to promote understanding and tolerance, to provide relaxation and enjoyment and disclose opportunities. Whatever the public library system can contribute to the dissemination of technical information or the improvement of industrial efficiency is, and should be, secondary to its function as a means of adult education and the provision of social satisfaction. It would be untoward if its resources and energies were diverted from that primary task, and the papers presented at the Edinburgh Conference give grounds for believing that in any re-examination of the place of the public library in adult education or the direct contribution it can make to the dissemination of technical and scientific information, its social function will be kept firmly in mind, and particularly by the men and women responsible for carrying out that service.

That reassurance is supported by the presence in the Civil Estimates of an entry of £2,000,000 for the acquisition of a site for the National Library. Only £50,000 of this sum is earmarked for 1951–52, and the project is thus a fairly distant scheme, like that for the Science Centre, which is also to accommodate the Patent Office and its Library, extended and modernized to constitute a first-rate central reference library on science and technology. Mr. F. C. Francis, in his paper dealing with the place of the libraries of Government departments, learned societies and research institutes in providing a full library service for industry, indicated that a sub-committee has already completed its report on the scope and plan of the proposed new Central Scientific Reference Library, although the report has not yet been made public. Mr. Francis emphasized, however, that no one library could provide all the service now required, and that the elaboration of scientific library services in Great Britain demands the greatest possible spreading of responsibility. The function of the National Library is to cover the greater part of the field itself and to co-ordinate the activities of the other libraries, seeking to ensure that all fields of information are properly covered.

Beyond the announcement that the proposed Science Centre is to be on a site on the south bank of the Thames, there has been no official pronouncement since Sir Robert Robinson's reference to the scheme in his anniversary address to the Royal Society on November 30, 1950. The site for the National Library has also been chosen, and the Ministry of Works has requested the London County Council to designate for this purpose in its first development plan the area lying opposite the British Museum on the south side of Great Russell Street. It is proposed that eventually the library of the British Museum shall be separated from the museum departments and accommodated in its own building on this site, much as, some seventy years ago, the natural history collections were transferred to South Kensington. Both projects will require many years for completion, and even the detailed planning is scarcely in sight. Nevertheless, Mr. Francis rightly directed the attention of the Library Association to both the short-term and the long-term problems which such projects pose, and to the challenge they offer to constructive thinking as well as to co-operation. That challenge should be taken up by the scientific worker and technologist as well as the librarian, and indeed by all who appreciate the large part which libraries can play in the dissemination and assimilation of our scientific and technical knowledge. As Mr. Francis indicated, prime importance is attached to the whole matter by the Government; but if the opportunities are to be utilized to the full and all obstacles to achievement overcome, the Government will require the sustained support over a period of years of informed opinion in scientific, technical and industrial circles.

RESEARCH ON BRICK-MAKING

NEW RESEARCH LABORATORIES OF THE LONDON BRICK CO., LTD.

OVER a large area of Great Britain the fletton brick has won its place as the cheapest common brick of the building industry, and an annual output of more than 2,000 million is nowadays achieved by the group of brickworks situated on the Oxford clay in the districts lying mainly around Bedford and Peterborough. In any manufacturing industry operating on this scale it is to be expected that there would be many problems calling for research, and a notable advance has recently been made by the largest fletton manufacturer, the London Brick Co., Ltd., which has recently opened new research laboratories at its Stewartby works near Bedford. The building, which was designed by Mr. C. C. Handisyde, provides efficient accommodation for the strong research team that has been built up since the War and, in addition, includes a display hall, library, and directors' conference and dining rooms. It is perhaps significant of the changes which are coming about in even the more traditional of our industries that accommodation for the Company's directors should be provided in close association with the research laboratories.

The laboratories are, naturally, built of brick. They are on an ample site and are designed in three wings on one floor on a flexible plan which will facilitate any future extensions that may be needed. Offices and small laboratories open off central corridors, and the lessons of modern school design have been utilized in that the larger laboratories obtain cross-ventilation and additional lighting over the corridors.

Other interesting features are the use of ceiling heating-panels in the laboratories to avoid the loss of valuable wall and floor space which other forms of heating would have required, and the imaginative use of bright, pleasant colours throughout the building in the decorations. Even the service pipes, which, owing to the nature of the site, could not be accommodated in under-floor ducts, are picked out in various colours in accordance with recommendations issued by the British Standards Institution.

Much of the research work is aimed at improving both the understanding and the operation of the manufacturing processes used in the Company's works, and studies are in hand on the conditioning and grinding of the clay, on the methods of pressing it into green bricks, and on the drying and firing processes involved. It is something of a surprise to find a well-equipped fuel technology laboratory devoted mainly to a study of the fuel content of the natural Oxford clay. Theoretically, the organic content of most of the clay used in the works is sufficient to produce all the heat needed for burning the clay. In fact, on account of the unavoidable inefficiencies of the burning process, some additional fuel has to be provided; but this is only a quarter of that needed for burning most other types of bricks. This is a matter of great economic importance in the fletton industry.

As an essential part of the research on plant and methods, a close statistical watch is kept on the qualities of the bricks emerging from the various works. By this means the effects of changes both in the manufacturing processes and in the nature of the raw clay can be accurately followed. Research of this kind is badly needed in a group of industries which are normally regarded as falling outside the field of chemical engineering, and it may well be that this pioneering work by the London Brick Co. will lead other industries to make similar efforts.

Work of a much more fundamental character is also being done. In association with a detailed geological survey of the Oxford clay deposits, a study has been commenced of the constitution of the clay. Differential thermal analysis is being used for the identification of clay minerals, and provision has been made for the utilization of X-ray techniques at a later stage. These are essentially long-term investigations and represent an imaginative and long-sighted view by the Company of its research activities.

In addition to the work concerned directly with brick manufacture, there is also some research in hand on processes designed to produce a light-weight aggregate for concrete by the bloating of clay, and other clay products of cellular structure. Attention is also given to the utilization of by-products.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Mode of Action of Antibiotics in Stimulating Growth of Chicks

The stimulating effect on chick growth of antibiotics given by mouth has been reported by Stokstad and Jukes[1] and many other workers. Their finding has been confirmed at Reading[2] on several occasions with a variety of diets including practical rations, but not at Greenford, where only practical rations were tested.

The first set of results reported here was obtained independently in the two laboratories. The diet was a practical chick-rearing meal to which procaine penicillin was added to supply 25 mgm. of the antibiotic/kgm. Day-old Rhode Island Red × Light Sussex chicks were used in both laboratories, but were obtained from different sources. Their mean body-weights in grams after three weeks on the diets were:

Laboratory	No. of chicks/group	Without penicillin	With penicillin
Greenford	10 (mixed sexes)	181	183
Reading	20 ♂	143	191

The second experiment was designed to eliminate sources of variation between the two laboratories. One large batch of National Baby Chick Mash was obtained and divided between them. Similarly, equal groups of cockerel chicks (Rhode Island Red × Light Sussex) from the same supplier were distributed to each on the day of hatching, and their housing conditions were made as nearly as possible the same. The chicks were given the experimental diets for three weeks and their mean body-weights in grams at the end of this period were:

Laboratory	No of chicks/group	Without penicillin	With penicillin
Greenford	20 ♂	188	191
Reading	20 ♀	167	192

The reasons for this marked discrepancy between results in the two laboratories is being investigated further; but the findings so far support the suggestion that the growth-stimulating effect of antibiotics results from their suppression of micro-organisms detrimental to the host. It is possible that at Reading, and in other laboratories, where chicks have been kept regularly for a number of years, such organisms may have become established, with a slightly retarded rate of growth as their only manifestation. Chicks are not normally kept in the Greenford laboratories, and it is therefore unlikely that such organisms would be present there. If this explanation proves correct, it could certainly account for some of the dramatic results obtained by many workers with antibiotics in practical poultry management.

Quite possibly, with chicks deprived of the animal protein factor or other vitamins, antibiotics may stimulate growth also by creating in the gut conditions more favourable to the synthesis and uptake of missing factors.

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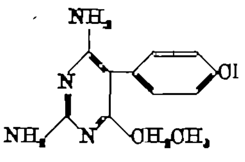
A 2:4-Diamino Pyrimidine in the Treatment of Proguanil-resistant Laboratory Malarial Strains

A series of 2:4-diamino pyrimidines substituted in the 5- and/or 6-position has recently been described[1] as having activity against malaria infections of laboratory animals. In particular, 2:4-diamino-5-*p*-chlorophenyl-6-ethyl pyrimidine (I), termed 50–63 here, showed a high degree of activity.



I

This compound has been tested against strains of malaria parasites showing experimentally induced resistance to proguanil. Its activity against these resistant strains falls little short of that which it exercises against normal strains.

Three resistant strains were used in these experiments. The proguanil-resistant *P. gallinaceum* was obtained from the Liverpool School of Tropical Medicine and is strain 6 as described by Williamson and Lourie[2]. This strain was tested for proguanil-resistance before proceeding further and was found to be at least 55 times more resistant to the action of proguanil than the normal sensitive strain. (Minimum effective dose for proguanil is 0·9 mgm./kgm. for the normal strain and more than 50 mgm./kgm. for the resistant strain, the minimum effective dose being defined as the dose which effected a 50 per cent reduction in parasitæmia compared with untreated controls, this being estimated graphically from dose-response curves.)

Two drug-resistant strains of *P. berghei* were used: the first a strain which had been subjected to sub-curative doses of proguanil, and the second to sub-curative doses of sulphadiazine. The method of inoculation and dosing is similar to that described by Goodwin[3]. After their respective courses of treatment, both strains were tested for proguanil- and sulphadiazine-resistance along with the untreated parent strain.

It had previously been shown[4] that treatment of *P. gallinaceum* infections in chicks by sub-curative doses of sulphadiazine had very quickly induced a high degree of proguanil-resistance in that strain, even before sulphadiazine-resistance became mani-

Table 1. Tests of Resistance of Proguanil- and Sulphadiazine-treated Strains of *P. berghei*

Experiment	Strain	Min. effect. dose proguanil (mgm./kgm.)	Min. effect. dose sulphadiazine (mgm./kgm.)	Degree of resistance*
1†	Parent	5·2	—	3·8
	Proguanil-treated	20	—	
2	Parent	—	0·07	1·1
	Proguanil-treated	—	0·08	
3	Parent	5·8	0·05	1·7 for proguanil, 3·2 for sulphadiazine
	Sulphadiazine-treated	10	0·16	
4	Parent	5·2	0·03	3·8 for proguanil, 4·3 for sulphadiazine
	Sulphadiazine-treated	20	0·13	

* Degree of resistance is expressed as the ratio of the minimum effective dose for resistant strain to that for parent strain.

† Exp. 1: after twelve treated passages. Exp. 2: eight months after exp. 1; strain treated occasionally with maximum tolerated dose of proguanil between experiments. Exp. 3: after seven treated passages. Exp. 4: after nine treated passages.

fest. Table 1, which summarizes these preliminary experiments, shows that the sulphadiazine-treated strain of *P. berghei* has also attained some degree of resistance towards proguanil.

The results in Table 1 also show the proguanil-treated strain to have become resistant to proguanil treatment. The ratio is of necessity small owing to the low activity of proguanil in *P. berghei* infections and its high toxicity to mice. It is also interesting to note that while the sulphadiazine-treated strain had quickly attained resistance to proguanil, the proguanil-treated strain showed no resistance to sulphadiazine. Similar work by Bishop and McConnachie[4] showed that cross-resistance to sulphadiazine by proguanil-resistant *P. gallinaceum* strains is only attained after prolonged treatment with large doses of proguanil.

Using these three resistant strains and the corresponding normally sensitive strains, 50–63 was assayed by methods previously described[1,5] and the minimum effective doses of the compound against each particular strain determined as above (see Table 2).

Table 2. Activity of 50–63 against Proguanil-resistant *P. gallinaceum* and *P. berghei*

Drug	Strain	Min. effect. dose (mgm./kgm.)	Degree of resistance
Proguanil	*P. gallinaceum*—parent	0·9	>55
	P. gallinaceum—proguanil-resistant	>50	
	P. berghei—parent	5	
	P. berghei—proguanil-resistant	>20	>4 for 'proguanil strain' 3·5 for 'sulphadiazine strain'
	P. berghei—sulphadiazine-resistant	17·5	
50–63	*P. gallinaceum*—parent	0·03	2·3
	P. gallinaceum—proguanil-resistant	0·07	
	P. berghei—parent	0·02	
	P. berghei—proguanil-resistant	0·06	3 for 'proguanil strain' 1 for 'sulphadiazine strain'
	P. berghei—sulphadiazine-resistant	0·02	

From Table 2 it appears that cross-resistance does not occur; 50–63 largely retains its high degree of activity against strains which respond little or not at all to maximum tolerated doses of proguanil. Further experiments show that *P. gallinaceum* does not readily become resistant to 50–63 after treatment with subcurative doses of that compound, in direct contrast to the ease with which proguanil-resistance is produced[6,7]. In the present series, an offshoot of the *P. gallinaceum* strain was treated through fourteen successive passages with a total of 95 doses of 50–63 at a dose of 0·04 mgm./kgm., approximately the minimum effective dose. At the end of this course of treatment, the minimum effective dose of 50–63 was determined for both the parent and treated strains (see Table 3).

Table 3. Test of Resistance of Parent and 50–63-treated Strains of *P. gallinaceum* to 50–63

Strain	Min. effect. dose of 50–63 (mgm./kgm.)	Degree of resistance
Parent	0·02	2·5
50–63-treated	0·05	

These results indicate the treated strain to be two and a half times more resistant to treatment with 50–63 than the normal strain. Knoppers has shown[8] that treatment of *P. gallinaceum* infections with quinine results after twenty-six weeks in the development of two-fold resistance; further treatment did not result in increased resistance. 50–63 may behave similarly and produce a low degree of resistance not easily increased by further treatment.

A more detailed and extended account of these observations will be published elsewhere.

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Formation of Extra-cellular Nitrogen Compounds by Fungi

In the course of work in this Laboratory on the nitrogen metabolism of mould fungi, it has frequently been observed that much less than the total amount of nitrogen supplied initially in the medium in the form of nitrate or ammonium salt is recovered in the fungus mycelium, although a high level of readily assimilated carbohydrate is present in the culture medium. Similar results have been obtained by other workers[1]; but it is not clear whether they are to be explained by incomplete assimilation of the nitrogen source or by the formation by the fungus of complex nitrogen compounds which either remain in, or are excreted into, the medium. A quantitative study of the uptake of inorganic nitrogen by fungi was therefore undertaken, using in the first place a strain of *Scopulariopsis brevicaulis*.

The fungus was grown in still culture in small conical flasks on a liquid synthetic medium containing 5 per cent glucose (AR), mineral salts, trace elements, and inorganic nitrogen as either potassium nitrate or ammonium sulphate. The ammonia medium also contained 1 per cent sodium succinate, the addition of which has been found necessary to ensure good growth on ammonium sulphate with this particular strain. The nitrogen source was sterilized separately from the other components of the culture medium. Each flask received exactly the same quantity of nitrogen initially. The disappearance of nitrate and ammonia from the medium was followed at intervals during growth of the fungus. Ammonia was determined by titration after distillation in Conway micro-diffusion units. Nitrate was determined as ammonia after reduction by Devarda's alloy. Simultaneous determinations of the total nitrogen in the medium were made by micro-Kjeldahl (nitrate, if present, being previously reduced with iron).

Differences were found between the total nitrogen and the inorganic nitrogen (nitrate or ammonia) in the medium which indicate the formation of extracellular 'organic nitrogen' during the growth of the fungus, as the accompanying figures show.

Nitrogen source	Amount of nitrogen per flask initially (mgm.)	'Organic-nitrogen' formed per flask (mgm.)											
		Days											
		0	3	4	5	6	7	10	12	15	16	17	23
NH_4	6·1	–	0·3				1·2	1·3	1·2	1·4			1·5
NH_4	6·8	–	0·3	0·7	0·9	1·4	1·6	1·4				1·6	
NO_3	6·6	–				0·7	0·9	1·2			1·4		

The nitrate and ammonia had completely disappeared from the medium by the sixth or seventh day, and it is thus evident that most of the formation of 'organic nitrogen' accompanies the active assimilation of inorganic nitrogen by the young growing mycelium. Thereafter the 'organic nitrogen' remains rather steady, possibly showing a slight tendency to increase. Other experiments have shown that the formation of extra-cellular 'organic nitrogen' takes place over the normal *p*H range at which growth occurs, and also with differing carbon/nitrogen ratios of the starting medium. It also takes place in shake culture, showing that it is not associated only with the special conditions of still culture.

At least 90 per cent of the 'organic nitrogen' is dialysable and therefore does not consist of extracellular enzymes. It gives strong reactions for α-amino-nitrogen when tested with ninhydrin after removal of any free ammonia. Paper chromatography indicates at least two ninhydrin-reacting substances in culture filtrates of the ammonia medium. One of these substances, but not the other, is also present in filtrates of the nitrate medium. These substances have not yet been identified, nor is it known what proportion of the 'organic nitrogen' is amino-nitrogen.

The formation of extra-cellular nitrogen compounds during the assimilation of ammonia or nitrate in the first stages of growth has been shown quantitatively and qualitatively (appearance of ninhydrin-reacting compounds) for a number of other fungi, including strains of *Penicillium griseofulvum*, *P. chrysogenum*, *Aspergillus niger*, *Trichoderma viride* and *Syncephalastrum racemosum*. The phenomenon thus appears to be of general occurrence, as is confirmed by a number of incidental references in the literature[1-4].

These observations are of considerable significance for the general problem of nitrogen metabolism in fungi. They show that the assimilation of inorganic nitrogen by these organisms is normally accompanied by the conversion of a surprisingly high proportion of the available nitrogen (10–20 per cent) into compounds which are not accumulated in the mycelium. The relation of these compounds to the process of assimilation, and whether they are to be regarded as excretion products, or as playing a more essential part, are questions which can only be discussed in the light of fuller knowledge. Further experiments on this problem are in progress and will be reported in detail elsewhere.

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Photo-Inactivation of the Plant Hormone Indoleacetic Acid by Fluorescent Substances

The fact that riboflavin and eosin, which are known to determine the photo-inactivation of indoleacetic acid[1,2], are both fluorescent, led us to investigate whether other fluorescent substances would also be effective in sensitizing such a reaction. Quinine sulphate, æsculin and 2,3,5-triphenyl tetrazolium chloride were tested. It was found by both chemical and biological experiments that these compounds were all active. These substances are colourless, but fluoresce with a visible colour, absorbing light in the ultra-violet region. They are not related chemically, fluorescence being apparently the only property common to them. The present experiments do not necessarily show that there is a direct cause-and-effect relationship between fluorescence and the capacity of inducing the photo-inactivation of indoleacetic acid.

Since many fluorescent substances are of natural occurrence in plants, it seems possible that they play a physiological part in plant growth reactions brought about by light. It also seems that this inactivation of auxin would explain the experimental results of many authors[1] who have treated plants with fluorescent substances.

As to the mechanism of the *in vitro* destruction of indoleacetic acid, it seems that there is always oxidation of this compound, which gives off hydrogen to an acceptor. This can be easily demonstrated by adding a few drops of methylene blue to the reaction-mixture (indoleacetic acid–fluorescent compound). The blue colour disappears within a few minutes of exposure to sunlight. In some instances (sensitization by riboflavin) atmospheric oxygen is required[3]. In other cases (for example, with quinine sulphate), oxygen decreases the reaction-rate. The reason for this is not yet understood.

In the case of catalysis by quinine sulphate, the reaction mixture becomes turbid upon exposure to light, by formation of a compound with lower solubility in water; this compound is ether-soluble. After evaporating off the ether, there remains a pink-brown residue with a strong smell of fæces.

It is possible that one step of the transformations brought about by light is the formation of skatole, by side-chain degradation of the indoleacetic acid molecule.

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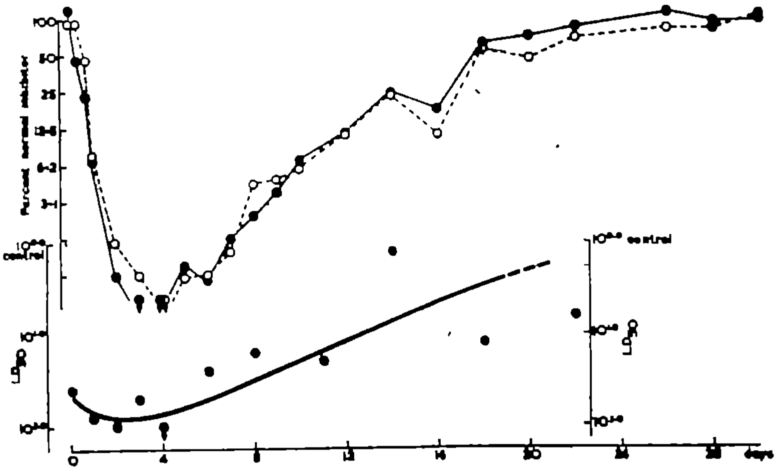
Protection by Receptor-destroying Enzyme against Infection with a Neurotropic Variant of Influenza Virus

In 1948, Stone reported that infection by influenza viruses of embryonated hens' eggs after allantoic inoculation[1], and of mouse lungs after intranasal instillation[2], could be prevented by pretreatment of the exposed cells with the receptor-destroying enzyme of *Vibrio choleræ*[3]. It seems worth adding to these observations the finding that death of mice from infection by a neurotropic variant of influenza virus, neuro-*WS*[4], can be similarly prevented by pretreatment of the mice with an intracerebral injection of receptor-destroying enzyme, and that the return of susceptibility to infection, following a single inoculation of receptor-destroying enzyme, runs roughly parallel to the return of inhibitory activity of the brain[5] to influenza virus hæmagglutination.



Upper graph. Destruction of *HA*-inhibitor in the right (continuous line) and left (dotted line) cerebral hemispheres, following inoculation of receptor-destroying enzyme into the right hemisphere. *Lower graph.* The number of control-mouse *LD*50 required to kill 50 per cent of the mice, when challenged with neuro-*WS* at various times after receiving receptor-destroying enzyme

Groups of 4–5 weeks old mice were inoculated in the right cerebral hemisphere with 12,000 units[6] of purified[7] receptor-destroying enzyme in 0·03 ml., two hours to twenty-two days before being challenged by intracerebral inoculation of neuro-*WS* into the right hemisphere. The times of receptor-destroying enzyme inoculations were so arranged that challenge occurred on the same day for all groups and could, therefore, consist of titrating a single neuro-*WS* allantoic fluid in each group of mice (four mice being used per 0·5 $\log_{10}$ dilution). The mice were observed for twelve days after challenge, at the end of which time all surviving mice appeared perfectly healthy. Protection was estimated by the degree of reduction in the titre[8] (*LD*50) of the neuro-*WS* from the level found in a comparable group of mice which had received no pre-treatment. Afterwards, it was shown that receptor-destroying enzyme which had previously been inactivated by heating at 70° C. for one hour had no protective action.

The above experiment was done in conjunction with a study of the destruction *in vivo*, by a similar dose of receptor-destroying enzyme, of brain inhibitor to heated Lee[9] hæmagglutinin. Hæmagglutinin-inhibitor was measured in saline suspensions of each cerebral hemisphere of four mice, at various intervals after inoculation with receptor-destroying enzyme, and the geometric mean of the titres for each side was compared with the geometric mean titre of thirty-two normal hemispheres. So that dissemination of the receptor-destroying enzyme throughout the brain should not be aided by the process of preparing the brain suspensions, all brains were heated at 62° C. for one hour before they were ground up and suspended in saline. Suitable control experiments had shown that this procedure resulted in adequate inactivation of receptor-destroying enzyme. It follows that the observed degree of inhibitor destruction (more than 99·6 per cent) must represent the proportion of brain inhibitor which is accessible to receptor-destroying enzyme inoculated intracerebrally.

The accompanying figure shows that approximately a hundred control-mouse *LD*50 were required to kill 50 per cent of the mice which had received receptor-destroying enzyme less than four days before challenge, and that susceptibility gradually returned after four days. The figure also shows that the same amount of receptor-destroying enzyme produced marked destruction of hæmagglutinin-inhibitor in both hemispheres; this destruction was greatest on the fourth day and was followed by a very gradual regeneration of inhibitor running roughly parallel to the return of susceptibility to infection.

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Inhibitory Action of Artificial Light on the Sexual Season of the Ewe

Recent studies on photoperiodicity have been undertaken in an attempt to hasten the onset of the sexual season of sheep[1-4], to extend the lactation period in goats, to accelerate the onset of oestrus in thoroughbred mares and to advance or prolong the egg-production season in pheasants[5]. Attempts to inhibit the sexual season are of considerable importance in solving certain problems of refractoriness of the gonads in the physiology of reproduction. Yeates[3] has shown that the cessation of the sexual season of Suffolk sheep occurs after 14–16 weeks exposure to an increasing plane of artificial light.

Two series of experiments were carried out to inhibit the sexual season of the ewe by artificial light. During the hours of daylight, artificial light was not used; control animals were available and ochred vasectomized rams were used for detecting oestrus. The term 'latency of cessation' denotes the period elapsing from the start of light treatment to the date of the last oestrus exhibited.

(*A*) Grade Suffolk ewes were exposed to light continuously from November 1, 1950. They were previously running on pasture under natural conditions of daylight until their sexual season had reached its height (per cent oestrus = 100). The experimental ewes were experiencing oestrus regularly but came off season some eight weeks earlier than the control. The date of cessation in the experimental group ranged from January 4 to February 1, with a mean of January 21 (21 ± 1·7), while in the control group the end of season ranged from February 7 to April 20, with a mean of March 17 (76 ± 5·7). The latency of cessation in the experimental group was twelve weeks, and the control ewes came off season when the natural daylight length was twelve hours. The length of cycle (17·4 days), duration of oestrus (36 hr.) and the frequency of silent heat (5 per cent silent heats expressed as a percentage of the total number of heats theoretically possible) were not significantly different in experimental and control groups.

(*B*) Œstrous ewes of six pure breeds (Blackface Mountain, Border Leicester, Dorset Horn, Romney Marsh, Suffolk and Welsh Mountain) and of one first cross (W.M. × D.H.) were exposed to a constant daily ration of 16 hr. light : 8 hr. darkness (long days) starting on September 4. They were previously subjected to a constant daily ration of 8 hr. light : 16 hr. darkness (short days) for some twenty weeks. The latency of cessation ranged from 6 to 24 weeks, according to the breed. The Dorset Horn and its cross showed the longest latency of cessation, whereas the mountain breeds (Blackface Mountain, Border Leicester and Welsh Mountain) had the shortest, and in Suffolks it was nine weeks. The date of cessation of the sexual season was on an average fifteen weeks earlier than the control.

It is concluded that the previous light treatment may control the maintenance and the cessation of the sexual season; and that either the presence of darkness as such or the contrast stimuli of the change from light to darkness is essential for the continuation of the sexual season of the ewe. The latency of cessation is also controlled by other factors besides light. Breeds of sheep which originated near the tropics have a shorter time-lag reaction to light than those breeds which originated nearer the poles. It seems that younger animals are more readily influenced by artificial light than adults. Individual differences are also shown in the response to light. The time of the year at which the light treatment starts determines the latency of response. The previous light environment is an important factor due to the residual effect of light. Both the ratio and rhythm of light control the speed of the response.

The mechanism of the light-stimulating action on the gonads is believed to be via the hypophysial-portal system[6], while the mechanism of the light-inhibitory action has not yet been elucidated.

This work was carried out in the Animal Research Station, Cambridge, during study leave granted from Fouad I University, Egypt. Detailed results of experiment (*B*) will appear elsewhere. Thanks are due to Dr. John Hammond for providing facilities and for his continuous encouragement.

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Control of Cauliflower Mosaic Virus

Caldwell and Prentice[1] emphasized in 1942 the value of seed-bed isolation in the control of cauliflower mosaic virus, which in Devon has seriously reduced yields of broccoli. Experimental work at this College has shown that infection in the seed-bed can still be the main cause of reduced yield, even when conditions favour extensive spread of virus in the field after planting.

Three varieties of broccoli, Extra Early, *A*6 and *B*1, were grown in two seed-beds, one adjacent to an infected seed broccoli crop and one half a mile from any *Brassica* crop. The seedlings were planted out in replicated plots. Although practically all the plants in the experiment developed virus symptoms before they were cut, an analysis of the results shows that plants from the isolated seed-bed gave both heavier yields and higher percentages of marketable heads. As no difference in varietal susceptibility was observed, the three varieties are treated together in the following table.

Comparison of Yields from the Two Seed-beds

Seed-bed	Per cent of curds of diameter more than 2 in. across	Av. total yield per plot (lb.)
Isolated by ½ mile	81	49·5 (s.e. ± 4·7)
Not isolated	44	36 (s.e. ± 2·12)

Fortnightly recordings of the plots showed that there was considerable variation in the expression of symptoms. Plants infected in the seed-bed developed vein-clearing followed by vein-banding symptoms[2], and secondary infections of a similar type were observed in the autumn. From December onwards, increasing numbers of plants showed an additional symptom, consisting of a diffuse mottling of small pale-green circular spots or rings standing out in contrast to the dark leaf background, that developed rapidly in young leaves which had previously shown no symptoms. These spots are suggestive of those caused by cabbage ring spot virus on cauliflowers as described by K. M. Smith[3]; but cross-inoculations on to *Nicotiana* sp. have so far been negative, and no leaves have been observed in which the spots have later become necrotic. The mottling is therefore considered to be a further expression of cauliflower mosaic virus.

An experiment using a systemic insecticide, *bis*-(*bis*-dimethylamino-phosphonous) anhydride, to control the aphid vector *Brevicoryne brassicae* alighting on seedlings from infected plants, showed that while this insecticide sprayed on to plants at a concentration of 0·3 per cent v/v gave an excellent control of the aphids, virus transmission was not inhibited. The experiment was carried out under optimum conditions for virus transmission.

Further work is now in progress.

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Relationship of Aphid Density to Altitude

THE dispersal of small insects to high altitudes by convection and turbulence is known to produce an insect-density gradient in which density decreases with height[1,2]. The distribution has never been expressed mathematically; and since the insect population of the air varies considerably from hour to hour, and most of the observations at the different heights were made at different times, mathematical analysis would have yielded little of value.

This handicap has been overcome in recent work, and the mean aerial density of aphids has been measured simultaneously at different heights using traps attached to a barrage balloon cable. The observations were made at Cardington, Beds, in co-operation with the Research and Development Establishment, Ministry of Supply.

Between May 27 and October 8, 1948, trapping with tow-nets was done simultaneously at 50, 250, 500, 1,000, 1,500 and 2,000 ft. above the ground during 08.30–10.30, 11.30–13.30 and 14.30–16.30 B.S.T. on suitable days. The nets had opening and closing devices, trapping only at the correct altitudes and times. Aphid densities (numbers per 10^6 cu. ft. of air) were estimated from the number of aphids caught and the run of wind through the nets[3]. Wind runs were measured with anemometers at 10, 250 and 2,000 ft., values at the remaining heights being estimated by interpolation[4]. Although tow-nets under-estimate density at wind-speeds below about 7 m.p.h., it is possible to make a correction for calm conditions[3,5], and Table 1 shows arithmetical mean density estimates with and without the correction; the two estimates probably encompass the truth.

Table 1. APHID DENSITY/10^6 CU. FT.

Height (ft.)	Arith. mean Corrected	Arith. mean Uncorrected	Mean log (density + 1) Corrected	Mean log (density + 1) Uncorrected	No. 2-hr. runs	Mean wind-speed (m.p.h.)
50	1,584·0	161·9	2·02	1·78	49	7·2
250	851·9	99·7	1·92	1·64	49	7·5
500	67·7	26·0	1·40	1·29	49	8·8
1,000	12·3	9·1	0·87	0·84	47	11·1
1,500	8·7	6·5	0·77	0·75	46	12·9
2,000	4·9	4·6	0·56	0·57	48	14·4

The distribution at any time is determined by the net effect of upward transport by turbulence and downward transport by gravity and biological impulse. It is not helpful to ascribe to an aphid a terminal velocity of fall as it is not an inert particle; but it is possible to obtain an estimate of the rate at which it tends to return to earth—the 'mean clearance-rate'—from a simple extrapolation of turbulence theory known to hold near the ground.

If χ is the density at height z, and ω is the 'mean clearance-rate', then for a quasi-stationary state the balance equation is:

$$\omega\chi = -K\partial\chi/\partial z,$$

where K is the turbulent transport coefficient. Rossby and Montgomery make $K = k_0 u_* z$ (see, for example, ref. 6, p. 247), where k_0 is von Kármán's constant (0·4) and u_* is the shearing velocity near the ground $(\tau_0/\rho)^{1/2}$). Then for any two heights z_1 and z_2,

$$\chi_1/\chi_2 = (z_1/z_2)^{-\omega/k_0 u_*};$$

hence a graph of log χ against log z should yield a straight line of slope $-\omega/k_0 u_*$. Fig. 1 shows the graphs for mean logarithmic density with corrected and uncorrected data, and the lines drawn are good fits down to 250 ft. Departures from the straight lines at lower heights could arise from: (i) sampling errors at the lower wind-speeds near the ground; (ii) an additional re-distribution factor representing the flight behaviour of living insects moving between air and terrestrial habitats; (iii) the source of supply being local and irregular, whereas the higher aphids will have come from larger and more remote areas—possibly biologically different—farther upwind; (iv) the velocity profile departing markedly from its theoretical shape.

From the straight lines, the values of $-\omega/k_0 u_*$ are $-1·2$ (uncorrected) and $-1·5$ (corrected): the order of magnitude of u_* is known to be 15 cm./sec. at the measured mean wind-speed[7]; hence the 'mean clearance-rate' is equivalent to approximately 7 cm./sec. (uncorrected) or 9 cm./sec. (corrected). Both values are much lower than such crude estimates of terminal velocity of aphids as exist; for example, Wellington's curves[8].

During the normal evening decay of flight activity, aphids which are brought near to earth will alight; and if the estimated 'mean clearance-rate' is a measure of the speed of return in the much calmer evening conditions, then the aphids in the lowest 2,000 ft. of the atmosphere should have returned to very low altitudes or to the ground, on the average, in about two hours. This estimated rate of clearance fits in well with observation[9].

For single days and single samplings there are frequent wide variations from the mean distributions represented in Fig. 1.

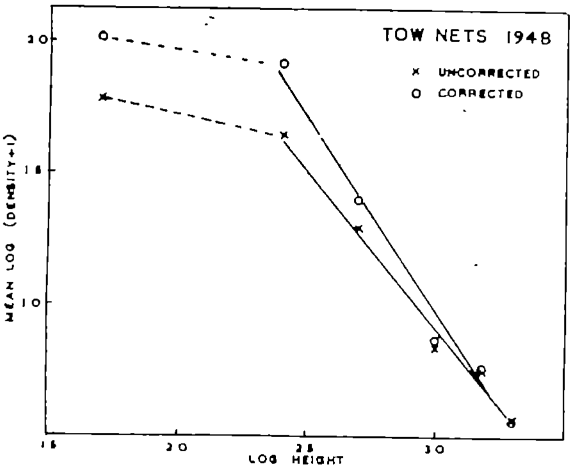

Fig. 1

In 1950 the work was repeated with suction traps, which are considered to be more reliable than tow-nets[3,5]; they were operated at 10, 150, 500 and 1,000 ft. The numbers of aphids caught per hour with each trap may be taken as the density for 132,000 cu. ft., since that volume of air is sampled by a trap in one hour irrespective of wind-speed. The results are scanty, for there were few aphids in 1950; but there are 65 separate hourly occasions between July 13 and 31 which can be used (Table 2). The average wind-speed was about the same as in 1949.

Table 2

Height (ft.)	For 65 hours Total No.	Mean log (No. + 1)	For 7 hours Total No.	Mean log (No.)
10	574	0·78	124	1 25
150	164	0 44	25	0 65
500	26	0·11	11	0 37
1,000	10	0 04	6	0·33

When mean log (catch + 1) is plotted against log (height) the points lie on a straight line between 10 and 1,000 ft., the slope being −0·4 (Fig. 2, lower curve); but there were too many occasions of zero catch at 1,000 ft. for the corresponding point on the graph to have any significance. There were, however, seven hours during which aphids were caught at all heights, and for these no adjustment was made before taking logarithms. The upper curve of Fig. 2 is for these results and has a slope of −0·5, from which the 'mean clearance-rate' is 3 cm./sec.

This changed estimate in clearance-rate may be the result of the change in trapping technique or of different degrees of validity of the simple assumption made in the analysis. As the work with suction traps is being extended, detailed examination of the meteorological factors will be postponed until more results are available.

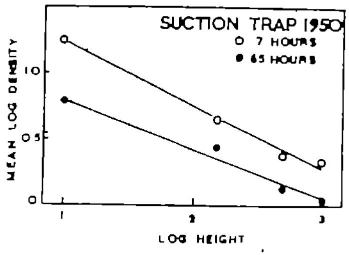

Fig. 2

C. G. Johnson
H. L. Penman

Rothamsted Experimental Station,
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April 16.

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Chromosome Number and Chromosome Morphology in *Helicophyllum crassipes*

Helicophyllum crassipes (Araceæ)[1] grows as a weed in the coastal belt of Egypt, in localities where the soil is light calcareous sand and where the percentage of salt is low. It is a corm-geophyte which sprouts late in October and flowers during January and February; flowering sometimes extends through March and April. The plant seems to possess a high capacity for seed production.

Chromosome counts and study of chromosome morphology were made in squashes of root-tips and anthers. Feulgen and acetic-orcein methods were used. For pollen grain mitosis Allen–Bouin as fixative and crystal-violet-iodine were used. Pretreatment with 8-oxyquinoline[2] (0·002 mol. per litre for 4 hr.) was also used in root-tip preparations. Material was collected from plants growing naturally.

More than two hundred metaphase plates (polar view) showing clearly the number of chromosomes and their morphology were counted and studied. The accompanying drawings were made from specimens subjected to 8-oxyquinoline pretreatment, which shows the constrictions clearly. This effect is due to the shortening of the arms of the chromosomes and resulting elongation of the constrictions.

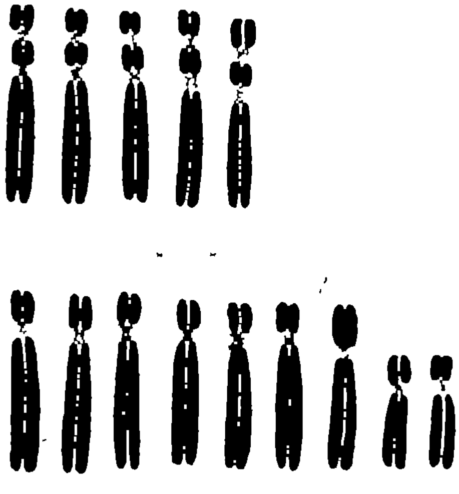

Fig. 1. Diagrammatic drawing of the chromosomes of *Helicophyllum crassipes* showing their comparative length and their constrictions

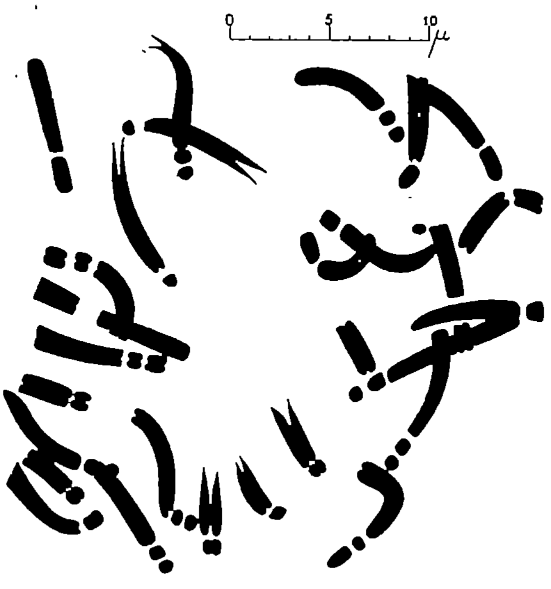

Fig. 2 Camera lucida drawing of a metaphase plate, polar view, using Leitz apochromatic objective, 90 ×, and compensating eyepiece 30 × (original magnification, 7,600 × ; reproduction, 2,500 ×)

In root-tips the diploid number was found to be 28. In every case it was possible to find a homologue for every chromosome, giving a definite count of 14 pairs.

The chromosomes were classified according to their morphology as: (1) chromosomes with two constrictions (primary and secondary); (2) chromosomes with a primary constriction only.

The primary constriction was invariably submedian in chromosomes with secondary constrictions, whereas in chromosomes with one constriction only it was subtelomeric. No chromosomes with strictly median or strictly telomeric primary constriction were noticed.

The chromosomes were also classified according to their length into long and short ones. Those with two constrictions were almost all long, except one pair which was slightly shorter than the rest. Those with a primary constriction only were also of the long type, except two pairs which were distinctly shorter (Figs. 1 and 2). The number of chromosomes with two constrictions is five; with one constriction only, nine.

In some nuclei a small, almost spherical chromatin body (staining like the chromosomes) was noticed. No explanation can yet be given as to the origin and occurrence of this body.

Polyploid nuclei with chromosome number higher than $2n$ were occasionally noticed; in a few cases the number was found to be 56, that is, tetraploid.

In pollen grains, mitosis takes place early when the grains are still young and before the thickening of the exine. Chromosome counts were 14. The chromosomes were found to agree in morphology with those of diploid cells in root-tips.

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March 8.

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Nitrogen Nutrition of Clover

VIRTANEN and collaborators[1,2] and Ghosh and Burris[3] have shown under aseptic conditions that red clover is able to make good growth when supplied with combined nitrogen in certain organic forms (for example, several amino-acids). Virtanen and von Hausen[1] reported, however, that white clover grew poorly on organic nitrogen. The finding that these closely related plants differed radically in their nitrogen requirements is of theoretical and practical interest, and has been further investigated by us.

Non-nodulated plants of red and of white clover (*Trifolium pratense* L. and *T. repens* L., respectively) were grown from seed entirely enclosed in test-tubes (8 in. × 1½ in. in size) plugged with cotton wool and containing an agar rooting-medium made up to the nitrogen-free formula of Chen and Thornton[4]. To this basal medium various forms of nitrogen were added in amounts representing 170 mgm. of nitrogen per litre of medium, the pH being adjusted to 6·5. All precautions were taken to secure asepticity in the cultures, the degree of achievement of this being judged chiefly by visual inspection of the agar medium during the course of the experiments. Very few cultures had to be discarded because of contamination.

Form of nitrogen supplied	Red clover		White clover	
	Increment in dry wt.*	Increment in nitrogen content*	Increment in dry wt.*	Increment in nitrogen content*
Ammon. nitrate	64	3·9	79	4·4
Ammon. sulphate	66	3·0	78	3·9
Potas. nitrate	64	3·2	53	2·9
l-Asparagine	78	4·5	90	4·6
l-Aspartic acid	27	1·9	90	3·3

* Mean increases (in mgm. per tube) over the corresponding values for control tubes (no combined nitrogen added) which were as follows (again as mgm. per tube): dry weight 61 (red), 35 (white), nitrogen content 1·0 (red), 0·6 (white). Each tube-culture contained 4–7 plants of red or 6–9 plants of white clover, with 8 tubes for each treatment, and 6·3 mgm. combined nitrogen was originally added to the agar medium of each tube.

After ten weeks growth under summer conditions, the dry weight (by heating at 95° C.) and total nitrogen were found for the plants from each tube. The results of the main experiment are presented in the accompanying table. Statistical analysis confirms that in both clovers the dry weight of plants receiving asparagine was significantly higher (at $P = 0.05$) than that attained with inorganic nitrogen, while in white clover the same applies to aspartic acid. Similar analysis of the results for nitrogen content shows that asparagine was absorbed as readily as (in white clover) or more readily than (in red clover) the most freely absorbed form of inorganic nitrogen, namely, ammonium nitrate.

These results fail to confirm that white clover is inferior to red in its ability to utilize organic nitrogen, and, in fact, tend in the opposite direction. The reasons for this and other divergences from the findings of Virtanen and von Hausen[1] are not immediately obvious, and may not be revealed until fuller study of the conditions affecting uptake of organic nitrogen by plants has been made. Meanwhile, it appears doubtful whether there is any major difference in the nitrogen requirements of the two clovers.

This question is relevant to studies such as those of Bond and McGonagle[5], where non-nodulated plants of different species of clover were grown as standards against which the effectiveness of different strains of the nodule organism in fixation of atmospheric nitrogen was assessed. In future work of that type it is probable that an organic compound such as asparagine could with advantage be provided as the source of nitrogen for the standard plants.

The above experimental work was carried out while one of us (J. T. V.) was holding a British Council scholarship.

J. T. Vantsis
G. Bond

Botany Department,
University of Glasgow. April 18.

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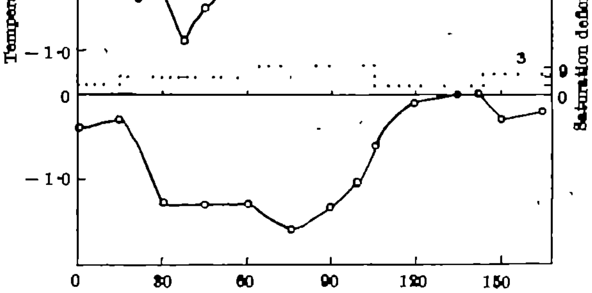
Body-Temperature of Small Insect Larvæ

Laboratory experiments carried out in the autumn of 1950 appear to support remarks made by Dr. D. A. Parry[1], to the effect that on general grounds he considers that various physical factors play a greater part than biological ones in determining the body-temperatures of small poikilothermal animals.

Using apparatus in which air temperature and rate of flow could be held constant, the variation of the air saturation deficiency (in the absence of radiant heat) produced considerable fluctuations in the internal body-temperatures of lepidopterous and hymenopterous larvæ. In the case of smooth-skinned larvæ of *Tenthredopsis litterata* Geoffr. (Hymen. Tenthredinoidea), the divergence of body-temperature with respect to air-temperature at the time of humidity change (graph 1) will be noted to resemble closely the fluctuation in the internal temperature of a piece of clay of similar size and shape when the latter is submitted to comparable environmental changes (graph 2). The divergence is therefore ascribed largely to evaporation and condensation at the outer surface of the larval integument, rather than to a mechanism involving gain or loss of internal fluids. This latter process can scarcely be the means in the case of the clay model; nor is it clear, in the case of the larva, that gain of internal water can occur quickly enough to produce the abrupt rise in temperature. This interpretation is emphasized by a comparison of the curves at such times as the environmental conditions were steady, when the clay is seen to return almost to air-temperature, whereas the larval temperature is depressed slightly below this level, presumably due to the thermal effects resulting from the loss of internal body-fluids not present in the model.



Graph 1. Internal body-temperature variation of *T. litterata* Geoffr. (weight 0·06 gm.)
Graph 2. Internal temperature of a piece of clay
Graph 3. Internal body-temperature of *M. rubi* (weight 2·5 gm.)
Solid curves: internal temperature-difference of larva or clay with respect to an air temperature of 20° C. Dotted lines: saturation deficiency of air in mm. of mercury

Thus while the depression of larval body-temperature below that of the surrounding atmosphere may be at all times in part due to the loss of internal fluids, the major portion of the effect at moments of humidity change is the result of surface phenomena.

Further information with regard to surface evaporation and condensation is provided by an experiment with a 2·5-gm. caterpillar of the fox moth (*Macrothylacia rubi*). The integument of this larva is densely setose and presumably capable of harbouring more moisture than that of a smooth-skinned form. For this reason an extended period of body-temperature depression due to the evaporation of surface moisture might be expected to follow atmospheric humidity change. Reference to graph 3 shows such a state of affairs to exist and a considerable depression to be maintained for some time, after which a slow return to a temperature approaching that of the air might be interpreted as due to the conductive heating effects of the surrounding atmosphere. Had this extended depression been due solely to a loss of internal fluid, which was finally almost completely exhausted, this animal might have been expected to show signs of desiccation; this was not the case. Furthermore, a return to conditions of evaporation, after a period in a moist atmosphere, resulted in a small but steady depression of body-temperature, denoting a continuous loss of fluid, which might be expected if now only internal fluid were being evaporated via some restricted aperture or region. This reinforces the suggestion that the initial extended depression was due mostly to loss of external surface moisture, which was finally almost completely exhausted, so that a short intervening period in a humid atmosphere was insufficient to restore its abundance.

Further details of this work and the methods involved, together with evidence of the importance of considering (*a*) the previous history of insects with regard to surface moisture, and (*b*) the nature and proximity of surfaces on which they may be supported, when making body-temperature observations, will be published elsewhere.

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University of St. Andrews,
University College,
Dundee. April 30.

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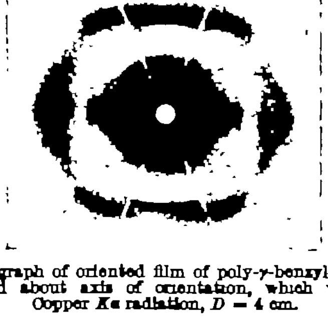
Structure of Synthetic Polypeptides and Proteins

In a recent series of papers, Pauling, Corey and Branson[1] and Pauling and Corey[2-7] have proposed structures for synthetic polypeptides and proteins based on helical configurations of the molecules, and have claimed that these account for the X-ray results of Bamford, Hanby and Happey[8] on the polypeptides, and for the X-ray photographs of a number of proteins. It is the purpose of this communication to indicate that, in fact, the unit cells of Pauling and Corey are unsatisfactory for at least two of the three polypeptides which have been studied in detail, and probably also for α-keratin. Comments on the structures of Pauling and Corey, and these authors' objections to the α_{II}-fold, will be reserved for a later paper from these Laboratories.

The X-ray data on poly-γ-benzyl-L-glutamate are interpreted in terms of a helical structure containing 11 amino-acid residues in three turns and a pseudo-orthorhombic unit cell with $a_0 = 25$ A., $b_0 = 17 \cdot 3$ A. (fibre axis), $c_0 = 14 \cdot 42$ A., and $\beta = 90°$ [2b]. The near meridional reflexions at 5·27 A., which are a striking feature of the diagram[3], are indexed by Pauling and Corey as (131) (230). The inclination of the normal to these planes to the b-axis is 24° 30′, and it may readily be shown that the corresponding reflexions in a fibre diagram should subtend a semi-angle χ at the centre of the diagram of approximately 23°. The observed value of χ from Fig. 3 of the paper by Bamford, Hanby and Happey[3] (upon which the American authors base their unit cell) is about 10°. This diagram was obtained with a film of polymer, the X-ray beam passing through one edge, and it might be considered that the difference between the two χ-values could be explained by double orientation of the molecules. This is not satisfactory, however. In a photograph taken with the beam normal to the film, the 5·27-A. reflexions are not resolved and appear as a polar arc. The equatorial reflexions in this photograph are also drawn out into arcs, showing that although the molecules lie mainly in the plane of the film, their orientation about the direction of stretching is not particularly high. Even so, the polar arc subtends a semi-angle of only 18°. A similar result is obtained from an X-ray photograph of the same film rotated about the direction of stretching (see photograph). Here again the polar reflexions are not resolved, and the polar arc is too short to permit a value of χ as great as 23°. The radial lines on the photograph correspond to $\chi = 23°$ and are obviously outside the main polar reflexion. (For purposes of comparison, the centres of the reflexions on the first hyperbola of the X-ray diagram of poly-γ-methyl-L-glutamate given in Fig. 1 of ref. 3 subtend an angle of 26° 50′. A comparison will show the very considerable difference between these reflexions and the polar reflexion of the accompanying photograph.) A comparison of the dispersions of the strong equatorial reflexions and the polar arc at 5·27 A. shows that the normal to the planes giving rise to the latter are inclined at about 10° to the fibre axis. Similarly, it may be shown that the other three reflexions on the hyperbola (4·48 A., 4·05 A. and 3·60 A.) are too near the meridian to correspond to Pauling and Corey's unit cell, although the diffuse nature of the reflexions makes this point more difficult to demonstrate.



X-ray photograph of oriented film of poly-γ-benzyl-L-glutamate. Film rotated about axis of orientation, which was vertical. Copper $K\alpha$ radiation, $D = 4$ cm.

The same results can, of course, be obtained from reciprocal lattice considerations.

For these reasons we believe that the repeat (or submultiple) along the fibre axis is smaller than that used by Pauling and Corey (5·76 A., that is, $b_0/3$), and is close to 5·45 A., as suggested by Bamford, Hanby and Happey[3]. We conclude that the particular helical structure and unit cell proposed are not consistent with the X-ray data.

The same conclusion applies in the case of the 1 : 1 copolymer of DL-β-phenylalanine and DL-leucine. It has been shown[4] that in the X-ray diagram of highly oriented fibres of this copolymer, the 5·35-A. reflexion is resolved into two near meridional spots, with $\chi = 11°$ 4′. This again is significantly smaller than the value (23°) calculated from Pauling and Corey's fibre repeat of 5·75 A., indicating that the latter is too large. The correct value calculated from $\chi = 11°$ 4′ is 5·51 A.

Thus, the three synthetic polypeptides γ-methyl- and γ-benzyl-L-glutamates, and the copolymer of DL-β-phenylalanine and DL-leucine, have fibre repeats (or submultiples) close to 5·45 A., in excellent agreement with the α_{II}-structure.

We feel that the structure proposed for α-keratin[2e], based on a helix with 3·7 residues per turn, and a fibre repeat of 5·65 A. can be criticized on similar grounds. The corresponding value of χ for the 5·15-A. reflexion is 24° 30′; the total length of the polar arc in porcupine quill corresponds only to $\chi = 15°$.

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Maidenhead, Berks. June 26.

[1] Pauling, Corey and Branson, *Proc. U.S. Nat. Acad. Sci.*, 37, 205 (1951).

[2] (*a*) Pauling and Corey, *Proc. U.S. Nat. Acad. Sci.*, 37, 235 (1951); (*b*) *ibid.*, 241; (*c*) *ibid.*, 251; (*d*) *ibid.*, 256; (*e*), *ibid.*, 261; (*f*) *ibid.*, 272; (*g*) *ibid.*, 282.

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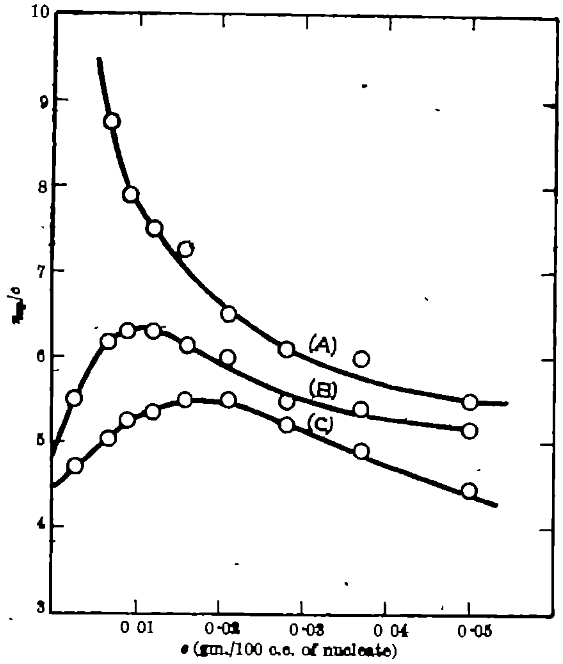
Viscosity of Sodium Thymonucleate

THE viscosity of sodium thymonucleate solutions shows some peculiar characteristics. There is considerable reduction in viscosity of a dilute solution of sodium thymonucleate in presence of neutral salts and alkali. Greenstein and Jenrette[1], as also Tennent and Vilbrandt[2], have postulated the reversible depolymerization of the nucleic acid molecule in presence of neutral salt and alkali. From the measurement of dissymmetry by the light-scattering method, Smith and Sheffer[3] have shown that the nucleic acid molecules coil up in solution in presence of neutral salts. The peculiar viscosity effect may similarly be attributed to coiling and uncoiling of the molecules rather than to reversible depolymerization in presence of salt. Since nucleic acid is a long-chain molecule with the acid groups distributed along the chain, it is to be expected that the sodium salt of the acid will behave as a polyelectrolyte, according to Fuoss's contention[4], in solution, and the peculiar viscosity characteristics may be explained on the assumption of a coiling–uncoiling effect with the extent of dissociation. Viscosity measurements of sodium thymonucleate solution have been under-



taken in this laboratory, and it will be evident from the accompanying graph that the reduced viscosity (η_{sp}/c) increases as the solution is diluted, a result contrary to that for neutral polymers and similar to that of polyelectrolytes.

This phenomenon may be explained as follows. As the solution is diluted, more and more of the sodium salt dissociates and consequently[4] the number of charge-centres on the chain increases. The mutual repulsion of similarly charged centres causes the chain to assume a more and more stretched out configuration with increasing dissociation, that is, with diminishing concentration of thymonucleate, and hence leads to higher reduced viscosity at lower dilution. This hypothesis may be tested by an experiment which it suggests. When a simple one-one electrolyte, sodium chloride, is added to a solution of sodium thymonucleate, we should expect that by a simple mass action effect, under the influence of Coulomb attraction, some of the sodium ions would be drawn back on the polymer chain, that is, the thymonucleate molecule will be less dissociated. When the concentration of sodium chloride is sufficiently high, almost the whole of the dissolved molecules will be undissociated over a considerable range of concentration and will behave like a neutral polymer. This is why Tennent and Vilbrandt[5] obtained a linear curve for reduced viscosity/concentration for sodium thymonucleate solution in presence of 1 per cent sodium chloride. When, however, the concentration of sodium chloride is much lower, sodium thymonucleate molecules will be completely undissociated and behave like a neutral polymer below a particular concentration of thymonucleate; above this concentration, some of the electrolyte groups will undergo dissociation and behave as polyelectrolytes. The reduced viscosity will, therefore, increase with concentration of thymonucleate. Curves *B* and *C* support this view; in presence of sodium chloride, the curves show a hump, the maximum of which occurs at a concentration of thymonucleate where the concentration of sodium ion from thymonucleate is nearly equivalent to that from added sodium chloride. At $3 \cdot 1 \times 10^{-4}$ gm. equivalent of sodium chloride the maximum is at 0·01 per cent or $2 \cdot 8 \times 10^{-4}$ g equivalent of thymonucleate (curve *B*), while a $5 \cdot 3 \times 10^{-4}$ gm. equivalent of sodium chloride th maximum is at 0·0175 per cent or $4 \cdot 9 \times 10^{-4}$ g equivalent of thymonucleate (curve *C*).

SADHAN BASU

Indian Association for the Cultivation of Science,
Calcutta 32.
March 20.

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Effect of Shear's Polysaccharide on Plasm Clotting

ONE of the agents most effective in causin regression of tumours is the polysaccharide whic Shear and his associates were able, some years ago to extract from the bacterium *Serratia marcescens*[1] This polysaccharide causes a high percentage o regression in the tumours of mice, but unfortunatel it is rather toxic for human beings. If more wer known as to the exact nature of the polysaccharide it might be possible to find other compounds simila in their action on tumours, but less toxic.

Heilbrunn and Wilson[2] have suggested that th polysaccharide behaves like heparin in preventin the division of cells; they have suggested that th polysaccharide may be a compound related to heparin. In cells generally, the initiation of mitosis i accompanied by a sharp increase in protoplasmi viscosity, the mitotic gelation, which is thought o as a protoplasmic clotting. Heparin prevents thu clotting; so, too, do dilute solutions of the bacteri polysaccharide[3].

Is the bacterial polysaccharide of Shear perhap a heparin or a heparin-like substance? Heilbrun and Wilson[2] have found that it gives a metachromati reaction with toluidine blue; this is a positive tes for heparins. Information as to the effect of th bacterial polysaccharide upon blood clotting wa sought in the following manner. Polysaccharid *P*-25, containing 36 mgm. per c.c. (I am indebted t Dr. M. J. Shear for kindly supplying a sample of th polysaccharide to the laboratory), was diluted wit distilled water. Freshly oxalated human plasma wa employed as the substrate, 1 c.c. of 0·1 *M* sodiu oxalate being added to 9 c.c. of blood. Clotting tim determinations were run at 37° C., in standard tubes upon a total volume of 0·3 c.c. (one-third plasma, one-third polysaccharide in distilled water or distille water control, one-third 0·025 *M* calcium chloride). Time was counted from the addition of the calciu chloride until the tubes could be safely inverted. Results were calculated in terms of the contro (exp./control × 100), and are given in the accompanying table.

EFFECT OF SHEAR'S POLYSACCHARIDE ON PLASMA CLOTTING

Polysaccharide (per cent)	Plasma clotting time (per cent control)
3·6	750
1·8	240
1·44	188
1·08	158
0·72	130
0·36	115

Shear's polysaccharide was shown by this method to inhibit the clotting of recalcified plasma; its effect is therefore heparin-like. Comparison with various commercial heparin preparations showed them to be approximately 138–320 times more effective.

This investigation was aided by a grant from the U.S. Public Health Service, administered by Prof. L. V. Heilbrunn.

Sylvia Most

Department of Zoology,
University of Pennsylvania,
Philadelphia. April 18.

Shear, M. J., and Turner, F. C., *J. Nat. Cancer Inst.*, 4, 81 (1943). Hartwell, J. L., Shear, M. J., and Adams, J. R., *ibid.*, 4, 107 (1943).

Heilbrunn, L. V., and Wilson, W. L., *Proc. Soc. Exp. Biol. and Med.*, 70, 179 (1949).

Heilbrunn, L. V., and Wilson, W. L., *Science*, 112, 56 (1950); *Protoplasma*, 39, 389 (1950).

Surface Tension of Liquid Metals

Atterton and Hoar's[1] communication recalls two papers recently published on this subject. Schytil[2] has shown that the surface-tension σ is related to the melting point T_m and the atomic volume V by

$$\sigma = K_1 T_m V^{-2/3}, \qquad (1)$$

where K_1 is a constant. The other paper, due to Auerbach[3], contains data to show that, for a considerable number of substances, including metals and even liquid helium,

$$\sigma = K_2 \rho v^{3/2}, \qquad (2)$$

where ρ is the density of, and v the velocity of sound in, the substance, K_2 being another constant. As Schytil points out, expression (1) can be converted to one similar to that due to Wen Po[4]:

$$\sigma = K_3 A \nu_D^2, \qquad (3)$$

where A is the atomic weight, ν_D the Debye frequency, and K_3 another constant.

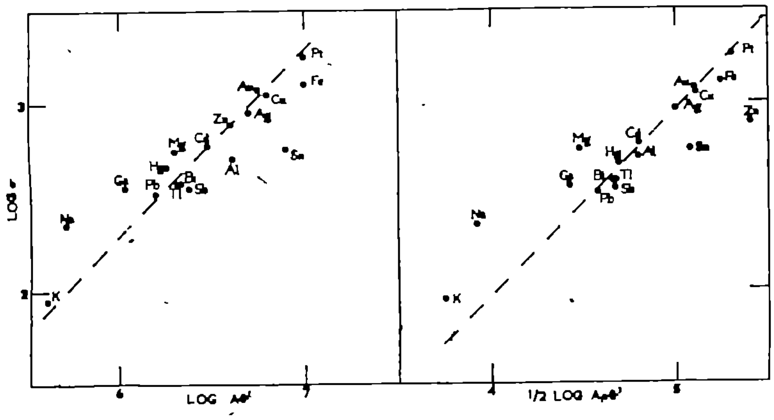
If we postulate (*a*) that the cube of the transverse velocity, c_t, is small as compared with that of the longitudinal velocity, c_l, or (*b*) that in many cases there is a linear relation between the two[5], Debye's expression for the number of oscillators assumes the form:

$$V \nu_D^3 = K_4 v^3, \qquad (4)$$

where V is the atomic volume and K_4 a constant. Combining (4) with (2) and introducing the Debye temperature θ_D instead of the frequency ν_D,

$$\sigma^2 = K_5 A \rho \theta_D^2 = K_5 p, \qquad (5)$$

where K_5 is a constant.



In order to reveal the discrepancies for small values of p, it is better to plot the logarithms of both sides of this equation. The values of ρ are taken from the International Critical Tables; those for θ_D are given by Seitz[6]. The data for σ are obtained from Atterton and Hoar's graph and from the International Critical Tables. They refer to temperatures at or near the melting point. It will be seen that the semi-empirical expression (5) is fairly successful in several instances. If the linearity of the data is compared with that to be expected from equation (3), it will be realized that there is little to choose between the two. The lines have slopes equal to unity: it would seem that slopes somewhat smaller than this would provide a better fit for each set of points. The best-fitting straight lines calculated from the regression coefficients have slopes of 0·861 and 0·856 corresponding to equations (3) and (5) respectively; they are not inconsistent with the theoretical values of unity. The fact that both expressions (3) and (5) are roughly satisfied is probably due to the inaccuracy of the experimental data, and also suggests that the empirical expression (2) is only another form of the one due to Wen Po[4].

R. A. Weale

Vision Research Unit,
Institute of Ophthalmology,
Judd Street, London, W.C.1.
May 7.

[1] Atterton and Hoar, *Nature*, 167, 602 (1951).

[2] Schytil, *Z. Naturforsch.*, A, 4, 191 (1949).

[3] Auerbach, *Experientia*, 4, 473 (1948).

[4] Wen Po, *Phil. Mag.*, 23, 33 (1937).

[5] Joos, "Theoretical Physics".

[6] Seitz, "Modern Theory of Solids".

In a communication in *Nature* of April 14, Messrs. Atterton and Hoar recorded the conclusion that "surface tension is approximately inversely proportional to atomic volume". May I venture to recall that this is a conclusion which I put forward some thirty-seven years ago, based upon determinations of the surface tensions of some of the commoner metals, which I had made at the Royal Mint, by measuring the depths of depressions in carbon tubes of small bore[1]. By plotting the reciprocals of the surface tensions of these metals against their atomic weights and side by side with their atomic volumes, the resemblance to Lothar Meyer's well-known curve became apparent. The resemblance was even closer when these reciprocals were plotted side by side with atomic volumes raised to the 2/3 power[2]. I felt justified, therefore, in suggesting that the surface tensions of molten metals, like other properties, are periodic functions of their atomic weights and that they vary inversely as some function of their atomic volumes. Now that figures for the surface tensions of more elements are available, it is satisfactory to find that Messrs. Atterton and Hoar have arrived at the same conclusion.

The implication of this relationship with regard to the penetration of liquid metals into compacted sand, to which they refer in the latter part of their communication, has, I think, some analogy to the behaviour of metals on the surfaces of cupels when undergoing cupellation in the process by which gold bullion is assayed. When the surface tension of the metal is lowered by the presence of tellurium, I have shown that the 'cupellation losses', normally allowed for by suitable 'checks', may, in extreme cases, be such that complete absorption of the metal by the cupel may occur[3].

S. W. Smith

7 De Vere Gardens,
London, W.8.
June 2.

[1] *J. Inst. Metals*, 12, No. 2, 168 (1914).

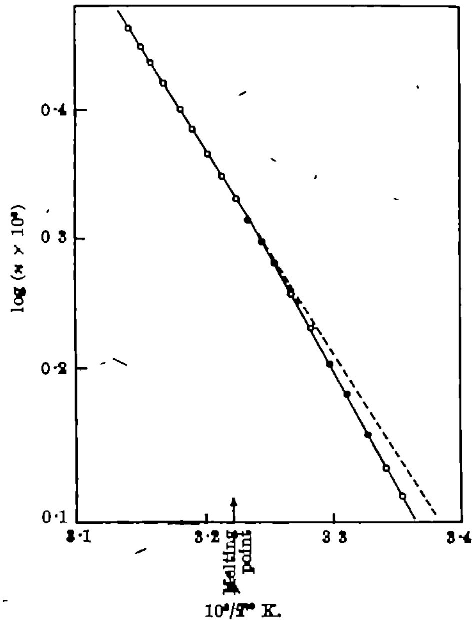
[2] *J. Inst. Metals*, 12, No. 2, 205 (1914).

[3] *Trans. Inst. Min. and Metal.*, 463 (1908).

Discontinuities in Supercooled Ionic Melts

During the course of a systematic investigation on the electrochemistry of boron trifluoride co-ordination compounds[1], discontinuities were observed in the temperature variation of viscosity on passing from the normal liquid to the supercooled state. In both temperature regions the viscosity could be expressed by an exponential relation of the form $\eta = \eta_0 \exp(B/RT)$, but the activation energy B was approximately 10 per cent greater for the supercooled state. The temperature coefficient of the specific volume (v) shows no such discontinuity at the melting point, and this fact may be used for emphasizing the discontinuous behaviour of the viscosity by the application of Batchinski's equation[2] $\eta = C/(v-b)$, where C and B are constants. For example, if the fluidity $\varphi = 1/\eta$ is plotted as a function of specific volume for acetoxytrifluoroboric acid, $H[CH_3.CO.OBF_3]$, there is a well-defined discontinuity at a point corresponding to the melting point, 37·5° C. The change in slope is 34 per cent, compared with an increase of 10 per cent for the activation energy B for this compound.

As boron trifluoride complexes are systems for which the activation energies of ionic migration are very similar to those of viscous flow[3,4], it is likely that similar configurational changes occur in the two processes and that ionic mobility at various temperatures will be proportional to the viscosity. It might therefore be expected that the specific conductivity of such liquids would show a corresponding effect at the melting point. This is, in fact, the case as may be seen from the accompanying graph, in which log κ is plotted against $1/T$ for molten acetoxytrifluoroboric acid. The increase in slope at the melting point is 13 per cent. A graph of specific conductivity as a function of specific volume shows the same phenomenon.



Electrical conductivity of molten acetoxytrifluoroboric acid

The ionic compounds formed by boron trifluoride with methyl, ethyl, n-propyl and n-butyl acetates behave in a precisely analogous fashion to the addition compound with acetic acid considered above. The effect, however, is not confined to ionic melts, as Dodd and Hu Pak Mi[5] have shown that plots of log η against $1/T$ for phenyl ether and m-chloronitrobenzene are discontinuous at the melting point. It is consequently of interest to determine whether or not these effects are general in supercooled melts. The data on such systems are rather scattered, but a recalculation of available information shows that the same trend is implicit in the figures of Walden, Ulich and Birr[6] for the viscosity and conductivity of certain molten picrates.

A fuller discussion will be published elsewhere.

N. N. Greenwood
R. L. Martin

University Chemical Laboratory,
Cambridge.
April 6.

[1] Greenwood, N. N., and Martin, R. L., *J. Chem. Soc.* (in the press)

[2] Batchinski, A. J., *Z. phys. Chem.*, 84, 643 (1913).

[3] Greenwood, N. N., Martin, R. L., and Emeléus, H. J., *J. Chem. Soc.*, 3030 (1950).

[4] Greenwood, N. N., and Martin, R. L., *J. Chem. Soc.* (in the press).

[5] Dodd, C., and Hu Pak Mi, *Proc. Phys. Soc.*, B, 62, 454 (1949).

[6] Walden, P., Ulich, H., and Birr, E. J., *Z. phys. Chem.*, 131, 1 and 21 (1927).

Dimensions of the Nitrite Ion

As part of a programme of X-ray investigations of N—O bond-lengths and angles, and in particular for comparison of the bond-lengths in the positive (nitronium)[1] and negative (nitrite) NO_2 ions, the structure of sodium nitrite[2] has been redetermined. Three-dimensional and differential Fourier syntheses (corrected for termination of series errors) give the following dimensions for the nitrite ion :

Bond-length	N—O	1·13(9) A.
Angle	O—N—O	132° 48′

The root mean square error in the bond-length calculated by the method of Cruickshank[3] is ±0·01 A., so that the value of 1·14 A. now found is not significantly different from the value of 1·15 A. for O—N in the nitronium ion in nitrogen pentoxide[4].

Full details of the determination will be published together with those for nitronium perchlorate, which is still under investigation.

M. R. Truter

Chemistry Department,
University of Leeds.
July 25.

[1] Cox, E. G., Jeffrey, G. A., and Truter, M. R., *Nature*, 162, 259 (1948).

[2] Ziegler, G. E., *Phys. Rev.*, 38, 1040 (1931).

[3] Cruickshank, D. W. J., *Acta Cryst.*, 2, 65 (1949).

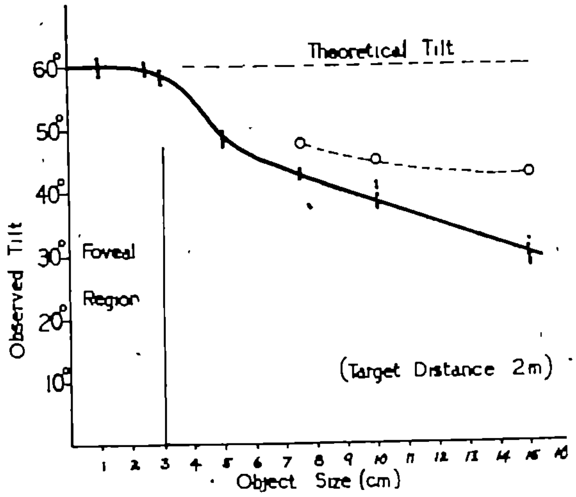
[4] Grison, E., Eriks, K., and Vries, J. L., *Acta Cryst.*, 3, 290 (1950).

Ocular Scanning and Depth Perception

THE relation between peripheral and foveal vision and the extent to which scanning movements of the eyes are necessary in the perception of three-dimensional space are problems of long standing. Experimental work on stereoscopic vision has been largely concerned with the measurement of stereoscopic acuity, using the three-needle test or one of its modifications, under carefully controlled conditions. Such tests give the minimum resolvable difference in depth which can be perceived by an observer under the given conditions; but they do not explain how the eyes function when they view the normal three-dimensional world. In normal observation of space the point of fixation ranges over a wide field, and the eyes are continuously receiving dissimilar uniocular impressions. It is generally assumed, however, that stereoscopic vision is based upon the stimulation of disparate retinal points, so that consequent on the presentation of unequal uniocular impressions the final perceptual pattern in space is determined by the retinal disparity from purely geometrical considerations. The experiments which are to be described show that this simple geometrical theory does not hold generally, but only if the space object forms an image entirely on the fovea.

A modified form of Wheatstone stereoscope was used to examine and measure the observed stereoscopic effects which resulted from given retinal image disparities. The two unequal uniocular impressions were obtained by using horizontally disposed arrows as targets in the stereoscope. Black arrows on white backgrounds, of equal illumination, were used as targets, the arrows being of equal thickness but of slightly different length. Each arrow was viewed by one eye alone, and the two fused impressions gave a perceptual image directly in front of the observer. This perceptual image was a horizontal arrow tilted out of the subject's frontal plane. The mirrors of the stereoscope were semi-transparent to allow observation of an indicator arrow, mounted on a divided circle, and placed coincident with the perceptual image. By aligning the indicator arrow with the perceptual image, the position and angle of tilt of the latter were determined. Except where otherwise stated, the subject viewed the two arrows with complete freedom of eye movement and with as much time as he required to make the alignment.

Several series of pairs of targets were used, all the pairs in a series having the same percentage difference in length but different mean length. The mean lengths and target distance were such that the angular subtense at the eye varied from 4° to 0·75°. The fovea subtends an angle of about 1°. With targets of angular subtense 4° the observed tilt was very much less than the theoretical value, that is, less than the value determined from the simple geometrical consideration mentioned in the first paragraph. Reduction in the angular subtense of the targets reduced the discrepancy between the observed and theoretical tilts until the images were entirely foveal, when the difference between the observed and theoretical tilts vanished. The full line on the graph shows, for one observer and for one series of targets, the variations in the observed tilt with the variation of angular subtense of the targets. The percentage size differences in the targets were such as to give a theoretical tilt of 60°. The observer had no detectable eye faults and was considered to have normal vision. Other observers with normal vision produced similar results.



If the targets were large, the eyes of the observer were seen to make continuous scanning movements back and forth along the targets. When these scanning movements were suppressed, by compelling the observer to maintain fixation of a small mark placed at the centre of one of the arrows, the perceptual images ceased to display any stereoscopic qualities and no tilt was observed. Again, in other experiments, small marks were placed beyond each end of one of the arrows and the observer was asked to make voluntary oscillations of the fixation point between the two marks. This artificial extension of the amplitude of scanning caused the observed angle of tilt (shown in the broken line on the graph) to be increased, although the increased tilt was still much smaller than the theoretical value. Both the increase in the angle of tilt under such extended scanning, and the tilts observed for large targets under normal scanning, were found to vary from individual to individual.

It is rather surprising that the graph of the observed tilt against angular subtense is a smooth curve. So far, no explanation for this variation of tilt with increasing peripheral imagery can be offered; but it should be mentioned that the conditions of observation in the experiment are to a certain extent unreal. The objects observed, which are the images of the targets in the stereoscope mirrors, lie in the observer's frontal plane. Hence, the variations in vergence during scanning are very much smaller than the variations which occur when an object tilted out of the subject's frontal plane is observed in normal vision.

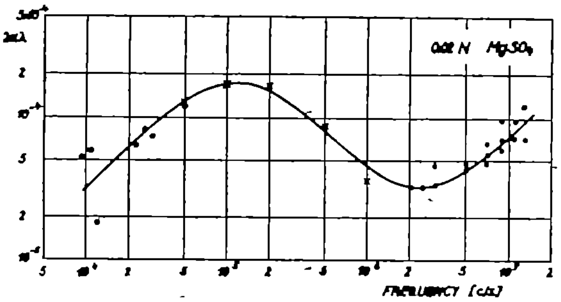
From the results, however, it is fairly clear that two separate processes are involved in our perception of space. If we observe limited fields the images of which are formed entirely on the fovea, our stereoscopic appreciation of space is governed entirely by retinal image disparity. But if the objects are larger —and they usually are in everyday life—the simple geometrical picture breaks down and the stereoscopic effects depend not only on retinal image disparity but also on the extent of field observed. In such extended field vision the experiments appear to show that space perception is achieved largely by the ranging or scanning of the field by the eyes. Such a scanning process can very probably be considered to be one of learning or experience, since extra-foveal spatial perception becomes much more accurate when consciously practised. The differences between observers then arise partly from differences in training but also quite probably from anomalies of various kinds in the binocular visual mechanism.

J. Adamson

Department of Natural Philosophy,
University,
St. Andrews.
April 16.

Absorption of Sound in Aqueous Solutions of Electrolytes

A large number of aqueous solutions of electrolytes have been investigated for frequency-, concentration- and temperature-dependence of their absorption of sound in the frequency-range 8 kc./s. to 15 Mc./s. It has been found that all uni-univalent salts investigated have no measurable sound absorption, that is, their excess absorption in concentrations up to 1 mole per litre is less than 10 per cent of the absorption of pure water. This proved to be the case also for a number of bi-univalent salts, except for high concentrations of sodium sulphate and magnesium chloride.



Absorption coefficient of a 0·02 N magnesium sulphate solution × wave-length ($2\alpha.\lambda$) vs. frequency

○, Measured by resonance method; ×, measured by reverberation method; ●, measured in progressive waves

The bi-bivalent sulphates examined (magnesium, manganese, copper, zinc, cobalt and nickel salts), on the contrary, showed very great absorption, which, from the slope of the frequency response, must be due to a relaxation process[1]. For example, the frequency response of the absorption of a 0·02 N magnesium sulphate solution is given in the accompanying graph, where $2\alpha.\lambda$ is plotted as a function of frequency. These parameters give a typical relaxation curve with a maximum at 120 kc./s. Other sulphates show similar curves, the relaxation frequencies of which are somewhat higher (for example, manganese, copper, zinc and cobalt sulphates), or lower (for example, nickel sulphate). The dependence on concentration from 0·002 to 0·2 mole per litre for magnesium sulphate proved to be linear within the limits of accuracy of measurement, that is, there is a constant absorption effect or absorption cross-section per molecule. Although this result is opposite to the expectation of Liebermann[1], who assumed an increase of the absorption cross-section proportional to the square root of the concentration, we believe that the relaxation process must be due to an interaction between the ions similar to that assumed by Liebermann. In favour of this are the changes of absorption observed in mixing different salts. In particular, we found the following rule for mixtures of magnesium sulphate and sodium chloride. The decrease of absorption observed when sodium chloride is added to a magnesium sulphate solution can be explained by the loss of some of the ion-pairs of the magnesium sulphate through interaction with the sodium chloride, which therefore cause no absorption in this frequency-range. The remainder of the magnesium sulphate concentration still effective in absorption is given by:

$$C_{\text{eff}} = [MgSO_4]\,\frac{[MgSO_4]}{[MgSO_4] + f.\,[NaCl]}\,;\quad f = 1/5.$$

The factor $f = 1/5$ can be explained by the difference in interaction between 2-2- and 2-1-valent pairs of ions.

The further increase of absorption[2] above 5 Mc./s. is also remarkable. From its frequency response, it seems to be due to another relaxation process, caused by a change in the hydration shells of the reacting ions. The dependence of frequency response and the amount of absorption on concentration and temperature are in accord with this view.

The measurements were made with different methods in successive frequency-ranges, since any one method is only applicable in a limited frequency-range of about 1 decade.

In the range 8–50 kc./s., the absorption of the solution was determined from the decay constant of a single natural vibration of the solution in a spherical glass vessel with thin walls[3]. The losses of the walls were eliminated by comparison with the decay constant of pure water, measured at the same natural frequency. The absorption of pure water was assumed to be given by

$$2\alpha/f^2 = 50 \times 10^{-17}\ \text{cm.}^{-1}\text{sec.}^2,$$

the value which is obtained at higher frequencies.

In the range from 50 kc./s. to 1 Mc./s., a statistical reverberation method according to Meyer and Skudrzyk[4] has been applied, using a 100-litre aluminium vessel. With this method a mean value of the decay constants of many natural vibrations is measured, within a band-width of ± 10 kc./s. The losses at the walls here, too, are eliminated by comparison with determinations using pure water.

In the frequency-range 3–15 Mc./s., the absorption was determined from the difference of level of the sound intensity in a plane progressive wave at two different distances from the source. This difference was obtained by photometrical comparison of the diffraction loss of the zero-order light of two beams of light crossing the sound field. The absorption determined for pure water by this method differs up to 10 per cent from the above-mentioned value. The excess absorption of magnesium sulphate as given in the graph is only of the same magnitude as the absorption of pure water in this frequency-range.

K. Tamm
G. Kurtze

III. Physikalisches Institut,
Universität,
Gottingen.
April 30.

[1] Liebermann, L., *Phys. Rev.*, **76**, 1520 (1949).

[2] Smith, M. C., Barrett, R. E., and Beyer, R. T., *J. Acous. Soc. Amer.*, **23**, 71 (1951).

[3] Cf. Leonard, L., *J. Acous. Soc. Amer.*, **18**, 252 (1946).

[4] Skudrzyk, E., *Oestr. Ing. Arch.*, **4**, 408 (1950). Mulders, C. E., *App. Sci. Res.*, B, **1**, 341 (1949).

FORTHCOMING EVENTS

Wednesday, August 29—Saturday, September 8

EIGHTEENTH NATIONAL RADIO AND TELEVISION EXHIBITION (at Earls Court, London, S.W.5).

Thursday, August 30—Thursday, September 13

ENGINEERING, MARINE AND WELDING EXHIBITION (at Olympia, Hammersmith Road, London, W.14).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT TEACHER IN THE DEPARTMENT OF PHARMACY AND BIOLOGY—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (September 1).

DEMONSTRATOR (temporary) IN BOTANY—The Secretary and Registrar, University College of North Wales, Bangor (September 1).

STATISTICIANS (with a university degree in statistics or in mathematics, economics or other appropriate main subject, combined with statistics, with at least second-class honours or equivalent) in the Board of Trade, London—The London Appointments Office, Ministry of Labour and National Service, 1–6 Tavistock Square, London, W.C.1, quoting JN.120 (September 6).

CIVIL ENGINEER on the staff of the Chief Mechanical and Electrical Engineer in the Production Department at London headquarters—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/365 (September 8).

ENGINEERS I at a Ministry of Supply establishment in London: (Ref. C.486/51A) to be responsible for planning and production, including preparation of plant layout, or either fuses, igniters, primers and all ancillaries for all types of ammunition, (Ref. C.487/51A) for small arms ammunition, including filling, (Ref. C.488/51A) with experience in methods of planning, sufficient to control a section responsible for the compilation and critical analysis of production and repair requirements for airframes, engines and associate equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 8).

ENGINEERS, MATHEMATICIANS or PHYSICISTS (Senior Scientific Officer grade) at a Ministry of Supply Experimental Aircraft Establishment in southern England, for research work in connexion with aircraft flight testing—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.221/51A (September 8).

LECTURER IN PHYSIOLOGY, and an ASSISTANT IN MATHEMATICS—The Secretary, The University, Edinburgh (September 8).

PHYSICISTS and ENGINEERS (Experimental Officer grade) at the Atomic Energy Research Establishment, Harwell, to take charge of the Electrical Standards Laboratory—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.234/51A (September 8).

PSYCHOLOGICAL TESTERS IN H.M. Prison and Borstal Service at Birmingham, Bristol, Durham, Liverpool and London—The Establishment Officer (E.84/4/7), Prison Commission, Dean Ryle Street, London, S.W.1 (September 8).

SCIENTIFIC OFFICERS or SENIOR SCIENTIFIC OFFICERS at the National Physical Laboratory for work in physics, mechanical engineering, metallurgy, radio and naval architecture—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.222/51A (September 8).

SENIOR ENGINEER, DESIGN SECTION, Dominion Physical Laboratory, Department of Scientific and Industrial Research, Lower Hutt, New Zealand—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (September 10).

SENIOR ASSISTANTS (Scientific): CHEMISTS experienced in analytical work, for the testing and analysis of soils, feeding-stuffs, fertilizers, milk, etc., BACTERIOLOGISTS experienced in laboratory routine, BIOLOGISTS experienced in the routine of a general biological laboratory, and specialized in either plant pathology or entomology and microscopy, BIOCHEMIST with knowledge of hygiene and pathology and ability to assist in teaching in these fields, BIOCHEMIST with sound knowledge and experience in nutritional work, CHEMICAL ENGINEER for supervisory duties, ELECTRONICS ENGINEER with specialized knowledge of Post Office relays—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4064/51LA (September 13).

ASSISTANT LECTURER or LECTURER IN CIVIL ENGINEERING at Gordon Memorial College, Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 15).

LECTURER IN AGRICULTURAL BOTANY—The Registrar, King's College, Newcastle-upon-Tyne (September 15).

LECTURER IN MINERAL DRESSING AND ASSAYING in the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 15).

PRINCIPAL RESEARCH OFFICER or SENIOR RESEARCH OFFICER (Ref. No 3510), to lead a scientific unit that will include a geologist, geomorphologist, pedologist and ecologist, to carry out surveys in Papua and New Guinea, organize the assembly of existing information and co-ordinate the work of the several specialists in the unit, a SENIOR RESEARCH OFFICER or RESEARCH OFFICER (Ecologist) (Ref. No. 3511), to serve as plant ecologist to the unit, and a SENIOR RESEARCH OFFICER or RESEARCH OFFICER (Geomorphologist) (Ref. No. 3512), to make special studies in the field of geomorphology, and act in general co-ordination with the geologist and pedologist—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 15).

SCIENTISTS, Grade II (with good honours degrees or equivalent qualifications in science or engineering, and some previous research experience) at London headquarters, to assist in the formulation and progressing of research programmes—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/366 (September 15).

SOIL CONSERVATION OFFICERS in the Department of Conservation and Extension, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (September 15).

ELECTRONIC ENGINEERS in Ministry of Supply establishments in southern England, for the design of radio and/or radar components, equipment and installations (including aerials) and engineering of prototypes for production—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.359/51A (September 17).

FORESTRY INSPECTOR (Grade III, established), and a FORESTER Grade III, unestablished)—The Secretary, Civil Service Commission, (5 Upper O'Connell Street, Dublin (September 20).

CIVIL and MECHANICAL ENGINEERS at Ministry of Supply research and development establishments in London, Glasgow, Farnborough, Christchurch, Salisbury and St. Helens, for design, development and installation work in the structural and plant engineering fields—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.485/51A (September 22).

ENGINEER I at a Ministry of Supply establishment at Salisbury. to be responsible for the design, erection, calibration and final testing of chemical plants—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.228/51A (September 22).

ENGINEERS I in Ministry of Supply establishments in London and the Provinces for (*a*) factory production management on gun carriages and tanks, ammunition, small arms, filling; (*b*) development of maintenance and services work in filling and explosives factories, (*c*) various Headquarters posts on production planning and progressing, or on maintenance, services, plant installation, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.472/51A (September 22)

ELECTRONIC ENGINEERS in the Ministry of Supply, to work near London or at provincial stations on the development and design of electrically operated systems for a variety of applications including weapons, telecommunications and radar equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.134/51A (September 24).

LECTURER IN DAIRY HUSBANDRY at Massey Agricultural College (University of New Zealand), Palmerston North—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 25)

PHARMACOLOGIST to the Alfred Hospital, Prahran, Melbourne—The Agent General for Victoria, Victoria House, Melbourne Place, Strand, London, W.C.2 (September 29).

LECTURER IN NUTRITION at the School of Home Science, University of Otago, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

PROFESSOR OF ANATOMY—The Registrar, University College, Cathay's Park. Cardiff (September 30).

PROFESSIONAL ENGINEERS, General Service Class (Main and Senior grades), in Government Departments—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Street, London, W.1, quoting S 86/51 (October 1).

DIRECTOR OF THE GEOLOGICAL SURVEY, Department of Industry and Commerce, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (October 18).

ASSISTANT BIOCHEMIST in the Department of Pathology—The Secretary, Bolton and District Hospital Management Committee, Royal Infirmary, Bolton.

ASSISTANT LECTURER IN PHYSICS—The Registrar, The University, Nottingham.

BIOCHEMIST, to direct and carry out work in intermediary metabolism and in problems of enzyme inhibition—Box No. 23, Ottawa, Ontario, Canada, quoting Competition No. G-18.

B.L.M.R.A. FELLOWSHIP, for research in the Leather Industries Department, University of Leeds under the direction of Prof D Burton, and a JUNIOR SCIENTIFIC OFFICER (with a good honours degree and, preferably, some knowledge of chemical engineering) to work in the chemical engineering section—The Director of Research, British Leather Manufacturers' Research Association. Milton Park, Egham, Surrey.

CHEMISTS or ENGINEERS (3), to visit members' works in all parts of the British Isles—The Director, British Launderers' Research Association Laboratories, Hill View Gardens, London, N.W.4.

HONOURS GRADUATE IN PHYSICS, to teach physics up to general B Sc. standard, together with some mathematics up to Inter.B.Sc. standard—The Principal, Gloucester Technical College, Brunswick Road, Gloucester.

PHYSICIST (honours degree in physics and some research experience essential) to take charge of the South Wales Laboratory in Swansea—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

POSTGRADUATE ASSISTANT in connexion with work on Nuclear Physics—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4.

PROFESSOR AND HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING (Heavy), Indian Institute of Technology, Kharghpur—The Ministry of Labour and National Service, Technical and Scientific Register (A.8.12), York House, Kingsway, London, W.C.2, quoting A.12/UNH/150/51.

PROFESSORS (2, one of whom should have special qualifications in applied thermodynamics) IN THE FACULTY OF MECHANICAL ENGINEERING, at the Technion (Institute of Technology), Haifa, Israel—The Secretary, The Technion Society of Great Britain, 13 Mansfield Street, London, W.1.

Senior Lecturer, and a Lecturer, in Physics, at the Bradford Technical College—The Director of Education, Town Hall, Bradford.

Senior Scientific Officers and Scientific Officers in various Government departments and covering a wide range of scientific research and development in most of the major fields of fundamental and applied science—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3399.

Teacher of Pharmacology (of professorial grade), and a Pharmaceutical Chemist, at the Hardinge Medical College, New Delhi—The Secretary (Division 5A), Ministry of Health, Savile Row, London, W.1.

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VOLUNTARY BODIES AND THE SUPPORT OF RESEARCH

IN the admirable record of beneficent activity which characterizes the successive annual reports of the Nuffield Foundation, the discrimination and care with which the Foundation selects the projects for assistance is obvious. It can fairly be claimed that, over the six years of its activity, the Foundation has consistently fostered the growing-points of science, and especially of the biological and social sciences, in exactly the way that Lord Beveridge recognized as so important in his report on voluntary action Much has, in fact, been done already by the Foundation to assist in keeping the advancing front of science in balance and ironing out the unevenness that sometimes hinders progress or contact between two or more fields.

One of the most interesting features of the Foundation's reports has always been the discussion of general policy and of the principles by which the trustees have sought to determine that policy. The sixth report[*] raises one matter of outstanding interest, especially to the scientific community, and its significance is strikingly emphasized by passages in two other recent reports from similar bodies—the Pilgrim Trust and the United Kingdom Carnegie Trust—as well as by one passage in the third report from the Committee of Public Accounts for the Session 1950–51.

The report welcomes the appointment last year by the Prime Minister of a committee under the chairmanship of Lord Nathan "to consider and report on the changes in the law and practice (except as regards taxation) relating to charitable trusts in England and Wales which would be necessary to enable the maximum benefit to the community to be derived from them"; it believes that it is in the public interest that the uses to which such funds can properly be put should be reviewed, and if necessary reformed. The report then emphasizes the need for flexibility rather than administrative convenience; while the ancient law of charities may require revision to meet modern needs, it is against too narrow and inelastic a definition of the objects of individual charitable bequests that precautions are required. Social advance would be impeded if charitable trusts were rigorously debarred from venturing into territories where statutory authorities are now enabled to make general social provision. As Lord Beveridge pointed out, new methods of meeting the changing needs of a developing society have in the past largely resulted from the prospecting of voluntary bodies, followed by central and local authorities consolidating and extending.

Any overlapping of effort or administrative untidiness is more than offset by the greater opportunity to experiment which such a relation between voluntary or private and public action affords, and the Nuffield Foundation rightly stresses the importance of such freedom to experiment, to move swiftly to the initiation or support of projects which promise to be of benefit to mankind. Some such projects might never be explored if it was always necessary to wait until public authority was convinced of the need, or could commit adequate resources to meet the need. The new feature in the situation to which the Foundation directs attention in this report is the possibility that bodies like itself may be faced with a less adventurous but more difficult choice of objectives. They may be required to turn from initiating to sustaining projects which hitherto have been sustained by the community.

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[*] Nuffield Foundation. Report for the Year ending 31 March 1951. Pp. 113. (London: Nuffield Foundation, 1951.)

The suggestion in the report that there may be a contraction of Government spending upon some social and intellectual purposes is not to be dismissed lightly. Though the nominal total of State support for learning and research has not as yet been decreased in the official estimates for the immediate future, the costs and materials of scholarship and research are steadily mounting in price. The real values of Government subvention, and of permanent endowments, for research are therefore bound to decrease. Moreover, the proposal in the White Paper on broadcasting policy to mulct the British Broadcasting Corporation of 15 per cent of the net revenue from wireless licences is not to be dismissed as merely an example of Treasury small-mindedness or dishonesty. If revenue contributed specifically for this purpose is to be raided thus as a contribution to rearmament, what is to stop the contributions of industry to the research associations or the revenue of the universities being raided on similar grounds ?

The speciousness of such an argument would be disturbing at any time, and in the present circumstances there will be profound disquiet in all circles interested in the furtherance of scientific and industrial research until the Government abandons so dubious a proposal. Nor is the disquiet diminished by the reference to the expenditure of the Department of Scientific and Industrial Research on the research associations contained in the report of the Select Committee on Public Accounts already noted. Commenting on the way in which the Industrial Grants Committee of the Advisory Council for Scientific and Industrial Research considers applications for grants and calculates the amount of any grant *pro rata* on the contribution made by the industry, the Select Committee expresses the opinion that *pro rata* grants are not best calculated to promote efficient economy, and may result in grants from public funds for research directly benefiting industries well able to meet the cost from their own resources.

The implications of this apparently reasonable argument deserve more attention than they have yet received. It is improbable that the Advisory Council, which is already informed of the details of research undertaken or proposed by each association, would be involved in any serious inquisition by the adoption of the Select Committee's recommendation for inquiry as to the financial position of the industry concerned. Leaving aside, however, the practical difficulty of assessing the capacity of an industry to finance research, the Committee's proposal for what is in effect a 'means test' shows a misconception of the whole purpose of co-operative research.

The case for State assistance of the research associations rests fundamentally on the belief that industrial research of this character is of direct advantage to the community as a whole, and not merely to the particular industry concerned. The economic well-being of the nation depends, in fact, on a progressive industry awake to all the opportunities which scientific and technical advance afford, and ready to turn them to advantage in the improvement of existing, or the development of new, products and processes. Part of the function of the research associations is indeed not so much the acquisition of new knowledge as the more effective and wider utilization of existing knowledge.

Accordingly, the important and fundamental question is not what should be the magnitude of any grant from the State, but whether the proposed programme of research is directed at the right targets. This is a question which is only with difficulty assessed from outside, and even from within an industry it may require a term of years to show the wisdom or otherwise of choosing the targets and activities adopted. Moreover, where part of the function of a research association is to educate the industry it serves and to seek to encourage the prosecution of research not only in the association's own laboratories but also in the industry at large, it would manifestly be a retrograde step to determine the research association's budget by the capacity of the industry to pay rather than, as at present, by the willingness of the industry to participate in co-operative research.

On the Select Committee's own showing, the Industrial Grants Committee of the Advisory Council is asking the right questions and putting first things first. Given that it is in the national interest to encourage as widely as possible the prosecution of industrial research, it would be a step backwards and false economy to change the emphasis or the arrangements and practice that have proved their value over more than three decades. What is essential is not the kind of scrutiny suggested by the Select Committee but, from time to time, a much more fundamental scrutiny of the whole structure and functioning of the research association movement in the light of changing conditions, to make sure that the nation and industry continue to get full value for their expenditure and that resources of money, materials and man-power are not diverted into this channel when they could more profitably be expended in other ways.

The outlook indicated in the Select Committee's report and in the Government's memorandum on the report of the Broadcasting Committee thus increases the concern already entertained, as suggested in the Nuffield Foundation's report, as to the possibility of rising costs compelling the Government to curtail scientific research. There has been no proposal as yet to cut the estimates for scientific research; but the situation fully warrants the suggestion that some statement of the Government's intentions should be made at an early date by the Lord President of the Council. Meanwhile, common prudence suggests that it would be wise for the Department of Scientific and Industrial Research, and also other bodies, including the universities, to scrutinize carefully their research programmes and ancillary activities with the view of eliminating any items for which a convincing case cannot be argued, and making sure that there is no waste of either man-power or materials.

Whether or not the pessimism suggested by the Government's memorandum and the report of the Committee of Public Accounts is justified, a realistic approach to research budgeting is undoubtedly required. The Nuffield Foundation's immediate concern is that it may be required in consequence of Government economy to choose between sustaining minimum academic activities thereby endangered and, on the other hand, encouraging novel proposals which may in such circumstances find it even more difficult to command a hearing. The danger of any real drying-up of enterprise in the field of research is unlikely to be great. What is endangered is the support of those growing points which from their nature are bound at first to be speculative and often illusory, but which nevertheless when genuine make decisive contributions to human welfare and the advancement of learning.

The present report of the Nuffield Foundation should therefore be read carefully by all who realize the importance under present conditions of preserving independent institutions which are free to experiment and to test the value of new projects in a way that no Government institution could readily do, even if free from the inhibitions already indicated. Both in the introduction to the whole report and in that to the section dealing with fundamental research, and again in that dealing with research into practical problems, it is apparent how great is the opportunity which still confronts the Foundation and with what care the Foundation determines its policy; and valuable as is its support of fundamental biological studies, that given to sociology may well be even more important at the present time. It is perhaps the most hopeful means available to us of averting that very real danger to which the weaker sociological departments in the universities might be exposed in competition with the stronger and more firmly established departments of physical science, in the absence of earmarked grants.

The Carnegie United Kingdom Trust*, like the Nuffield Foundation, is required to promote pioneer efforts for the advancement of social welfare, but in view of its smaller resources, which are only a quarter of those of the Nuffield Foundation, the Trust has concentrated its resources on objects which can be promoted significantly by a relatively small outlay and has consistently withdrawn its support as soon as success or failure has been conclusively demonstrated. When that stage is reached, failures, as, for example, the Bureau of Current Affairs, are abandoned, and successful ventures are transferred to public or voluntary bodies, while the Trust passes to fresh ventures. The most important single enterprise to which the Trustees have set their hands, for example, is the development of library services, on which since 1913 they have spent more than one and a half million pounds. This work will now continue without further financial assistance from the Trustees, and the current report for 1950 records that in this period annual expenditure by public library authorities in the United Kingdom increased from £800,000 in 1911 to £6,700,000 in 1948.

Other instances are cited in this report of the way in which modest experiments by the Trust have developed into institutions with a permanent place in the social structure of Great Britain and now in receipt of an Exchequer grant. So many of the old projects have now for such reasons been dropped that the total sums already earmarked for dispensation in the new quinquennium 1951–55, including £40,000 for the development of museum services, leave a considerable margin, either for the introduction of new schemes of development on a large scale or for financing single pieces of pioneer or experimental work likely to prove of national importance. Some four-fifths of the Trust's budget is, in fact, available for such purpose, and it would seem that the Trustees are now faced with a choice between assisting innovations in social welfare now increasingly in the hands of public authorities, or assisting voluntary enterprises even if they are not strictly of the pioneering type.

The picture displayed by the Carnegie Trust calls for reflexion as much as does that of the Nuffield Foundation's report. Both vindicate abundantly the value of the independent trust in social pioneering and research and the room for such voluntary work to-day. It should be no less clear that the limits of such enterprise and their freedom to experiment will be seriously circumscribed if they are only able to operate in association with public authorities, to which they would of necessity be subordinate. Definition or delineation of function is not easy; but it is clear that much would be lost if the promotion of social advance or of research in general were entrusted exclusively to the State. Both State institutions and voluntary associations have their part to play, and the latter are the repositories of the initiative and freedom to experiment which are always the sources of real advance in science or other human activities. There could be no clearer warning of the need for some such independent institutions, to preserve the atmosphere in which research and the pursuit of learning or the service of mankind are most fruitfully pursued, than the intimation of the narrowness of view and short-sightedness which are liable to cramp official action or policy that is given in the two official papers already mentioned.

EVOLUTIONARY THEORY

Animal Evolution

A Study of Recent Views of its Causes. By G. S. Carter. Pp. xv+368. (London: Sidgwick and Jackson, Ltd., 1951.) 30s. net.

"ANIMAL Evolution", by Dr. G. S. Carter, is an unusually well-balanced account of the present state of evolutionary theory written with the student reading zoology at a university chiefly in mind. The discussion is restricted to animals and largely to those in which the reproduction is bisexual. There are two equal parts: (1) the basis of biological fact; (2) the theory of evolution.

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* Carnegie United Kingdom Trust. Thirty-seventh Annual Report. Pp. viii 49. (Dunfermline: Carnegie United Kingdom Trust, 1950.)

In the opening chapter, "The Palæontological Data", the author distinguishes the characteristic patterns of evolution at three levels: micro-, macro- and mega-evolution. In "The Genetical Background", special attention is devoted to the physiology of the gene after a brief presentation of the basic principles of chromosomal organization and of the phenomena of mutation. In "The Species in Zoology", the traditional concept of the systematist—the species as a kind of animal, distinguished from others by at least one consistent character—is contrasted with the species of the naturalist and of the geneticist: a chain of interbreeding communities. The latter is preferred; but it is noted that there is usually convergence toward the same conclusions with respect to living forms. The genetics of differences within and between species is gone into briefly. In Chapter 4, "Intraspecific Categories", it is pointed out that even in common species the occupation of the range is in most cases highly spotty and that this is very important to evolution. The convenient term 'deme' (of Gilmour and Gregor) is used for these partially isolated, and often rather small, communities. The cline and the subspecies are also discussed. In Chapter 5, on "Competition, Isolation and Natural Selection", the author goes at considerable length into the conclusions of statistical genetics as well as into experimental and observational evidence on the success of selection within and between species.

The conclusions of Part 1 are applied systematically to the interpretation of "Micro-evolution" in Chapter 6 and of "Macro- and Mega-evolution" in Chapter 7, continued under the heads "Pre-adaptation", "Evolutionary Trends", "Evolution and the Life-history" and "Rates of Evolution" in the remaining chapters.

In his final conclusions, the author dwells especially on the concept of evolution as a "change in the animal's whole life, in its ecology, habits and behaviour as well as in the organization of its body", and as a process concerned with harmonious genotypes rather than separate genes. He also emphasizes that evolution in bisexual forms is something that happens to populations, not individuals or lineages, and again stresses the importance of the deme as the elementary unit of population.

The reviewer is especially glad to note the emphasis on the genotype and on the deme. He ventures, however, to suggest that these may be tied much more closely together than is done here. In a species with exclusive bisexual reproduction there can be no selection by genotype (beyond a mere summation of separate processes, relating to the average differential effects of the genes) except on the basis of interdeme selection. Such a process occurs wherever the demes are differentiated, in partial isolation, and those with superior adaptation to common environmental or social conditions can contribute more than their share to the next generation by infiltration of neighbouring, less adaptive portions of the species. Random drift of any sort is of more than trivial significance only in conjunction with local selection; but a joint process ensures the differentiation of the genetic complexes of demes, even under common conditions, and thus provides material for interdeme selection.

While Dr. Carter approaches evolution primarily from the point of view of ecology, his conclusions are, I believe, quite in harmony with those of most geneticists on such matters as the roles of micro- and macro-mutation and on the various topics indicated by the chapter titles in Part 2. The greatest gap that he finds in the genetic evidence, that might perhaps be expected to be available, is the absence of known mutations that go beyond mere changes in proportions of parts or replications (including homœotic ones) in such a way as to give a basis for "the appearance in the course of evolution of novelties in the organization of the body where there was no previous differentiation to be modified into them".

SEWALL WRIGHT

'THE EXCELLENT MR. RAY'

John Ray

A Bibliography. By Dr. Geoffrey Keynes. Pp. xv+163+4 plates. (London: Faber and Faber, Ltd., 1951.) 50*s*. net.

DR. KEYNES acknowledges in the first sentence of his preface that it was Canon Raven's biography of John Ray, published in 1943, that first opened his eyes to "the extraordinary qualities and endearing character of that remarkable man" and induced him to provide a supplement to Raven's book in the form of a "full-scale bibliography" of Ray's works. This he has done with the attention to detail which we should expect from a vice-president of the Bibliographical Society. Each of Ray's books is fully described, many of them with a photographic facsimile of the title-page, and all with a collation of sheet-signatures and an enumeration of the contents by pages, followed by a list of the copies known to survive, with an indication of the libraries in which they are preserved. With one exception, these libraries are in Britain, and most of them are the great national and university or college libraries. In these categories, however, there are one or two curious and unexplained omissions. For example, while the Universities of Aberdeen, Glasgow and Edinburgh are duly entered, there is no mention of the senior Scottish University, that of St. Andrews, although there is in one of its libraries at least one volume that would have been worthy of record. The abbreviation *YML* occurs in a number of places in the text; but is not included in the "List of Abbreviations" which follows the preface. It may be worth pointing out, therefore, that it is explained on p. 154 in the "Index of Copies Recorded" as referring to "Yale Medical Library".

The author expresses, in his preface, the hope that he has "brought forward evidence in a bibliographical dress" of Ray's "modesty, his loyalty and his integrity". As a matter of fact it is not immediately obvious that he has added a great deal to what we already know on these topics from Canon Raven's "Life". We do, however, learn that Ray, excellent old-fashioned scholar that he was, went to the trouble (and perhaps expense) of reprinting a title-page to rectify two, not very conspicuous, errors in Latinity and that the ignorance, or carelessness, of a bookbinder has left at least two of the surviving copies with the original, incorrect, page, several of the others with the corrected one, and one copy with both.

The volume is finely produced. The printing is what we expect from the Oxford University Press at its best. It is printed on grey paper, and, since the author is a distinguished surgeon as well as a bibliographer, one may assume that he is satisfied that this will avoid eye-strain. Whatever may be the case in conditions of full illumination, this may perhaps not be so in the dim lighting to which we are becoming accustomed in these days of electricity cuts.

Finally, in the "Note on the Portraits of Ray" on p. 151 it is stated that the portrait in the British Museum (Natural History), attributed to Mary Beale, "bears no resemblance to Ray and is difficult to accept as a portrait of him". The present writer, having shared a room with this portrait daily for some ten years, does not find it so hard to believe that it really represents the man whose name is inscribed on it.

W. T. CALMAN

RELATIVITY FOR EXPERIMENTAL PHYSICISTS

Weltsystem, Weltäther und die Relativitätstheorie

Eine Einführung fur experimentelle Naturwissenschaftler. Von Prof. Dr. Karl Jellinek. Pp. xv+450. (Basel: Wepf and Co., 1949.) 45 Swiss francs.

THERE is no lack of books on Einstein's theory of relativity, but Prof. K. Jellinek, the author of a five-volume work on physical chemistry and formerly head of the Physical Chemistry Institute of the Technical High School at Danzig, believes that none before his own is really suitable for experimental physicists. It is just as important to-day as when relativity theory first appeared that those engaged in experimental research in physics should have sound ideas about the fundamental concepts of space, time, motion and mass; yet most existing books leave them in a muddle, destroying their old ideas without giving them anything tangible in exchange. The books written for mathematical physicists are often excellent in their own way, but an abstract system of differential equations is rather unsatisfying to the experimentalists, who wonder if this is all they are offered to replace their former belief in a physical ether. The books written for a popular audience avoid abstract mathematics; but they are often superficial, revelling in paradoxes and sensational pronouncements, so that they are more suitable for seekers of entertainment than for seekers of truth.

A third kind of book is needed, which, without sacrificing accuracy, stresses the concrete rather than the abstract and the positive rather than the negative. For example, after giving the usual rejection of Newton's concept of absolute space, Prof. Jellinek asserts emphatically that relativity physics still admits of a universal frame of reference. This assertion is supported by quotations from Einstein, Kopff, Thirring, Beck, Eddington, Tolman and Robertson. The author also believes that relativity physics still admits of belief in a universal ether, with three essential properties. It is, as a whole, at rest relative to the universal frame of reference; it propagates the phenomena of light, electro-magnetism, gravitation, and inertia with constant velocity relative to that frame, irrespective of the velocity of the source; all material bodies, such as electrons, positrons, neutrons, protons, atoms, molecules, and the heavenly bodies represent certain modifications of the ether, through which they move freely. These opinions are supported by quotations from Einstein, Eddington and Weyl. The author also holds some other beliefs about the ether (pp. 23–26), which he recognizes as not generally accepted, but he points out that these can be rejected without affecting the arguments of the rest of the book. As for the space-time continuum, he believes, unlike Eddington, that this should be considered merely as a useful mathematical device and not as a physical reality like the universal frame of reference and the ether, which give a firm basis for clearing away all the paradoxes usually associated with relativity.

The topics mentioned above are dealt with in the preface and two short chapters. A long third chapter (pp. 27–142) deals with the special theory of relativity, on much the usual lines except for the stress on optical experiments and a long discussion of the clock paradox. The fourth chapter (pp. 143–166) gives a brief introduction to tensors. Here and elsewhere the only knowledge that the student is assumed to possess is very small, merely the elements of calculus and of mathematical physics. A long fifth chapter (pp. 167–307) deals with Einstein's theory of gravitation rather differently from usual; to reduce the difficulty, the simplest ideas of the theory are treated at length, before passing on to the important but more difficult aspects. A more general formulation of this theory is given in a short sixth chapter (pp. 308–331). The seventh chapter (pp. 332–381) returns to the questions of a universal frame and ether, and investigates them for three statical cosmological systems, while the eighth chapter (pp. 382–404) investigates them for a non-statical and expanding universe. The ninth chapter (pp. 405–412) gives a brief account of E. A. Milne's kinematical relativity. Unfortunately, Einstein's latest theory was not available when the book was published. In conclusion, there are several mathematical appendixes, a bibliography, and indexes of authors and of subject-matter.

It would be presumptuous for me to pronounce on the soundness of the controversial parts of this book, but it can be safely asserted that they will be found of great interest. It is a pity that the high price may prevent many from examining the book for themselves.

H. T. H. PIAGGIO

BRITISH ORCHIDS

Wild Orchids of Britain

With a Key to the Species. By V. S. Summerhayes. (New Naturalist Series.) Pp. xvii+366+72 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1951.) 21s. net.

NO group of British plants has attracted more attention than our native orchids. In spite of this, prior to the appearance of Mr. V. S. Summerhayes's book, no real authoritative work on the subject existed. Now we have a comprehensive book dealing with the plants from every point of view, their classification, natural history, ecology and biogeography all receiving adequate attention. Moreover, the volume is well illustrated by a series of colour and other photographs, text figures and maps.

Just after the First World War, British orchids became the objects of much intense research. Taking cognizance of this work, but neglecting such trivialities as *Orchis francis-drucei*, and reducing *O. hebridensis* to its proper level as a subspecies of *O. fuchsii*, Mr. Summerhayes has produced on pp. 107–8 a thoroughly trustworthy list of species. Each of the species admitted to this list is discussed so fully that one wonders at the author's skill in getting the essential facts into so small a space. Careful scrutiny of his descriptions only serves to confirm their general reliability. This, of course, does not imply that no minor blemishes exist, for such do occur, especially among the dactylorchids.

In the first place, we feel sure that the orchid figured on Plate 38*b* has little to do with the *O. traunsteinerioides* forms recorded from Wicklow and Durham; the differences between the two sets of plants are too strongly marked for that. Furthermore, we doubt the relationship suggested between the Wicklow and Durham plants and true *O. traunsteineri*, of which we possess authentic Irish specimens. We do, however, recognize their obvious affinity with *O. majalis*. As for the origin postulated on p. 295 for *O. traunsteinerioides*, it seems to be impossible for several cogent reasons: the chromosome numbers of the putative parents do not fit, nor, in the case of the Durham plant, do its associates and characters.

In respect of *O. purpurella*, certain pronouncements are made which cannot be harmonized with fact. It is asserted to be the latest flowering of the marsh orchids, and the month of its appearance is given as July. Here, in North Durham, it is the earliest of all. In 1950, a late season, masses of inflorescences were visible on May 29; even this season, on May 12, the flowering spikes were well advanced. Much the same holds true in the Inner and Outer Hebrides, where the flowering of *O. purpurella* is at its height during the last week in May, just ahead of *O. latifolia* and *O. occidentalis*.

Similarly, we cannot understand the remarks concerning the anthesis of *O. fuchsii* and *O. ericetorum* made on p. 272, where we are informed that in the Hebrides the former may precede the latter. According to our observations, made over a period of years, Hebridean *O. ericetorum*, even high up the mountain-sides, commences to flower in the middle of May with *O. fuchsii* ssp. *hebridensis* following about June 15. Thus in 1950, in Lewis, Harris, South Uist and Eriskay, although there was some overlap in July, *O. ericetorum* had quite disappeared when *O. fuchsii* was at its best.

The sections devoted to ecology and biogeography now come up for comment. Concerning the former, we have nothing but praise. However, in the case of the biogeography, the accounts should be received with some measure of caution. On p. 69 the pronouncement that the Ice Age occurred 10,000–100,000 years ago is incorrect. Had the latter date been given as 600,000 years ago, we should have had a much closer approximation to the truth. Again, Mr. Summerhayes is inclined to emphasize older conceptions about the history of our flora and fauna. He seems to be unaware that recent investigations have pointed strongly to the possibility that a not inconsiderable portion of our biota migrated to the British area during the last Interglacial Period, or even during favourable interstadial phases in the Upper Pleistocene glaciation. Such contingents, forced westward to suitable refugia when more rigorous conditions returned, and released finally as the glaciers waned, may well be responsible for some of the distributional anomalies so puzzling to plant geographers.

As an appendix we have an excellent and workable key to the species described, followed by a useful glossary, a bibliography and a series of distributional maps. The latter follow the usual practice of blackening the whole of a vice-county when only a single station is concerned. For example, although *Gymnadenia conopsea* and *Anacamptis pyramidalis* are confined in the Outer Hebrides to the small Isle o Fuday, the whole of v.c. 110 is blackened; such procedure may easily vitiate serious phytogeographical researches.

Botanists owe a debt of gratitude to Mr. Summerhayes for producing such an excellent book, and w unhesitatingly recommend it to all interested i British orchids.

J. W. Heslop Harrison

INSECTS AND HYGIENE IN BRITAIN

Insects and Hygiene

The Biology and Control of Insect Pests of Medica and Domestic Importance in Britain. By Dr. Jame Busvine. Pp. xiv+482. (London: Methuen and Co., Ltd., 1951.) 30s. net.

INSECTS do not play a major part in the transmission of human disease in Great Britain, and the damage which they do to stored foods, to clothing, to the structural timbers of buildings, or to furniture is on the whole insidious, and although in the aggregate it is extensive enough, much of it passes almost unnoticed. But as every applied entomologist, every medical officer of health and, indeed, every housewife knows there are a great many troublesome insects in our midst and it is not always easy to obtain the information about them that is necessary for their effective control. Dr. Busvine has produced a truly scientific and very practical treatise on this diverse collection of insects. He has made the attempt of setting out within a single volume the general principles of pure entomology—systematics, anatomy, physiology and ecology, the general principles of applied entomology, and the practical details for the diagnosis and treatment of every pest problem in the home or in the warehouse, in foodstuffs, in timber or on the body. Many of the topics are necessarily treated in a brief and superficial style. But on the whole the author has succeeded in maintaining an admirable balance in the treatment that he gives to all sides of the subject.

In these days when new synthetic insecticides discovered in the past ten years have brought about a revolution in our powers for destroying insects by chemical means, it is sometimes forgotten that most of the insects that trouble the health of man can be controlled by common cleanliness. It was improvements in cleanliness and not insecticides which led to the disappearance of the bed-bug from the houses and the louse from the persons of the upper classes of Britain in the nineteenth century. The flea canno maintain itself in clean houses or clean cinemas; no can the house-fly breed in clean back-yards. It is a notable feature of Dr. Busvine's book that although the sections dealing with insecticides and their uses are particularly good, the biological methods of control—of which domestic hygiene is often the most important—are given full weight.

But the control of insects in human communities is often impossible without the backing of the law In Britain the local authorities have varied legal powers for dealing with insects infesting houses, with verminous persons or with divers nuisances connected with insects. It is useful to find all these matters set out briefly in this book. There are also keys for the identification of most of the insects to which reference is made and an appendix giving chemical details about most of the insecticides now in use.

V. B. Wigglesworth

Laboratory Physics

By J. H. Avery and A. W. K. Ingram. Pp. xi+439. (London: William Heinemann, Ltd., 1950.) 16*s*.

TWO science masters, who obviously have first-hand and wide experience of the difficulties which confront sixth-form and first-year university students when performing the standard physical experiments, have combined to write this excellent text-book. Not only is the student encouraged to make some of the apparatus himself—there are brief instructions on soldering, glass-blowing and drilling, etc., to help him—but also the teacher will find the more precise specification of apparatus than is usual in text-books of this kind most useful in setting up the experiments. Detailed descriptions of nearly two hundred experiments grouped into sections on mechanics and properties of matter, heat, light, sound, magnetism, electricity, and—one which will appeal perhaps more to the technical colleges—electronics are given. The authors state that they were encouraged to include this last section because of the considerable quantity of ex-Government equipment now available to the public. Exercises, problems, a good bibliography, together with an introductory section containing some excellent advice on laboratory notebooks, errors and graphical methods, complete the book.

The diagrams are on the whole clear, but some might with advantage have been larger. Enough theory is given with each experiment to explain the principle and method employed. Natural and forced convection are discussed and the distinction between them carefully emphasized. The authors do not hesitate to point out where difficulties arise, as, for example, in the determination of the internal resistance of a primary cell, and the student is quite correctly referred to the late Sir Cyril Ashford's excellent article on this subject for further information. The 'real is positive' sign convention is used in the light section, but the diagrams are so drawn that the 'new Cartesian' convention can also be applied to them. A regrettable omission is Owen's method for the determination of neutral points by directional loci.

S. Weintroub

Etat actuel de la chimie et de la physique des molécules géantes

Science de base des industries des matières plastiques. Par Prof. H. Mark, avec la collaboration de Prof. T. Alfrey et Prof. R. B. Mesrobian. Pp. xv+548. (Paris: Masson et Cie., 1950.) 3150 francs.

THIS substantial book provides an up-to-date, detailed and excellently documented account of the physics and chemistry of large molecules. A useful feature is the full description given of the light-scattering method for the determination of molecular size and shape. The mechanical properties of polymers are treated thoroughly, as is the phenomenon of 'ageing'. On the chemical side, copolymerization and emulsion-polymerization are selected for discussion of the scientific principles involved. There is an interesting final chapter on the preparation and properties of *cyclo*-octatetraene, included because of its interest in connexion with the synthesis of new monomers. The book is based on a series of lectures given by Prof. H. Mark in Liège in 1948, and the Belgian editors are to be congratulated on their initiative and on their meticulous translation and excellent presentation of the material.

D. P. Riley

A Short Guide to Chemical Literature

By Dr. G. Malcolm Dyson. Pp. vii+144. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1951.) 8*s*. 6*d*. net.

IN arrangement and general treatment this book is an up-to-date version of Dr. F. A. Mason's "An Introduction to the Literature of Chemistry" published a quarter of a century ago, though the treatment is somewhat fuller, and a chapter, "Works of Reference on Medicinal Chemicals", replaces that on the "Special Literature on Dye Chemistry" in Mason's book. There is further a good chapter on "Making a Search in the Literature" which extends that in Mason's book, and an appendix giving an example of an organic chemical search. The book, moreover, contains two other useful appendixes: the first of these deals with some old and obsolete journals; the second gives a list of journal years and volume numbers more extensive than that to be found in "The Chemist's Yearbook" and covering the interruptions and changes of the past ten years or so. The book is admirably designed to serve its purpose. It is admittedly selective and cannot well be criticized on the grounds of omissions. One or two slight suggestions might, however, be ventured. The section dealing with historical text-books omits Bugge's "Das Buch der grossen Chemiker". If only for its copious references, this is a much more valuable work than several of those included. Among the list of chemical periodicals, the omission of the *Transactions of the Institution of the Rubber Industry* is surprising, and the *American Dyestuffs Reporter* might have been included among those dealing with dyes and textiles. Similarly, *Biological Abstracts* or *Abstracts of World Medicine* would appear to be at least as worth including among the abstract journals as *Excerpta Medica*.

Audubon Water Bird Guide

Water, Game and Large Land Birds, Eastern and Central North America from Southern Texas to Central Greenland. By Richard H. Pough. (Sponsored by National Audubon Society.) Pp. xxviii+352+48 plates. (Garden City, N.Y.: Doubleday and Company, Inc., 1951.) 3.50 dollars.

THIS excellent little book by R. H. Pough is a guide to the birds to be found on or near the marshy and watery areas of eastern and central North America. It is published under the sponsorship of the National Audubon Society, the many bird portraits in colour being by Don Eckelberry, while the black-and-white sketches are from the pencil of E. L. Poole, both of whom are worthy upholders of the tradition of the great bird artist Audubon.

The field covered is a wide one. It embraces not only truly aquatic species such as grebes and petrels but also birds of the marshes and birds associated with marshy areas. We read of herons, bitterns and egrets, plus ducks, geese and swans; we come to waders and even game birds and birds of prey.

A considerable amount of interesting information is given under the heading of 'habits', including the greatest age known to have been attained by the species under consideration; for example, the osprey twenty-one years, golden eagle thirty years and gannet sixteen and a half years. But the last-mentioned would not necessarily be an old bird; it might, indeed, be but in the prime of life, for there are grounds for believing the gannet lives long.

Frances Pitt

OBSERVATION OF A LINE IN THE GALACTIC RADIO SPECTRUM

Radiation from Galactic Hydrogen at 1,420 Mc./sec.

THE ground-state of the hydrogen atom is a hyperfine doublet the splitting of which, determined by the method of atomic beams, is 1,420·405 Mc./sec.[1]. Transitions occur between the upper ($F = 1$) and lower ($F = 0$) components by magnetic dipole radiation or absorption. The possibility of detecting this transition in the spectrum of galactic radiation, first suggested by H. C. van de Hulst[2], has remained one of the challenging problems of radio-astronomy. In interstellar regions not too near hot stars, hydrogen atoms are relatively abundant, there being, according to the usual estimate, about one atom per $cm.^3$. Most of these atoms should be in the ground-state. The detectability of the hyperfine transition hinges on the question whether the temperature which characterizes the distribution of population over the hyperfine doublet—which for want of a better name we shall call the hydrogen 'spin temperature'—is lower than, equal to, or greater than the temperature which characterizes the background radiation field in this part of the galactic radio spectrum. If the spin temperature is lower than the temperature of the radiation field, the hyperfine line ought to appear in absorption; if it is higher, one would expect a 'bright' line; while if the temperatures are the same no line could be detected. The total intensity within the line, per unit band-width, should depend only on the difference between these temperatures, providing the source is thick enough to be opaque.

We can now report success in observing this line. A micro-wave radiometer, built especially for the purpose, consists mainly of a double superheterodyne receiver with pass band of 17 kc., the band being shifted back and forth through 75 kc. thirty times per second. The conventional phase-sensitive detector and narrow (0 016 c./s.) filter then enable the radiometer to record the apparent radio temperature *difference* between two spectral bands 75 kc. apart. These bands are slowly swept in frequency through the region of interest. The overall noise figure of the receiver, measured by the glow-discharge method[3], is 11 db., and the mean output fluctuation at the recorder corresponds to a temperature change of 3·5°. The antenna is a pyramidal horn of about 12° half-power beam-width. It is rigidly mounted at declination −5°; scanning is effected by the earth's rotation.

The line was first detected on March 25, 1951. It appeared in emission with a width of about 80 kc., and was most intense in the direction 18 hr. right ascension. Many subsequent observations have established the following facts. At declination −5° the line is detectable, by our equipment, over a period of about six hours, during which the apparent temperature at the centre of the line rises to a maximum of 25° above background and then subsides into the background. The source appears to be an extended one approximately centred about the galactic plane. The frequency of the centre of the line, which was measured with an accuracy of ±5 kc., was displaced some 150 kc. above the laboratory value, and this shift varied during an observing period. Both the shift and its variation are reasonably well accounted for by the earth's orbital motion and the motion of the solar system toward Hercules. The period of reception shifts two hours per month, in solar time, as it ought to.

Some conclusions can already be drawn from these results. Extrapolation of radio temperature data for somewhat lower frequencies[4] suggests that the background radiation temperature near the 21-cm. line is not more than 10° K. Then the hydrogen spin temperature is not more than 35° K., if the source is 'thick'. But we can calculate the opacity of the source on the assumption of a spin temperature of 35° K. and 1 $atom/cm.^3$, using only the observed line-width and the matrix element of the transition in question, and we obtained 900 light-years for the absorption-length. As this is much smaller than galactic dimensions, we conclude that the temperature observed corresponds indeed to the spin temperature at the source. To the extent that 'self-absorption' contributes to the observed line-width, the true absorption length at the frequency of the centre may be *less* than that computed. Further evidence for relatively high opacity is the absence of large frequency-shifts, which would be expected to arise from galactic rotation were the opacity-thickness comparable to the size of the galaxy. This conclusion is contrary to the prediction of Shklovsky[5], who has recently discussed the possibility of detecting galactic line radiation.

We have made rough theoretical estimates of the efficacy of various processes through which energy is exchanged between the hydrogen hyperfine levels and the other thermal reservoirs in the interstellar matter plus radiation complex. Of these we find exchange with the radiation field (involving spontaneous emission) and exchange with gas-kinetic energy of the hydrogen atoms (via H–H collisions) much the most important, with the latter process probably dominant. This is consistent with the observation, and if correct implies that the gas-kinetic temperature of the hydrogen exceeds, but not greatly, the spin temperature. The estimated spin relaxation time for these processes is of the order of 10^3 years.

This work was assisted by a grant from the Rumford Fund of the American Academy of Arts and Sciences.

H. I. Ewen
E. M. Purcell

Lyman Laboratory,
Harvard University,
Cambridge,
Mass.
June 14.

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[4] Herbstreit, J. W., and Johler, J. R., *Nature*, **161**, 515 (1948).

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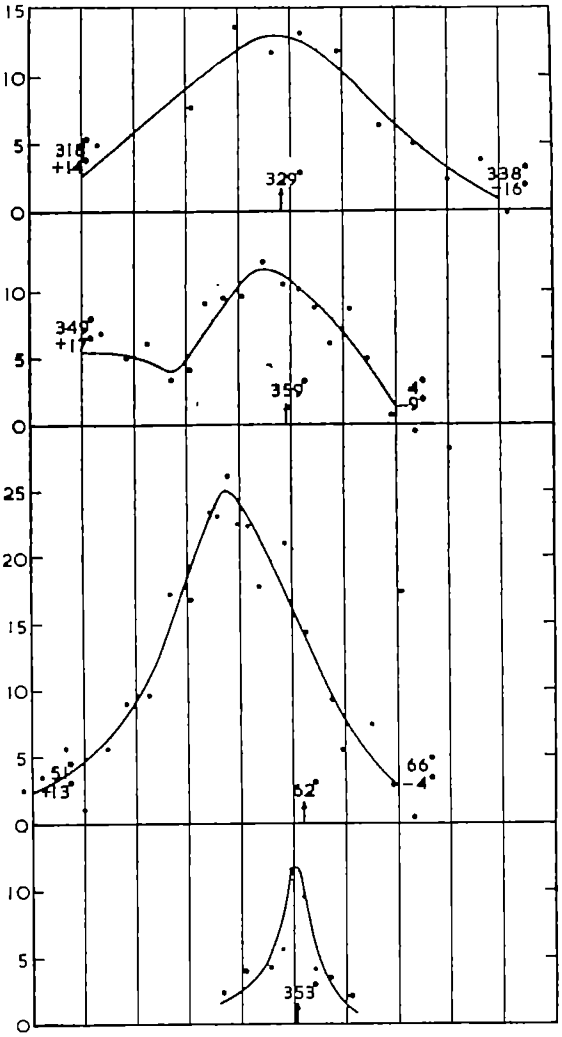
The Interstellar Hydrogen Line at 1,420 Mc./sec., and an Estimate of Galactic Rotation

FOLLOWING a suggestion made by Dr. H. C. van de Hulst in 1944[1], attempts have been made to measure the radiation at 1,420 Mc./sec. (λ21 cm.) emitted by atomic interstellar hydrogen. The first experimental evidence for the presence of this interstellar emission line was obtained by Ewen and Purcell on March 25, 1951 (see the preceding communication). In the Netherlands, the first successful measurements were made on May 11.

The receiver consists of a double superheterodyne instrument, with a crystal-controlled first local oscillator, which is switched between two frequencies 110 kc. apart thirty times per second by a reactance modulator. By varying the frequency of the second local oscillator, the two frequencies can be moved together through a 4-Mc. wide pass band at 1,420 Mc. The pass band of the second i.f. channel is 25 kc. wide. Behind the usual phase-sensitive detector a narrow-band filter with a time constant of 12 sec. is used. So the difference between two frequency bands 110 kc. apart is measured. The noise factor of the receiver has not yet been measured. The losses in the coaxial antenna cable are rather high, and an effective noise factor of the whole receiving system of 25 has been deduced from other measurements with the sun as a source of noise. Important parts of the receiver have been constructed at the Philips Laboratory in Eindhoven under the supervision of Dr. F. L. Stumpers.

The receiver has been mounted behind a movable paraboloid of 7·5 m. aperture and 1·7 m. focal-length at the radio station at Kootwijk, which was kindly put at our disposal for these measurements by the Radio Department of the Post and Telegraph Service. The beam-width at half-power is 2·8°.

The results of the measurements made on a few of the first tracings are shown in the accompanying graphs. While these tracings were being made, the instrument was left in a fixed position relative to the earth, the motion across the sky being provided by the earth's rotation. The frequency of the second local oscillator is switched every 3 min. between positions in which either of the two pass bands coincides with the spectral line. The first position gives a positive, the other a negative, deflexion on the recording meter. The curves show the intensity as function of the right-ascension; the interval between successive vertical lines is 20 min. of time. The point at which each sweep crossed the galactic equator has been marked with an arrow, accompanied by a number giving the corresponding longitude. The galactic co-ordinates at the beginning and end of each tracing have also been indicated. The curves shown may be slightly distorted because the radial components of the orbital motion of the earth, of the sun's motion relative to the nearby interstellar clouds and of differential galactic rotation are different for the various directions. However, we do not believe that these effects will have seriously affected the general shapes of the records, except for latitudes less than $1\frac{1}{2}$°, where in some directions the line is greatly widened by galactic rotation, and the measured intensities will be too small.



It is evident from the wide spread in galactic latitude that the clouds observed must be relatively close to the earth. From the width of the emission line observed in the region of the centre of the Galaxy, where the rotation of the galactic system does not affect the line, it is found that the random velocities average about 5 km./sec. in one co-ordinate, which agrees approximately with what had been found from absorption lines in the visual region. With such small velocities it is unlikely that the gas extends to more than an average distance of about 50 parsecs from the galactic plane. With an average latitude of the order of 8°, the gas seen in the general direction of the centre cannot then be farther away than 300 or 400 parsecs. In Cygnus the distance may be twice this amount.

These small distances might be taken as an indication either that the more central parts of the Galaxy are devoid of atomic hydrogen, or else that within a distance of between 500 and 1,000 parsecs in the galactic plane the gas becomes optically thick in the wave-length of this line. Although we should like to reserve a definite judgment until more complete measures have been obtained, we believe the latter alternative is the more probable on the basis of the results so far available.

In order to test the presence of radiating hydrogen in the inner regions of the Galaxy, measures have been made across the Milky Way at l = 355°, 30° from the centre, where the change of frequency due to differential galactic rotation should make it possible to observe the gas up to large distances. Provisional measures indicate that the emission line in this direction has an effective width of about 330 kc./sec., or 70 km./sec., and that the rotational velocity of the galactic system at a distance from the centre equal to half the sun's distance from the centre is approximately 190 km./sec. This agrees well enough with the rotational velocity of 205 km./sec. computed from a schematic model of the galactic system[2]. (In both cases a value of 270 km./sec. has been assumed for the rotation near the sun.)

The graph at the bottom shows the results of a registration across the Milky Way at 355° longitude and at a frequency 250 kc./sec. lower than the normal frequency of the line, corresponding to a differential radial velocity of +55 km./sec. The gas clouds observed at this frequency are presumably situated at an average distance of about 8 kiloparsecs. It may be noted that the spread in latitude is quite small, and may roughly correspond to the beam-width of the instrument, as would be expected for these large distances.

The tracings reveal many irregularities in distribution. The extension to high positive latitudes in the second graph may possibly be connected with the well-known dense clouds in Ophiuchus. The maxima in the Cygnus region lie systematically about 2½° south of the galactic circle at longitudes between 40° and 45°, while between 56° and 62° they occur roughly 3° north of the plane. Though no weight should be attached to the exact differences in height of the various sweeps, the intensities in Cygnus appear to be definitely higher than in other regions (except in that opposite the centre). This may be ascribed to the effects of galactic rotation. The fact that the intensity is also lower in the direction towards the centre, where these effects are presumably negligible, is possibly due to the superposition of continuous background radiation, which has probably a considerable intensity in this direction.

The measurements reported in this communication are of a provisional nature. Improvements in the receiver are possible, and are now being made in preparation for more systematic measurements.

The investigation has been made possible by grants from the Netherlands Organization for Pure Research (Z.W.O.).

C. A. Muller
J. H. Oort

Netherlands Foundation for Radio Astronomy,
Kootwijk Radio Station.
Observatory,
Leyden.
June 26.

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[1] Van de Hulst, H. C., *Nederl. Tij. Natuurkunde*, 11, 201 (1945).

[2] Oort, J. H., *Bull. Astro. Inst. Netherlands*, 9, 193 (1941).

The following cable dated July 12 has been received from Sydney, N.S.W.:

Referring Prof. Purcell's letter of June 14 announcing the discovery of hyperfine structure of the hydrogen line in galactic radio spectrum, confirmation of this has been obtained by Christiansen and Hindman, of the Radio Physics Laboratory, Commonwealth Scientific and Industrial Research Organization, using narrow-beam aerial. Intensity and line-width are of same order as reported, and observations near declination 20° S. show similar extent about galactic equator. J. L. Pawsey

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VARIATIONS IN THE CHEMICAL COMPOSITION OF STRATOSPHERE AIR

By Dr. K. F. CHACKETT, Prof. F. A. PANETH, F.R.S., P. REASBECK and B. S. WIBORG

Londonderry Laboratory for Radiochemistry, University of Durham

In a previous article[1] analyses of upper air samples obtained from 52–66·5 km. height by means of *V2* and Aerobee rockets were described, and it was shown that in all cases the composition of the samples was nearly the same as at ground-level, with respect to the ratio of helium, neon and argon to nitrogen. At the same time it was pointed out that some uncertainty must be attached to the helium values because the air was sent to us in glass vessels. Recently, we received, from the University of Michigan, stratosphere air in the original steel bottles in which the samples had been collected; a new and improved sampling technique had been employed, and in the meantime our method of analysis had also been further developed. We now wish to communicate our latest results, which provide evidence for gravitational separation between 64·3 and 71·8 km. height (M.S.L.). Details of the experimental procedure will be published later.

We owe the following information about the new sampling arrangements to the scientific workers of the Department of Aeronautical Engineering, University of Michigan[2]. Three evacuated steel bottles were located immediately behind the hollow nose cone of an 'Aerobee' rocket. The bottles were soldered to thin copper tubes, one inch in diameter, the sealed-off ends of which projected into the cone. The latter was ejected automatically just before sampling. At a predetermined instant a steel knife was arranged to cut through one tube, and five seconds later this was squeezed shut at a lower point by a pyrotechnically operated vice. The second and third bottles were opened and shut at successively later times. Control experiments had shown that the sealing mechanism gave satisfactory vacuum-tight seals without the use of solder.

A successful flight took place from the White Sands Proving Ground in New Mexico on December 19, 1950. After recovery, the three steel bottles were dispatched to us and their contents analysed by our micro-method for oxygen, nitrogen and the inert gases helium, neon and argon. Since our previous work, an entirely new apparatus had been built with several improvements over the old model. Thus, the air pipette was of smaller volume, enabling us to take smaller amounts of gas (between 0·07 and 0·10 c.c. s.t.p. for each analysis); the same pipette was used for the helium–neon analysis and for the nitrogen–argon analysis; and the fractionating column consisted now of fifteen units instead of twelve, each smaller than formerly, and operated by means of a mechanical device which could be set to perform any number of fractionations and then stop.

In general, runs on the stratosphere air were sandwiched between runs on ground-level air, so that a good check could be kept on the satisfactory working of the apparatus. As we found in the earlier work, the oxygen content of the samples was much below normal in spite of the fact that the sampling vessels were always cold. It is impossible to assume that there really is this deficit of oxygen in the

Sample		Height (km.)	Date of sampling	Date of first analysis	Oxygen	Helium	Neon	Argon
16*A*	Glass vials	49·6–53·6	2.6.49	4.8.49	0·61	0·96	0·98	1·00
25*D*		50·4–53·3	6.12.49	17.4.51	0·60	0·98	1·00	1·00
15*B*		53·6–57·7	2.6.49	25.7.49	0·12	1·00	1·00	1·01
19*D*		54·7–58·3	21.7.49	6.3.51	0·00	1·01	1·45*	1·01
3*B*		55·4–65·5	27.5.48	1.12.48	<0·02	0·98	0·99	0·99
1*B*		61·1–72·0	9.10.47	4.1.48	<0·02	0·93	1·00	1·01
B-6	Steel bottles	64·3–67·0	19.12.50	12.6.51	0·07	1·44	1·08	0·93
B-8		67·0–69·6	19.12.50	25.6.51	0·25	2·02	1·18	0·89
B-9		69·6–71·8	19.12.50	9.5.51	0·03	1·49	1·07	0·95

upper air, and we suppose that the walls of the bottles and connecting tubes were so well cleaned during the initial pumping and degassing that they were able to take up most of the oxygen at room temperature during the interval—five to six months—between the flight and the analysis.

In view of the ever-present danger of a partial loss of oxygen during sampling, it has always been our habit to express the figures for the rare gases in relation to oxygen-free air or, in other words, to the nitrogen + argon content; since we have now found some variations in the argon content, we think it best to relate all figures to nitrogen. The accompanying table gives for each gas the value of the ratio:

$$\frac{\text{volume of gas, relative to nitrogen, in sample}}{\text{volume of gas, relative to nitrogen, in ground-level air}}.$$

For convenience we have included in the table the results of previous analyses also. All figures are quoted to two places of decimals only, although the errors calculated from individual experimental results (usually two or more) are often less than one-half per cent. The figure marked with an asterisk is unreliable owing to contamination by, apparently, hydrogen.

The first six samples in the table show no appreciable variation in chemical composition from ground-level air. The results of 16*A*, 15*B*, 1*B* and 3*B* have been published before[1]; 25*D* and 19*D* were later analysed for the special reason that McQueen[3] had found in air from these samples as well as from 15*B* a shift in the relative proportion of the nitrogen isotopes which he interpreted as an indication of gravitational separation. Our figures are in contradiction to this interpretation, as has already been pointed out with respect to 15*B* by the workers at the University of Michigan[4], whose own experiments confirm our findings. However, while we are certain about the correctness of the analyses, it is perhaps not impossible that contamination by ground-level air during the process of sampling has obscured shifts in the chemical composition.

Quite different are the results of the last flight. In every one of the three steel bottles we found a marked increase of the helium and neon content and a deficit of argon. The shift of the helium percentage is greater than that of the other two gases. All this is in qualitative agreement with the supposition that the samples come from a region in the stratosphere where gravitational separation has been effective.

It is the first time that such an effect has been observed with certainty. In earlier experiments we found a small increase of helium at heights between 21 and 25 km., and M. Shepherd and E. Regener a deficit of oxygen between 19 and 29 km.[5]; but we were reluctant to consider the evidence as conclusive[6]. It is not safe to rely on helium analyses if the sample has been stored in a glass vessel, and contact with stop-cock grease is sufficient to reduce appreciably the oxygen content[1]. In Regener's experiments there was a further source of possible error: his stratosphere sample was during the whole time in contact with metallic copper, so that, according to our experience, disappearance of some oxygen was to be expected.

Of the three steel bottles used in the last flight, the first one, *B*-6, opened and sealed perfectly. As to *B*-8, we were informed that the opening may have been poor as the knife was at the time of recovery in an unexpected position. In *B*-6 we found 0·388 c.c. of air (s.t.p.), in *B*-8 only 0·185, but as the sample came from a greater height there seems to be no reason to suspect the essential correctness of the sampling; it is qualitatively in agreement with expectations to find in *B*-8 a stronger shift in composition than in *B*-6. Concerning *B*-9, however, we doubt whether the sample is representative for the height given. Here, as well as in *B*-8, the opening might have been incomplete as the knife had cut only half-way; nevertheless, we found in this bottle 0·535 c.c. (s.t.p.), a considerably greater volume of air than in either *B*-6 or *B*-8, in spite of the greater height. As at the same time the shift in composition is not even as strong as in *B*-6 (see especially the very accurate argon figures) we strongly suspect that, after the sampling at about 70 km., the sealing was not perfect and that afterwards some ground-level air had leaked in; after recovery the sealed copper tubing was covered with glyptal, but that does not exclude the possibility of a previous leakage. If from the volume of gas measured in the other bottles we calculate the amount to be expected in *B*-9, we find that only about a fifth of the quantity contained came from 70 km.; assuming the rest to be ground-level air, we can allow for this contamination. Instead of helium 1·49, neon 1·07 and argon 0·946 we obtain the following 'corrected' figures for *B*-9: helium 3·44, neon 1·35 and argon 0·73. We feel that this procedure is the best in the circumstances, but even if the latter figures are nearer the true value than those obtained by direct analysis, they are very rough.

Our figures do not agree quantitatively with any simple theory. This, however, is scarcely surprising, since the samples may be the result of many alternating phases of gravitational separation and of remixing. Another possibility is that an initially homogeneous layer began to separate gravitationally, but owing to the different mean velocities of the constituent molecules the helium reached its equilibrium concentration with respect to nitrogen more completely than the heavier gases. Taking the helium ratios for *B*-6 and *B*-8 as representing the composition at the midpoints of the sampling intervals, it may be shown that a good fit is obtained with a temperature of 230° K., and with the midpoint of *B*-6 as 3·0 km. above the level at which separation commences. The calculated figures for the neon in *B*-6 and *B*-8 are then 1·13 and 1·26, the argon figures 0·83 and 0·71 respectively; the calculated helium, neon and argon ratios in *B*-9 are then about 2·8, 1·4 and 0·6 respectively. These calculations are, however, of little value except as an illustration of the deviations from a simple theory, if only because it is estimated that the actual temperature at these heights is nearer 280° K.[7].

Since it is proved now that the sampling technique of the Michigan team of scientific workers can reach heights in which diffusive separation becomes effective, it is hoped that more samples from these, and from even greater, heights will soon be collected. Only if more experimental material is available will it be possible, and worth while, to try to develop precise ideas about the stillness, or otherwise, of the stratosphere at heights from 64 km. upwards. So long as about 0·1 c.c. of air (s.t.p.) can be collected (containing normally 5×10^{-7} c.c. helium, $1 \cdot 8 \times 10^{-6}$ c.c. neon and $9 \cdot 3 \times 10^{-4}$ c.c. argon), we shall be able to carry out on each sample at least one analysis of these three gases with the present accuracy of 1 per cent. Air from greater heights may show such marked variations in composition that still smaller samples and, accordingly, a somewhat reduced accuracy, will give valuable information.

We wish to express our thanks to Messrs. L. M. Jones and E. A. Wenzel, of the Engineering Research Institute of the University of Michigan, for their long-distance collaboration, and to the United States Signal Corps Engineering Laboratories who have sponsored and supported the research at Michigan. We also acknowledge with gratitude financial assistance rendered by the Gassiot Committee of the Royal Society, and one of us (P. R.) a Further Education and Training grant.

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[2] U.S. Signal Corps Project, University of Michigan Progress Report, September 1, 1950, to December 31, 1950.

[3] McQueen, J. H., *Phys. Rev.*, **80**, 100 (1950).

[4] Hagelbarger, D. W., Loh, L. T., Neill, H. W., Nichols, M. H., and Wenzel, E. A., *Phys. Rev.*, **82**, 107 (1951).

[5] See Paneth, F. A., *Quart. J. Roy. Meteor. Soc.*, **65**, 303 (1939).

[6] Gluckauf, E., and Paneth, F. A., *Proc. Roy. Soc.*, A, **185**, 89 (1946).

[7] Bartman, F. L., Liu, V. C., and Schaefer, E. J., U.S. Army Signal Corps Contract, July 1950.

MODERN INSECTICIDES AND THE BALANCE OF NATURE*

By Dr. D. STEWART MacLAGAN

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SINCE man first scratched the soil in an endeavour to obtain more food, he has had to contend with the vicissitudes of a hostile environment. Of the factors inimical to increased productivity, few are of greater significance than the direct and indirect toll exacted by insects and their allies; the loss in world crop-production alone being at least ten per cent, and double that figure according to other estimates. This is not so remarkable if it is borne in mind that nearly three-fourths of all species of animals are insects.

For hundreds of years, therefore, man has been driven of necessity to combat his insect enemies. Within the past decade, however, chemists have synthesized new pesticides which have penetrated the realms of plant protection, veterinary and medical hygiene, at great speed. Despite the remarkable insecticidal and acaricidal properties of these new substances they are not the universal panaceas which was portended in the first flush of enthusiasm. They have their limitations and dangers, and ignorance of their ultimate effects has led to their abuse. For good or ill, however, there is no doubt that these artificial aids to pest control have received a warm welcome from diverse sources.

The two main groups of these 'wonder' insecticides are the chlorinated hydrocarbons and the organophosphates. Members of both groups are now in use throughout the world in connexion with pest problems which seemed well-nigh insoluble. With the advent of DDT, BHC, DNT, HETP, etc., man's potential control over the lower orders was never so powerful as it is to-day, and the 'discovery' of these chemicals will rank as a major contribution of science to the world.

Some of the original claims made for DDT were exaggerated; but used with discretion, it is probably the most generally useful insecticide available being highly toxic to most insects. A unique feature—not without danger—is its extraordinary persistency, which renders DDT of special value where good persistence on foliage is essential. Thus, DDT has proved its effectiveness against a variety of plant-feeding caterpillars, weevils, pollen and flea beetles, several moths, and against the cotton jassid in the Sudan. Mosquitoes and other flies, fleas and lice, are highly vulnerable. Throughout the stock-rearing countries of the world, this 'penicillin of insecticides' is proving a boon to harassed stockmen in their struggle against blowflies, keds and ticks. Fortunately, DDT is less harmful to bees than was first suspected; but no undue risks should be taken in this respect, such as spraying open blossom.

Another 'wonder' insecticide is the gamma-isomer of benzene hexachloride. Although of lower persistency, it has a degree of volatility not possessed by DDT. This accounts for its spectacular results as a soil-insecticide, especially against wireworms—formerly responsible for losses of 0·5 cwt. per acre of English wheat and oats, for every 100,000 wire worms per acre. In addition, BHC gives good control of certain aphides, sawflies, root-maggots and leaf-miners. Abroad, the age-old menaces of locusts and termites may eventually be eliminated by this new weapon. So toxic to locusts is gamma-BHC that 3 gm. are enough to kill a ton of them. Equally remarkable results are being obtained in the control of mange-mites and ticks; for example, the scab-mite which has ravaged the sheep-flocks of the Old World for two thousand years can now be eradicated by one dipping in a BHC suspension.

The synthetic organophosphates originated in Germany, during the Second World War, as substitutes for nicotine. Of these, HETP was the first to be used commercially; but has been partially superseded by DNT or parathion, of which the outstanding feature is its extreme toxicity to aphides and spider-mites—both largely unaffected by the chlorinated hydrocarbons. Parathion is non-ovicidal and seldom persists actively on foliage for longer than three days. Of special interest is the discovery by American and Australian investigators that parathion gives commercial control of chrysanthemum eelworm, thereby suggesting a solution of the eelworm problem in other crops.

These are the principal achievements of three insecticides in world-wide use; but so many are appearing on the market that some may be outmoded sooner than seemed probable a few years ago. As these chemicals have not been received with universal approbation, what are the charges that have been levelled against them? The presumed hazards to human health, through the cumulative effects of toxic residues, falls outside the scope of this paper, so that the other potential danger can now be considered.

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* Substance of a paper read on August 10 before Section D (Zoology) of the British Association meeting at Edinburgh.

Two years ago, in a contribution to *Discovery*, I remarked that "because of the greater susceptibility of numerous parasites and predators than the pests themselves, and the rapid resurgence of pests in the virtual absence of natural enemies, the indiscriminate use of these new chemicals might seriously upset the balance of nature". To what extent has this prognostication materialized?

Evidence from numerous sources leaves no doubt that sprays of DDT on fruit-trees lead to an increase of 'red spider' (*Paratetranychus* spp.). This was presumed to be due to destruction of natural enemies; but more recent work in the United States and in Holland supports the view that DDT has also a direct stimulating effect upon the reproduction of the mites. Nevertheless, DDT can kill thirty or more of the insect enemies of red spider, and if used soon after bud-burst it may destroy many beetles which act as pollinators. Mealybugs and many species of 'greenfly' are practically unaffected by DDT, and tend to increase when it is used alone. This is due to its lethal action upon the larvæ and adults of predators such as hover flies, lacewings and ladybird beetles. Similarly, the use of DDT against certain root maggots intensifies the injury, apparently by killing predators of the puparia.

Recent studies of the fauna of apple-orchards in Nova Scotia have revealed a tangled skein of interrelationships between phytophagous mites and insects, parasites, predatory mites, bugs and beetles: additional complications having followed the use of insecticides and fungicides. In general, it seems that the populations of red spider and scale insects in so-called 'neglected' orchards are lower than in orchards subjected to spraying with DDT. In several areas, DDT has so reduced the activities of the *Aphelinus* parasite of woolly apple-aphid that the latter has required treatment with BHC. Aerial application of DDT (1 lb./acre) has given reasonable control of forest defoliators in the United States, without causing permanent damage to invertebrates serving as fish-food in the streams and lakes; but in another investigation the density of invertebrates was greater one year after spraying than before, suggesting some interference with the natural balance. It is considered inadvisable to use more than double the above rate to avoid harm to birds, and treatment should not be carried out during the nesting season.

Charges against BHC include the causation of greater injury by cotton bollworms (*Heliothis* spp.) due to destruction of predatory bugs, and an increase of sugar cane borer (*Diatraea*) through destruction of the egg-parasites (*Trichogramma* spp.). Nor is there any doubt that dusts of BHC are extremely toxic to bees and other pollinators, so that on no account should they be used on open blossom. Beans dusted with this chemical to control black dolphin (*A. fabae*) have failed to set seed—a result of interference with cross-pollination. Earthworms are not seriously affected, whereas older insecticides such as derris and lead arsenate are highly toxic to them. Neither DDT nor BHC gives the spectacular knockdown of pyrethrum; but like derris, both are deadly to fish. Although parathion is potentially less dangerous to beneficial insects because of its much lower persistence than either DDT or BHC, it is quite toxic to many predators of aphides and spider-mites.

The adverse effects of insecticides on beneficial species is by no means a new problem; but the potency and persistency of modern synthetics have raised specific problems concerning their appropriate application to avoid abuse. It has been realized for many years that tar-oil winter washes were directly associated with the increase of red spider in the orchards of southern England, and that they were not favourable to the establishment of the imported parasite (*A. mali*) of woolly apple-aphid. American investigators concluded in 1931, and again in 1935, that sprays of lead arsenate were seriously reducing the efficiency of an important parasite of the codling moth, and that egg-parasitism was lowest in orchards tended according to the most up-to-date rules of husbandry. Applications of lime-sulphur have repeatedly been noted as ultimately leading to outbreaks of scale insects, due to paralysis of their parasites; and in 1941, cryolite was found to cause such a high mortality among predatory coccinellids that they were incapable of exercising their former control of citrus mealybugs. Both old and modern sprays, designed to combat codling moth, generally result in heavier infestations of red spider and leaf hoppers. These adverse effects can nevertheless be minimized by appropriate choice of the chemical and judicious timing of its application. For example, nicotine dust does little harm to larval coccinellids and syrphids, and arsenicals are relatively innocuous to many parasites and predators. When there is a differential emergence, in time, of hosts and parasites, it is often possible to restrict spraying to periods when the parasites are least vulnerable. Maximum injury to beneficial insects is most likely to result from spraying when they are in maximum abundance, namely, during the later phases of outbreaks.

All these ameliorative measures designed to conserve parasites and predators, and the outcry about adverse effects of insecticides, are based on the assertion that natural enemies have a significant role in suppressing potential pest-populations below the 'level of economic significance'. The words in inverted commas should be noted, because the role of natural enemies (including pathogenic organisms) in eventually effecting the collapse of insect-outbreaks is an entirely different subject. Since the multiplication of parasites and predators is dependent on the density of the host-insect, economic control is feasible only if the host is always present to a density which favours the natural enemies, without causing damage to the food-plant of the host—a finely adjusted interaction indeed. It must be emphasized, also, that mortality attributed to biotic factors is only a part of total mortality, which is the combined result of many factors.

Of the numerous projects which have been launched with the objective of controlling pests by the introduction of parasites and predators, only some twenty have been really successful—and mainly in tropical or semi-tropical regions of the world. Projects for augmentation of native parasites have proved disappointing and costly in relation to the increment of parasitism. Even in countries of an old-established agriculture, where pests and their enemies have had ecological opportunities of attaining relative stability, there is no dearth of pest-outbreaks. A survey of old books and periodicals shows that, even in Britain, crop and stock have suffered intermittently for centuries, and before the use of insecticides was given any consideration. This carries no implication that it is not worth while making the fullest use of all available natural enemies of pests, but simply that they cannot be solely relied upon as permanent controlling agents. Indeed, no less an authority on biological control than Dr. W. R. Thompson makes the following statement: "The discontinuity and variability in habitats, produced by physical factors, both in time and space, is the primary extrinsic factor of natural control".

In view of the repercussions, already outlined, which have followed the application of some of the new chemicals, it is of interest to consider briefly the kind of happenings which may be expected, on theoretical grounds, to follow the operation of any drastic mortality factor in a biological complex of phytophagous insects, predators and parasites. Volterra gave quantitative expression to predator–prey interactions, and has enunciated basic generalizations or 'laws', of which the third is his 'Law of the Disturbance of the Averages'; stating that if two species living together (one feeding on the other) are destroyed in proportion to their numbers, the average number of the prey increases and that of the predator diminishes.

The interesting practical significance of this law is that while an insecticide (or any other highly destructive factor) causes an immediate reduction of the damage, the effect is temporary even in respect of species which are materially suppressed by natural enemies. These are dependent for their increase on the population-density of the host, so that their increase is much slower than that of the host when both population-densities are low. Hence, impoverishment of a natural complex of this kind temporarily releases the host from control, and there follows a series of violent fluctuations in the average density of the host, until the natural enemies re-establish the former relative stability. During this period, before the natural enemies can exercise adequate control, the pest may attain densities of serious economic import.

That such effects occur, sometimes, after application of a potent insecticide, is well exemplified by the resurgence of aphides and red spider, following the application of DDT to fruit-trees; but here the trouble is intensified by the prolonged toxicity of the residues to the notoriously susceptible parasites and predators. This exemplifies an important point concerning the application of insecticides (particularly in respect of those with persistent residues), namely, the risk of encouraging some *other* pest through destruction of its natural enemies, and more so if the second species is not seriously affected itself by the chemical.

When a species that is known to be significantly affected by biotic factors of mortality attains 'pest' status, then the plant doctor is indeed placed in a dilemma. He must either advise the avoidance of insecticides, to give the natural enemies free rein, and warn the grower of some recurrent injury; or else he must advise the judicious use of insecticides, to obtain immediate amelioration of the trouble, and warn the grower about repeating the treatment to avoid more serious injury. The correct course of action can be determined only after gauging the economics of the situation, but with profit-margins becoming increasingly dependent on yield and high-quality produce, the fundamental issue for many growers is: 'Can I afford *not* to spray?'.

As to the likelihood of disturbing the so-called 'balance of Nature', the majority of biologists realize what Darwin implied even if his choice of the word 'balance' may appear unhappy to a modern physicist. The quasi-equilibrium eventually attained in Nature is not necessarily, however, to the benefit of man. Interference with Nature is generally accepted as unavoidable, if productivity is to be increased. Modern techniques for increasing yields are certainly conducive to increasing 'imbalance', through gross interference with organic Nature; and unfortunately, in tilting the balance favourably in one direction there frequently ensues a series of unforeseen repercussions. The ultimate re-assertion of Nature is unusually well demonstrated in the world of insects.

Surveying the evidence in retrospect, there is no doubt that extensive and indiscriminate use of the new potent and persistent pesticides could bring about serious consequences; not only by disturbing predator–prey and host–parasite interactions, as outlined heretofore, but also by leading to the production of chemical-resistant strains of pests. Even now, on many farms in Illinois, the resistance of house-flies to DDT has become so high that a change-over to other insecticides is considered desirable. In general, the potential dangers of some of the new synthetics would appear to be least when applied to crops under rotation in temperate climates, and greatest when applied to non-rotated crops under tropical conditions.

The latest developments, in the form of systemic insecticides, may provide the plant doctor with a way out of his dilemma. As a result of war-time investigations in Germany, a group of insecticidal compounds were 'discovered' and found to be absorbed by the leaves and roots of plants. Their 'internal' or systemic action is negligible in plants which have stopped growing, however; and a few plants are intolerant. None the less, these systemic insecticides, for example, octamethylpyrophosphoramide, have a remarkable combination of desirable features; being deadly to sap-suckers, relatively non-toxic to beneficial insects, of reasonable persistency in the plant, and harmless to mammals if used in appropriate dilutions. The supreme advantage of an insecticide such as the above is that the natural enemies of the pest are enabled to reinforce the artificial control of the chemical. Incidentally, this decreases the risk of development of resistant strains of the pest. An 'internal' insecticide has also obvious advantages against leaf-miners, stem-borers, root-suckers, and other species which are difficult to control because of their inaccessibility. Further exploration of the uses and limitations of systemic insecticides (and fungicides) is eagerly awaited.

A survey of the situation concerning the new insecticides seemed desirable if for no other reason than to direct attention to the various factors which are involved in natural controlling complexes. Their analysis, involving assessment of the relative significance of mortality factors, has become of considerable urgency so far as insects are concerned, as a direct result of the synthesis of these remarkable new pesticides and their appearance on the market in ever-increasing profusion. The suitability of an insecticide is not merely a question of toxicity and cost—the chemist can tell us about that—it is the ecologist who must be the final adjudicator as to the appropriate uses of these powerful artificial aids to pest control. It would be most unfortunate should they be denigrated through incompetent or over-enthusiastic handling.

LIFE AND WORK IN EXTREME ENVIRONMENTAL CONDITIONS

It must have been almost without precedent that Section A (Mathematics and Physics) of the British Association should have devoted a session at the recent Edinburgh meeting to so biological a subject as "Life and Work in Extreme Environmental Conditions". The title might have included pressure as well as temperature extremes; but the former were not considered by any of the speakers, and the morning was devoted entirely to the effects of thermal stress. The study of this subject is not new, for it began two hundred years ago; but it has been taken up again recently with some intensity, and its importance for industry and the Armed Services can scarcely be over-emphasized. Those who have been frustrated in their attempts to lay in a stock of fuel for the winter of 1951–52 may feel that it has considerable importance for the ordinary citizen.

The president of the Section, Sir David Brunt, was in the chair and the first paper was given by Dr. O. G. Edholm, who pointed out that the subject under discussion must be counted an unusual one since it had brought together physicists, psychologists and physiologists. Had Dr. Edholm realized what the discussion would bring forth, he might have said even more about the widespread interest of the subject. His paper dealt with the basic principles of heat regulation in man. He emphasized the relative constancy of the body temperature and discussed the various ways by which this is maintained. He directed attention to the fact that the various organs produce heat at different rates, and emphasized the over-riding effects of exercise and of the ductless glands in varying the amount of heat produced by the body as a whole.

The second paper, by Dr. F. Marsh, was the only one which did not deal with human physiology. The work he described had been done on rabbits at Abadan in the Persian Gulf, where he had studied the effect of raising their temperature by exposing them to the sun. The rabbit loses heat mainly by varying its respiration-rate and the amount of blood flowing through its tongue. Observations were made of the animals' respiration-rate, carbon dioxide output, rectal temperature, heart-rate and venous hæmoglobin. Dr. Marsh did not give any details of the methods he had employed to make these measurements, but his observations showed that after the body temperature had risen to a certain height, which varied from one rabbit to another, there was great danger of collapse and death at any time from then onwards for at least twenty-four hours, even if the animal was cooled to a normal temperature by placing ice on its fur, and if it appeared relatively normal after this had been done. In considering the application of this work to man, the chief conclusion was that prevention is better than cure.

Dr. N. H. Mackworth described work which he had done in an improvised wind tunnel at Fort Churchill in Canada on the effect of cold and wind in destroying touch discrimination in the fingers. This is an important matter where fine work is concerned because gloves destroy a man's manual dexterity. But so do cold and wind, so that to remove the gloves to do the job often leads to unfortunate results. Dr. Mackworth made two points which were no doubt noted by the physicists in his audience. In defining conditions for fine work out of doors, it is not enough merely to give the temperature and wind velocity. The reaction of the man and some way of measuring it are just as important, because, first, no two men are able to withstand extreme conditions equally well, and, secondly, acclimatization and practice can lead to great improvement in the performance of a single man. He illustrated this by showing how much better men accustomed to working out of doors performed in these experiments than those who normally did all their work in warm rooms.

A joint communication by Profs. E. M. Glaser and R. A. McCance dealt with some of the fundamental adjustments by which the temperature of the internal organs is maintained, and they pointed out that in order to achieve this the temperature of the peripheral parts of the body may vary very widely. The temperatures of the skin and limbs are usually lower, but may be higher than the mouth or rectal temperature. They also directed attention to the fact that some variation in the internal temperature is compatible with life and even with comfort, and that after the internal temperature has been raised or lowered by a degree or more it tends to stabilize itself for many hours at or near the new temperature even when the man returns to the original environment. In other words, the body is so organized that it tends to produce a balance between heat gain and heat loss rather than to maintain a fixed internal temperature. In this respect its regulating mechanisms may be compared with the governor of a steam engine rather than the laboratory thermostat which usually operates by cutting in and cutting out as the temperature of the bath varies.

Dr. T. Bedford drew upon his great experience of industrial work to bring out the facts that industrial efficiency depends very much upon the temperature at which the work is done. He showed, for example, that the output from mines is affected in this way and that there are interesting differences between the European miner and coloured workers. A wet-bulb temperature of 84° F. reduces the efficiency and output of European miners very materially, much more so than it does those of coloured people; this is probably because the European sets himself a relatively much higher standard in a cooler environment. Dr. Bedford produced many other instances of the effects of temperature. In hot industries, for example, the output tends to rise in winter, whereas in cold industries it tends to rise in the summer.

Warp breakages can be reduced by raising the temperature under which cotton is woven; but in hot humid environments human efficiency falls, so that a mean has to be found at which the man and the cotton thread can both survive. This has been shown to be about 75° F. (dry bulb) and 73° F. (wet bulb). Dr. Bedford concluded by quoting some work of Dr. Mackworth's which has shown that the reception errors of telegraphists rise very rapidly when the external temperature and humidity reach a certain point.

Dr. Ezer Griffiths was the last speaker on the programme. He discussed various ways of measuring temperatures and humidity as they applied to man and pointed out the failings of the kata-thermometer. He then described a mechanical man which has recently been designed and which can measure the heat absorbed by or radiated from itself by using electronic recording. The control panel, which Dr. Griffiths displayed, looked very complicated, although he said it was simple—as no doubt it was, compared with the physiological control panel in the hypothalamus.

Sir David Brunt opened the discussion by saying that he had encouraged the organization of this meeting as he was anxious to know how the environment which he had studied as a meteorologist affects the bodies which the physiologists set out to study. His idea had been to stimulate interest in the climatic conditions under which man ceases to work efficiently and to discover whether physiologists and psychologists are prepared to find out more about this. The lively discussion which followed centred largely upon the word 'comfort'. Miss M. V. Griffiths and others spoke about the advantages of floor heating. It was stated that if the temperature of the floor is 72–75° F. people in the room can be maintained in comfort when the temperature of the room itself is only 54° F., though this was doubted by Dr. Bedford—evidently one of the world's 'cold mortals'. The heating and ventilation of motor buses also came in for some discussion, a matter of some importance to many people to-day. The most satisfactory system seems to apply the heat near the floor and ventilate the bus near the ceiling. Reducing the humidity brought in on wet clothes and inseparable from expired air appears to be a very important matter in bus management because, apart from the comfort of the travellers, it greatly reduces the time which has to be spent by the maintenance staff in sponging down the interiors to keep them clean. Two geographers joined in the discussion and pointed out the importance of work of the kind described at the meeting for anyone who has to study man's place in Nature. Both put in a plea for more work of the same kind and also for meteorological records which could be made the basis of geographical science. At present the material supplied to them by the meteorological services gives no clue as to how a man would react under those conditions. In a final word, Prof. Glaser pointed out that any discussion of comfort must take into account the fact that what is comfortable for *A* is not comfortable for *B*, and that what is uncomfortable for *A* to-day may be quite comfortable for him in a few weeks time when he has become acclimatized. He also pointed out something much more striking, namely, that comfort can be achieved at an internal temperature relatively far removed from the person's 'normal' one; and as a last shot at the reliability of comfort as an index of any value, he directed attention to the fact that the man in a *rigor* from malaria with a rising temperature usually feels most miserably cold.

OBITUARIES

Prof. A. Sommerfeld, For.Mem.R.S.

THE death of Prof. Arnold Sommerfeld, at the age of eighty-three, occurred in Munich on April 26, after he had been knocked down by a motor-car.

With Sommerfeld one of the physicists has passed away who helped transform physics from what we now call classical physics to the new or quantum physics. "Quantum Theory is a child of the twentieth century", Sommerfeld was fond of saying, alluding to the fact that Planck introduced the quantum constant h in the theory of black-body radiation in 1900. Much of the rearing of this infant fell to Sommerfeld.

Sommerfeld's main contribution to quantum physics consists not of the fundamental laws or models. To his name there remains attached the fine structure constant and the method of applying quantization to more than one variable; the discovery of selection and intensity rules and thereby the interpretation and classification of a wealth of spectroscopic data in the optical and X-ray region; and the opening up of a new era in the theory of metals by his application of Fermi statistics to the electrons in metals. His main importance lies in his untiring probing into the new methods of atomic physics, by carrying problems to the ultimate test of quantitative agreement between experiment and theory. He was tireless in propounding the new theory at home and abroad in a spirit of optimism and enthusiasm; and no one has done so much for the consolidation of the rapidly developing new physics as he did by the five editions of "Atombau und Spektrallinien" which appeared between 1919 and 1931, each with many chapters re-written and brought up to date. Physicists all over the world have derived great profit from this labour, which seemed scarcely to interrupt the steady flow of research papers of Sommerfeld himself and his numerous pupils.

Sommerfeld was proud that he came from Königsberg, a geographical outpost and spiritual bastion among German universities. His father was a medical man, and the son graduated at the Gymnasium (1886) and University (1891) there. Franz Neumann, then ninety years old, who was the originator of the teaching of theoretical physics as a subject in its own rights and of the seminar method of teaching theoretical subjects, had made Königsberg one of the foremost schools for mathematics and mathematical physics. Sommerfeld's dissertation (under F. Lindemann), on "The Arbitrary Functions in Mathematical Physics", deals with the development of functions according to systems of orthogonal functions. Up to his death Sommerfeld found occasion to enlarge on this first brilliant work of his.

The full power and originality of Sommerfeld's mathematical construction appeared soon after in a series of papers on the diffraction of light by an edge (1894). The advance of this theory over previous ones (Fresnel, Kirchhoff) lies in defining the solution entirely by the differential equation of wave propagation together with the boundary conditions on the opaque half-plane; the method is an ingenious combination of image methods and of Riemannian multiply connected planes. In later years (1911), Sommerfeld extended the method when he discussed the diffraction of X-rays by deep wedge-shaped slits (Walter and Pohl) in papers that led to a reliable value of the then still unknown wave-length of X-rays.

In 1895 Sommerfeld became assistant to Liebisch in the Mineralogical Institute in Göttingen; but soon after he turned to more inspiring work than drawing crystals by becoming assistant to Felix Klein. This great master of mathematical synthesis deeply impressed Sommerfeld. Together they planned and carried out the writing of the four monumental volumes "Theorie des Kreisels" (1897–1910), in which the subject of gyroscopic motion is used as a theme for making evident the manifold connexions between dynamics and a variety of mathematical subjects.

The period in Göttingen ended in 1897, when Sommerfeld was appointed to his first chair, that of mathematics at the Bergakademie in Clausthal in the Harz Mountains, not far from Göttingen. The three years he spent there, newly married, were very happy ones.

His next appointment was the chair of applied mechanics at the Technische Hochschule, Aachen (1900–6). His contact with the engineering school turned his interest to applied subjects, even although he tackled problems of fundamental importance. The papers of this period, on viscous flow lubrication, on friction, on the beats between generators working on the same grid, are among those to which Sommerfeld liked to look back in a spirit of satisfaction not unlike that of Goethe's Faust when he speaks of the improvements he is bringing to the country by constructing canals and irrigation.

At the same time, the problems of ether physics were occupying Sommerfeld. The proper modes of vibration of a rigid spherical electron was a problem seriously discussed at that time, and Sommerfeld, like others, wrote highly mathematical papers on this subject, of which the last appeared in 1905, the year of the birth of relativity. Of more lasting importance are his studies of the electromagnetic fields which are emitted by the sudden stopping of a cathode ray, the *Bremsstrahlung* or white X-ray radiation according to the hypothesis formulated independently by Stokes, Liénard and Wiechert. This subject was followed up as, through the experiments of Barkla on the polarization of X-rays, more than mere total intensity data became available, and as similar effects were measured for gamma-rays. Later it appeared repeatedly in quantum form in papers by Sommerfeld's pupils.

Meanwhile, Sommerfeld had moved to Munich. It was Röntgen, the mighty man in the philosophical faculty, who insisted that Sommerfeld would be a worthy successor to Boltzmann in this chair that had been vacant for some time. A small but autonomous Institute for Theoretical Physics was connected with the chair. The workshop facilities and a few instruments made it possible to illustrate by simple experiments some of the conclusions arrived at in the theoretical courses. L. Hopf's work on Reynolds's number for flow in an experimental river-bed, and soon Laue, Friedrich and Knipping's discovery of X-ray diffraction by crystals, fully justified the existence of such an institute which had appeared to some as a self-contradiction.

In Munich Sommerfeld soon began to attract students in ever-growing numbers. P. Debye, whom he had brought with him from Aachen as his assistant, shared with Sommerfeld the success of building up a first group of graduate students who were keenly intent on physics and also enjoyed the colourful life which Munich offered by the combination of its natural and artistic climate. Many a problem was raised and discussed in the after-lunch meetings in the Hofgarten Café, between Sommerfeld and his group, the experimentalists from Röntgen's laboratory and those of the Technische Hochschule. These frequent informal meetings of physicists of various degrees of experience were most stimulating, even more so than the official colloquium which took place once a week during term-time.

Sommerfeld's success as a teacher was due to the clear and concrete expression of his ideas, and to the choice of subject in his lectures, which made even the young student realize that behind the domain of established theory there follows a domain of unsolved problems. The research on which he was currently engaged often occurred in preliminary form in Sommerfeld's course lectures; thus in 1909 the theory of relativity appeared in his electrodynamics course at a time when he was developing the four-dimensional vector form of this theory, and in 1927 the application of Fermi statistics to metals. This made his introduction to physical theory always an exciting experience full of reality. Further, Sommerfeld had a keen appreciation of intellectual capacity and real endeavour at whatever stage it appeared, and he was a friend, not only a teacher, to his students. He took them home and made them perform, or listen to, music or reading. In winter, skiing expeditions would be organized during week-ends or in the Easter vacations. On such occasions a long line of physicists might be seen making their way up the snowy slopes, and a panting discussion might be heard through the clean cold air of recent or future experiments and theories.

Among the problems of applied physics to which Sommerfeld and his pupils made essential contributions, that of the propagation of electric waves along the surface between two media stands foremost. His student days had been marked by the impact of Hertz's experiments on the theory of electromagnetism. In 1898 he gave a quantitative theory of Hertz's results on waves along wires; in 1911 his pupil Hondros discussed waves of all types travelling along dielectric rods. Starting in 1909, a series of papers dealt with the propagation of radio waves along an earth assumed flat or spherical, and with the directed action of horizontal antennæ (v. Hoerschelmann). Many years later, Sommerfeld gave a condensed account of this group of papers in Franck and Mises' book on partial differential equations in physics.

Regarding Sommerfeld's contributions to the development of atomic theory, the account can be short, because this is so much more recent work that it is still firmly imbedded in the memory of university teachers in many countries, who are handing on to the new generation their own personal impressions of Sommerfeld and his work, which they gained either at his school or in the course of his extended visits to other universities (Spain, 1922; United States, 1922–3; England, 1926; India, Japan, California, 1928–29; Volga congress, 1930; Ann Arbor, 1931). Sommerfeld's book "Atombau und Spektrallinien" has been, from 1919 on, an unfailing guide through the rapidly accumulating volume of atomic theory. In 1929 it was supplemented by the "Wellenmechanischer Ergänzungsband", which, some years later, was converted into a full-fledged companion volume "Wellenmechanik" (3rd edit., 1944). With the advent of wave-mechanics, theoretical atomic physics returned to the type of eigenvalue problems which had been Sommerfeld's favourite field from his early days on. No wonder that he impressed his personal stamp on the account of the new subject.

Among the major decisions in Sommerfeld's life were the refusals to accept the chairs of theoretical physics in Vienna (1917) and in Berlin (1927). He retired from the Munich chair in 1935, but continued intensive scientific activity up to the very last. The six volumes of "Vorlesungen über theoretische Physik" (the last of which is being prepared for publication) are, as he wrote, a bequest to the young generation; their preparation enabled him to survive the political chaos during his years of retirement. It is hard to believe that so vigorous and in many ways novel an account of classical physics should have been written by a man nearing, or even surpassing, his eightieth year. Two of the volumes have appeared in English translation, and the others are to follow shortly.

With his long list of scientific papers and his monumental books on atomic theory and on classical physics, Sommerfeld will always be regarded as an imposing figure standing on the threshold between two periods in the history of physics. As long as his pupils live, they will bear an affectionate memory of a great teacher and unselfish friend.

P. P. EWALD

Mr. Lincoln Ellsworth

LINCOLN ELLSWORTH, whose death took place at the end of May, was one of the pioneers of polar flying, both in the Arctic and the Antarctic. He was born in Chicago in 1880 and was employed for several years on survey work on Canadian railways, and also as an assistant engineer on goldfields in Alaska. During the First World War he was in the U.S. Army Air Corps.

Ellsworth first became known to a wider public in 1925, when his father decided to finance a flight which Roald Amundsen was planning to make to the north pole in Dornier-Wal flying boats. When near the pole it was found necessary to land on a lead of open water in the polar pack. The take-off, however, proved extremely difficult. One of the flying boats was abandoned, and it was three weeks before the other was again airborne and able to return to Spitsbergen from a farthest north latitude of 78° 44′.

Next year Ellsworth again collaborated with Amundsen, who was negotiating for the purchase of an Italian airship, renamed the *Norge*. Nobile was the technical expert, Amundsen provided the polar knowledge, and much of the financing again came from Ellsworth. The expedition was entirely successful. It took off from Kings Bay, Spitsbergen, on June 11, 1926, and after crossing the north pole landed at Teller in Alaska three days later.

Ellsworth's next effort was to assist Sir Hubert Wilkins in plans for a voyage in 1931 from Spitsbergen northwards under the pack-ice in the submarine *Nautilus*. He did not himself take part in the expedition, but was one of the party that same summer on the airship *Graf Zeppelin* on her Arctic voyage from Friedrichshafen over Franz Josef Land and Severnaya Zemlya (Nicholas II Land).

This first contact with Wilkins was the beginning of a long and intimate association, and Ellsworth now turned his attention to the Antarctic, with Wilkins as his adjutant. His first attempts, however, in 1933–34 at the Bay of Whales in the Ross Sea, and in 1934–35 from Snow Hill on the east coast of Graham Land, were unsuccessful; but next year, with Hollick-Kenyon as pilot in a Northrup machine, the *Polar Star*, a flight was made from Dundee Island on the north-east coast of Graham Land across Antarctica to the Ross Sea. No less than three landings were made, and the flight, which had begun on November 23, 1935, ended on December 4, when the machine landed on the Ross Barrier some miles inland from the Bay of Whales. Ellsworth's radio had failed at an early stage in the flight, and in view of the uncertainty arising the British, Australian and New Zealand Governments in collaboration decided to divert *Discovery II* from her usual oceanographical work. She arrived at the Bay of Whales on January 15 and rescued Ellsworth and his companion, who had been living in an ice cave for six weeks. This flight was the most successful yet made in the Antarctic, and the three landings to wait until the weather improved were a completely new departure in polar flying, representing a striking advance from Ellsworth's flying boat experience in 1925.

After his trans-continental flight, Ellsworth made one more expedition to the south, in 1938–39, when a flight was made over Princess Elizabeth Land at 12,000 ft. along the 79th meridian to 72° S. On his return, Ellsworth sold his ship *Wyatt Earp* to the Australian Government, having by now seen polar flying develop from the first uncertain stages to his own successful flight across the Antarctic continent.

J. M. WORDIE

Miss V. E. Beneš

VLASTA EVA BENEŠOVA was born in Kutna Hora, Bohemia, on December 2, 1919. She studied at the Lycée at Kolin and was a distinguished student in the Pharmaceutical Department of the University of Prague. After holding various provincial appointments she returned to Prague and began to carry out research work on "La sedimentation des Algues", under Prof. Silvestr Prat. In 1947, with the aid of a bursary, she proceeded to Paris and continued her research at the Sorbonne under Prof. W. Plantefol. She published three papers in the *Comptes rendus* of the Paris Academy of Sciences in 1948 and 1949, her work on *Hæmatococcus pluvialis* being an important contribution to our knowledge of the Volvocales. Afterwards, fired with enthusiasm by a visit to the marine station at Roscoff, she began a serious study of the marine algæ, under Prof. J. Feldmann and M. Chadefoud. In 1949 she sailed for Australia, where she collected marine algæ extensively on the coasts of New South Wales and made an intensive search for members of the Ceramiales with the view of a detailed study of their life-cycles. Despite her language difficulty she taught easily, and Prof. Burges writes of the active and successful contribution that she made to the study of the algæ in the University of Sydney. Towards the close of 1950, in a serious fall in the laboratory, she fractured her pelvis; but she made a good recovery and returned again to collect on the shores of New South Wales, a locality for which she had developed a deep regard. Perhaps it was too soon for her to venture alone on reefs as difficult as those near the Woy Woy Research Station, for to the dismay of her friends, on March 10 she did not return from the collecting ground.

Prof. Feldmann writes: "Sa tragique disparition qui est venue si soudainement interrompre sa carrière, constitue une perte sensible pour l'Algologie. Mais le souvenir de Vlasta demeurera surtout vivace dans le cœur de ceux qui l'ont connu et ont pu apprecier ses qualités d'esprit et de cœur." LILY NEWTON

WE regret to announce the following deaths:

Prof. J. W. Bigger, during 1924–50 professor of bacteriology and preventive medicine in the University of Dublin, aged fifty-nine.

Harald Blegvad, secretary-general of the International Council for the Exploration of the Sea, on August 22, aged sixty-five.

Brigadier E. M. Jack, C.B., C.M.G., director-general during 1922–30 of the Ordnance Survey, on August 10, aged seventy-eight.

Dr. John R. Loofbourow, associate professor in the Massachusetts Institute of Technology, known for his work on absorption spectroscopy and the biological effects of radiation, on January 23, aged forty-seven.

NEWS and VIEWS

National Science Foundation : Dr. Harry C. Kelly

The second of the technical divisions of the National Science Foundation, 901 16th Street, N.W., Washington, D.C., has been established with the appointment of Dr. Harry C. Kelly as assistant director for the Division of Scientific Personnel and Education. The Division of Biological Sciences was the first of the four statutory divisions to be established. The Division of Scientific Personnel and Education will be responsible for the development and administration of programmes relating to the granting of scholarships and fellowships by the Foundation in the mathematical, physical, biological, engineering, and other sciences. Until recently, Dr. Kelly was head of the Scientific Section of the Office of Naval Research Branch Office in Chicago. Previously he was chief of the Scientific and Technical Division which advised General Douglas MacArthur on the development of a scientific and technical programme for Japan. Under his leadership, Japanese scientific men elected a representative body to reorganize and rehabilitate their national bodies of science. These activities led to a new Science Council, democratically elected by qualified men of science.

Nuffield Foundation Grants to the University of Cambridge

The Nuffield Foundation has made a grant of £25,000 over a period of five years for the development of calculating machines in the Mathematical Laboratory, University of Cambridge, under the direction of Mr. M. V. Wilkes. This Laboratory has already built a high-speed electronic calculating machine (the Edsac) and applied it in a number of fields of scientific research. It has become evident that there are many opportunities in Cambridge for such applications, and the present machine is already overloaded. The Foundation's grant is to be used for the construction of a new machine, which will be more reliable than the present one, slightly faster, contain more storage capacity and be able to handle a much larger quantity of work. The general design of the new machine is already clear and a certain amount of preliminary work has been undertaken. The Foundation has also made a grant of £5,000 over a period of five years for the support of "theoretical studies in biochemistry" to be carried out in the Chemical Laboratory under the direction of Sir John Lennard-Jones. Of this grant £4,400 is to be used for the salary of a senior assistant, whose duties will be to pursue research in subjects likely to be of value in biochemistry and to supervise the work of research students in the same field, and the remaining £600 for incidental expenses. The programme of work is the outcome of recent studies in Sir John Lennard-Jones's Department, the immediate purpose of which was to discover the principal factors which determine the shapes of molecules. This has led to the new views of the significance of 'lone pairs' of electrons, and of the so-called 'hydrogen bond' or the 'hydrogen bridge' of molecules of biological interest. Theory alone cannot be expected to unravel the problems of complex molecules such as proteins, but it may help in choosing between some of the models which have been proposed. These, and other similar problems, require for their solution not only experts in biochemistry, chemistry and physics, but also others with a good training in mathematics and theoretical chemistry.

The Peckham Health Centre

It is with regret that we note the closing down of the Peckham Health Centre. In a statement prepared by the directors of this pioneer health centre they indicate that an approach to the Ministry of Health disclosed that in principle Peckham was deemed to be contrary to the policy of the Ministry. It could not receive support from the Health Act because it could not be fitted into the existing administrative scheme for the following reasons : the health centre has been concerned exclusively with the study and cultivation of health and not with the treatment of diseases ; it is based exclusively on the integrated family and not on the individual ; it is based on a "locality" and has no "open" doors ; the basis is contributory and not free. The directors also state that Peckham has been based on autonomous administration and so does not conform to the lines of administration laid down by the Ministry. Moreover, Peckham arises out of an original conception which extends into a region beyond the ambit of present-day medicine and hygiene and so is not eligible to receive the enabling stamp of authority. The building has now passed into the control of the London County Council, which proposes to use it for other purposes.

Mechanism and Evaluation of Antiseptics

A conference which meets to discuss the mechanism and evaluation of antiseptics must necessarily cover a wide field, and this is evident in the eighteen papers to be found in "Mechanism and Evaluation of Antiseptics" (*Ann. New York Acad. Sci.*, 53, Art. 1, 219 ; 1950 ; 3 dollars), which prints the papers given at a conference held in 1949. It is impossible in a short space to indicate the contents of so many papers ; they discuss streptomycin and other antibiotics, the procedure of paper-disk assay, the meaning of bacteriostasis, bactericidal effect and rate of disinfection, the interaction of surface-active agents and proteins, the role of antagonisms in the evaluation of antiseptics, present trends in the methods of testing antiseptics, the mode of action of halogens, and kindred subjects. The bibliographies attached to each paper extend the usefulness of a volume which will interest everyone concerned with the control of injurious organisms.

Foremanship Training in Technical Colleges

On all sides of industry there is evidence of the increasing recognition of the vital role of the foreman in modern management. Broader study of the job, improved selection, and extensive training schemes are developments which are now prominent features in many industrial organizations. Yet there are still large areas where little has been done, and this problem has recently been considered by the British Institute of Management. A sub-committee was set up which, in its report, suggests practical ways in which technical colleges may give immediate help in the training of foremen ; its recommendations are based on comprehensive evidence of the needs of industry and modern methods of meeting them. The sub-committee indicates that it is only concerned with short-term programmes designed to appeal to the established foreman and that, though such brief courses may be a useful introduction, they are no substitute for progressive long-term training within industry and outside. No recommendations were made about the means of training potential foremen or the contribution of the technical colleges to the long-term training arrangements of the small firms, and these are matters deserving further and urgent study. Copies of the report may be obtained from the British Institute of Management, 8 Hill Street, London, W.1.

Society for the Bibliography of Natural History

INSTITUTED for the study of the bibliography of all branches of zoology, botany and geology, the most recent issue of the *Journal of the Society for the Bibliography of Natural History* contains a detailed list of the published writings of C. J. Maynard (1845–1929) by Charles Foster Batchelder (2, No. 7; Jan. 1951). Maynard spent most of his life on a small farm at Newton, Massachusetts. He had little formal education and at first worked on the family farm. Soon he took up taxidermy, and through this managed to eke out a frugal existence while making valuable contributions to knowledge of the natural history of his birthplace and two districts which he visited frequently—Florida and the Bahamas. Altogether Maynard published more than 250 books and papers, many of them bearing the imprint of a very unconventional and original man. With some of his more important works Maynard took pride in setting the type, making wood-cuts, drawing lithographs and doing all the press work himself. He also issued price lists of natural history specimens which he had for sale, and, much to the horror of many orthodox taxonomists, more than once chose such lists to describe new species.

Radio Communication and Radio Measuring Instruments Committee

A JOINT Committee, to be known as the Joint Advisory Committee on Radio Communication and Radar Measuring Instruments, has been set up from representatives of three trade associations—the Radio Communication and Electronic Engineering Association, the Radio and Electronic Component Manufacturers Federation and the Scientific Instrument Manufacturers Association. The Committee is open to all members of these associations; it is not itself, however, a trade association, but rather an advisory body for all matters relating to the development and production of radio-communication and radar-measuring instruments. In particular, it is expected that the provision of this single channel for consultation with Government departments on matters of common interest in this field of measuring instruments will prove convenient both to the industry and to the departments. The secretary of the Committee is the assistant secretary of the Radio Communication and Electronic Engineering Association, which is at 59 Russell Square, London, W.C.1.

International Congress on Analytical Chemistry, 1952

FURTHER details are now available concerning the arrangements for the International Congress on Analytical Chemistry which is to be held in Great Britain next year. The Congress will meet at Oxford during September 4–9. Papers will be issued in advance of the meeting and the contributors will give only a brief summary of their papers, most of the time being given over to discussion. Arrangements have been made to publish the whole of the proceedings in a special number, or numbers, of *The Analyst* as soon as possible after the Congress. During the Congress it is proposed to have in operation working demonstrations illustrating new techniques or special applications of older techniques in analytical chemistry. In addition to this, and quite separate from it, there will be a trade exhibition comprising apparatus and books. This exhibition will be under the management of Mr. W. Thompson, of the Imperial College of Science and Technology, London, S.W.7. The honorary secretary of the Congress is Mr. R. C. Chirnside, Research Laboratories, General Electric Co., Ltd., Wembley.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have recently been announced: S. M. Taylor (agricultural officer, Sierra Leone), director of commerce and industry, Sierra Leone; A. E. Trotman (director of agriculture, Jamaica), member for agriculture and natural resources, Tanganyika; J. J. Lawrie (assistant conservator of forests, Gold Coast), assistant conservator of forests, Somaliland Protectorate; W. D. Burrowes (agricultural economist, Jamaica), senior agricultural economist, Jamaica; L. A. Powell (agricultural officer, Jamaica), senior agricultural officer, Jamaica; D. N. Smalley (senior agricultural assistant, Nyasaland), principal agricultural assistant, Nyasaland; G. Moore, agricultural officer, Gold Coast; G. P. Leedal, geologist, Tanganyika; G. F. Burnett, scientific officer (entomologist), Colonial Insecticides Research Unit, Tanganyika; J. F. Garden, veterinary officer, Tanganyika; R. C. Nixon, veterinary officer, Tanganyika; G. Y. Benzies, assistant meteorologist, Nigeria; J. F. Fisher, meteorological officer, Nyasaland; E. H. Holland, veterinary officer, North Borneo; M. A. Prentice, entomologist, Uganda.

City and Guilds of London Institute

MR. J. W. VOELCKER has been appointed secretary of the City and Guilds of London Institute for the Advancement of Technical Education in succession to Mr. G. C. Stephenson, who has retired, but who will continue to help and advise in the work of the Institute. Mr. Stephenson has been secretary of the Institute since 1924. Mr. Voelcker studied electrical engineering during 1920–22 at the City and Guilds College, and then he went to the Massachusetts Institute of Technology. He joined the English Electric Co., Ltd., in 1925. Mr. Voelcker is the general editor of *The Central*, the journal of old students of the City and Guilds and Finsbury Technical Colleges, and president of the M.I.T. Club of Great Britain.

University of London: Appointments

THE following appointments in the University of London have been announced: Mr. W. B. Emery, to the Edwards chair of Egyptology tenable at University College, from October 1, or as soon after as possible; Dr. E. Glaister, to the University readership in mechanical engineering tenable at the Imperial College of Science and Technology, from October 1; Mr. T. W. Hutchison, and Mr. R. Turvey, to University readerships in economics tenable at the London School of Economics and Political

Science, from October 1. The title of professor of veterinary anatomy in the University has been conferred on Mr. James McCunn, in respect of the post held by him at the Royal Veterinary College.

The Night Sky in September

New moon occurs on Sept. 1d. 12h. 49m. U.T., and full moon on Sept. 15d. 12h. 38m. The following conjunctions with the moon take place: Sept. 3d. 13h., Saturn 5° N.; Sept. 17d. 02h., Jupiter 5° S.; Sept. 27d. 21h., Mars 0·02° S.; Sept. 28d. 05h., Venus 7° S. In addition to these conjunctions with the moon, Mercury is in conjunction with Venus on Sept. 12d. 13h., Mercury being 8·3° N. Mercury is too close to the sun during the early part of September to be seen; at the middle and end of the month it rises at 4h. and 5h. respectively, and may be seen for a short period before it is lost in the sunlight. Venus is in inferior conjunction on Sept. 3, but later in the month can be seen in the morning hours, rising at 4h. 05m., and 3h. 10m., on Sept. 15 and 30, respectively. The crescent form of the planet is easily seen with small optical aid and the stellar magnitude varies between $-3 \cdot 3$ and $-4 \cdot 2$ during the month. Mars, a morning star, rises about 2h. 15m. throughout September; towards the end of the month the planet is very close to α Leonis. Jupiter rises at 19h. 55m., 19h., and 17h. 55m., at the beginning, middle and end of the month, respectively, stellar magnitude $-2 \cdot 5$. Saturn is in conjunction with the sun on Sept. 29 and is too close to the sun during the month for favourable observation. Autumnal equinox occurs on Sept. 23d. 21h. Occultations of stars brighter than magnitude 6 are as follows: Sept. 13d. 19h. 23·6m., ι Aquar. (*D*); Sept. 22d. 23h. 49·2m., 136 Taur. (*D*); Sept. 23d. 0h. 16·2m., 136 Taur. (*R*). (*D*) and (*R*) refer to disappearance and reappearance, respectively, and the times refer to observations made at Greenwich. On Sept. 1 an annular eclipse of the sun takes place and is visible as a partial eclipse at Greenwich, where it begins at 11h. 20m. and ends at 12h. 53m. The magnitude of the eclipse at Greenwich is 0·16, and the greatest phase is attained at 12h. 07m.

Announcements

Lieut.-General Sir Frederick Morgan has been appointed Controller of Atomic Energy in succession to Lord Portal of Hungerford.

Mr. Vernon Harbord, a consulting metallurgist and a partner of the firm of Messrs. Riley, Harbord and Law, has been elected president of the Institution of Mining and Metallurgy for the session 1952–53. Mr. Harbord is a past student of the Royal School of Mines. During the Second World War he was a metallurgical adviser to the Armament Research Department. He has served on the council of the Institution since 1940, being vice-president during 1947–50.

The seventh Dalton Lecture will be delivered by Lord McGowan in the Manchester Town Hall on September 27, at 7 p.m. Lord McGowan will speak on "A Hundred Years of Chemistry" The lecture is open to the public, but admission is by ticket, obtainable free from the Honorary Secretary, Arthur Carroll, 9 Central Avenue, Sale, Manchester. Supporting the 1951 Dalton Lecture, there will be an exhibition illustrating the progress of chemistry on September 27 (10 a.m.–9.30 p.m.) and September 28 (10 a.m.–8.30 p.m.) in the Gas Showrooms Basement, Town Hall Extensions, Mount Street, Manchester. Admission is free.

A conference on "The Rheology of Films and Surfaces" has been arranged by the British Society of Rheology, jointly with the local branch of the Chemical Society, at the Washington Singer Laboratories, University College, Exeter, and will be held during September 27–29. Further particulars can be obtained from the honorary secretary of the British Society of Rheology, Dr. E. W. J. Mardles, Royal Aircraft Establishment, Farnborough, Hants.

The Second International Congress on Astronautics is to be held in the Caxton Hall, London, S.W.1, during September 3–8. The Congress will be in two parts, the first (September 3–5) being for delegates only, when the business discussed will include the inauguration of an International Astronautical Federation. The second part (September 6–7) will be open to the public, and will consist of the presentation of technical papers.. Further particulars can be obtained from the Secretary of the British Inter-planetary Society, 157 Friary Road, London, S.E.15.

The ninth annual meeting of the Electron Microscope Society of America will be held in the Franklin Institute, Philadelphia, Pennsylvania, during November 8–10. Besides contributed papers, and an exhibit of electron micrographs and commercial exhibits, there will be a symposium on "Elementary Electron Optics and Factors effecting the Electron Microscopical Image". Programmes and abstracts will be available from T. G. Rochow, American Cyanamid Company, Stamford, Connecticut; information regarding local arrangements can be obtained from D. D. Pendleton, Radio Corporation of America, Camden 2, New Jersey.

A joint meeting lasting about a week of Commissions 2 (Soil Chemistry) and 4 (Soil Fertility and Plant Nutrition) of the International Society of Soil Science will be held in Ireland in 1952, probably during July. The main purpose of this meeting will be to examine and discuss the application of soil science to the solution of farming problems through the medium of soil analysis, field experiments and other branches of soil research. All papers will be printed in advance, and those desiring to submit papers are requested to consider preparing them in the near future. All communications should be addressed to the secretary of the Department of Agriculture, Dublin, and marked 'International Society of Soil Science Meeting'.

The eleventh series of postgraduate lectures organized by the Oil and Colour Chemists' Association will be given by Dr. H. W. Thompson, of the University of Oxford, in the Lecture Theatre of the Royal Institution, 21 Albemarle Street, London, W.1, at 6.30 p.m., on October 11, 18 and 25. Dr. Thompson will speak on "Molecular Dynamics and Chemicals Problems". The lectures are open to all on payment of a fee of 10*s.*; application should be made to the general secretary of the Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, London, E.C.4.

CURRENT TRENDS IN OCCUPATIONAL PSYCHOLOGY

A DISCUSSION on "Current Trends in Occupational Psychology" occupied the morning session on August 10 of Section J (Psychology) of the British Association. The first contributor was Dr. C. B. Frisby, director of the National Institute of Industrial Psychology. Dr. Frisby began by tracing the development of industrial psychology in Britain during the past thirty years. For most of this period, emphasis had been laid on the investigation of capacities rather than inclinations, and on the use of laboratory methods of inquiry. The Hawthorne studies, and fuller employment, had then caused attention to become focused on conditions affecting motivation at work. In consequence, the industrial psychologist had had to devote more of his time to field investigations; and these had produced new methodological problems.

Dr. Frisby illustrated his contentions by references to three post-war inquiries carried out by the National Institute of Industrial Psychology. One was into joint consultation. It was a study of current practice, and an attempt to identify factors apparently associated with successful joint consultation. The second was designed chiefly to survey current practice in regard to the status, selection and training of supervisors in industry; but was aimed in addition at the improvement of existing selection and training procedures. The object of the third investigation was to discover principles governing the determination of optimum units of work in repetitive tasks that had been greatly subdivided. "It is clear that at some point in the breaking-down process, for a variety of reasons, the operative will become less effective than he was with the larger task. The problem was how to give some guidance to the production engineer in identifying this point."

All three investigations demonstrated the need for sound means of assessing attitudes to work and satisfactions derived from working conditions; and a basic methodological problem was that of finding ways of doing this which would be adequate and acceptable but not time-consuming. Dr. Frisby said that attitude scales have possibilities that should be more thoroughly explored in Britain; but that the interview is usually to be preferred, and interviewing skill is of great importance to the industrial psychologist. Other problems thrown up by the three researches centred on consideration of criteria of occupational success, the most difficult—and perhaps the most important—of all the tasks facing the occupational psychologist.

Dr. N. A. B. Wilson, senior psychologist to the Admiralty, read a paper—part of which was heard by H.R.H. the Duke of Edinburgh—on "Applications of Psychology in the Defence Departments". Psychologists, he said, can scarcely be expected to abolish war. So far, with the possible exception of a few psychiatrists, they have not even proved very good at what is called psychological warfare, which is the art of winning wars without actually fighting, or basic warriorship. The activities of psychologists in the Defence Departments can, in fact, be grouped under two main headings: fitting the man to the job, and fitting the job to the man. In the first group are to be found problems arising in the improvement of methods of personnel selection, methods of training and examining (for example, aircraft pilots), and documentation (for example, at recruiting centres). In the second are problems arising in the improvement of methods of work (for example, gun drills), design and layout of equipment (such as aircraft cockpits), and living and working conditions (for example, operating conditions in extremes of climate). In the Admiralty, the Naval Motion Study Unit, which is the joint responsibility of the Director of Operational Research and the Senior Psychologist, has made proposals that would reduce by two the size of a gun-crew. The psychologist's contributions in this field were of two kinds. He advised on the design of experiments and on the criteria needed in the evaluation of proposed changes; and he advised on the needs and capacities of operators of equipment. His aim was to help to ensure that all drills and equipment prepared for Service use show the maximum possible adaptation to the needs and capacities of all probable users in all probable operational circumstances.

Dr. Wilson commented on five topics that seem likely to provide much work for military psychologists. First, man-power planning in terms of quality is now becoming possible. Given the composition of a naval entry in terms of classification test scores, and given a fairly stable connexion between those scores and advancement, useful estimates can be made of the petty officer material—judged by present standards—likely to be available in a few years time. Secondly, more consideration is being given to the utilization of marginal groups, including the very able or unusually qualified; the dull; the physically substandard; 'high-grade funnies'; and the unstable. Thirdly, within the Services there are many organizational arrangements that would repay investigation in the light of what we now know about human abilities and interests. Fourthly, the educative function of Service psychologists should be developed. For example, they could profitably make better known the advantages of 'over-learning' skills and providing trainees with knowledge of their own progress in training; and of the proper co-ordination of control adjustments with related display changes in equipment design. There is also a need for the further *ad hoc* training of personnel selection officers to give day-to-day advice on matters, falling within their sphere, which the Service psychologists have no opportunity of considering, and for the provision of information, for the ordinary man in the tank or ship or aircraft, on the uses of applied psychology in warfare. Fifthly, it is becoming evident that there is a place for the discreet use of attitude and opinion surveys in the personnel work of the Services. Dr. Wilson concluded his paper, which was very well received, by directing attention to the need of the Services for psychologists who are competent theoretical men and methodologists.

A paper prepared by Dr. E. Anstey, head of the Civil Service Commission Research Unit, on "Applications of Psychology in the Civil Departments", was read by Mr. D. McMahon. It was concerned chiefly with the work of psychologists employed by the Civil Service Commission, either on the Civil Service Selection Board or in the Research Unit; but towards its close, passing reference was made to the place of psychologists on the Prison Commission and elsewhere.

Psychologists have made three distinctive contributions to the Civil Service Selection Board: first, in the planning of the work of the Board; secondly, in bringing to its activities a certain quality of expert knowledge in the scientific study of personality; and thirdly, in insisting from the outset on the need for a well-designed follow-up scheme, from which an objective judgment of the value of the board's procedures could be obtained. The last of these contributions, Dr. Anstey believes, is the most important; and the outcome will be a series of reports, the first of which has already appeared.

The main activities of the Research Unit have been job analysis, test construction and follow-up. The follow-up has included an inquiry into the progress of a hundred entrants to the Administrative Class who, being already employed in the Civil Service, did not go through the Civil Service Selection Board procedure. They had been given instead a more conventional written examination and board interview, though the board interview had been preceded by a private interview. The whole selection procedure had proved satisfactorily valid, when judged two years later by an overall grading of present performance; and the written examination alone had been found to have made a very useful contribution.

Dr. Anstey thinks that the time is ripe for psychologists in the Civil Service Commission to devote more time to discovering how to get the best out of people who have been selected. The incentives problem is of even greater importance in the Civil Service than in private industry. He wants to see more research done on the size and internal organization of the 'working group'; and on what he calls 'internal incentives', which would help individuals to make regular self-assessments of the quality and quantity of their work. He urged psychologists in the Civil departments to be clear in their own minds about the worthwhileness of their research projects before embarking on them; to make their reports intelligible to non-technical readers; and to aim at striking a satisfactory balance between a high professional standard and practical effectiveness.

Mr. Alec Rodger, reader in psychology at Birkbeck College, University of London, and consulting psychologist to the Admiralty and to the Central Youth Employment Executive, contributed a paper on "Vocational Guidance in Britain", in which he reviewed the past and present work of psychologists in this field and outlined several urgent problems. Conditions for research and development are now more favourable than they have ever been before, partly because the increasing need for the proper use of human resources in industry has directed attention to the advantages of sound guidance. This is shown in the new orientation of the Youth Employment Service and in the work of the Ministry of Labour's Industrial Rehabilitation Units: in both, psychologists have a small but important place.

The most pressing need of all, Mr. Rodger said, is for the clarification of our concepts of occupational success and failure, for without this we shall continue to lack satisfactory criteria whereby to judge the worth of much of our other scientific and technological work. A second need is for better ways of studying the 'requirements' of occupations. Here we have been too long content with the listing of ill-defined qualities that have been considered, on the basis of 'hunch', to be important. Empirical investigation is wanted, and it may well be founded provisionally on the notion that the best way to arrive at satisfactory conclusions about the requirements of an occupation is to study people who are acknowledged failures in it, and to compare them with people who are acknowledged successes. Thirdly, there is a need for a better functional classification of occupations. The conventional grouping of them, as concerned with ideas or things or people, is inadequate.

These papers seem to indicate clearly that occupational psychologists in Britain are in considerably better intellectual health than they were in the years immediately before the War. In research and development alike, they are making substantial strides in industry and in the Service and Civil departments. The work of the Service departments is perhaps particularly impressive in its range and quality. The papers read at this discussion are to be published in book form by Messrs Methuen and Co., Ltd.

TREND OF INORGANIC AND PHYSICAL CHEMISTRY SINCE 1850*

THE development of inorganic and physical chemistry during the past hundred years falls into two periods. Until the end of the nineteenth century these two branches of chemistry experienced a steady evolution, while their theoretical foundations, laid at the beginning of modern chemistry, remained unaltered; but about 1900 a revolution set in which changed these very foundations. The difference is as great as the contrast between the quiet security and constant progress of the Victorian age and the upheaval caused in this century by the two World Wars.

One of the greatest achievements during the first period was the discovery of the Periodic Law; it was based on Lavoisier's conception of the chemical element and on the atomic theory founded by Higgins and Dalton. No explanation for the Periodic Law could be given, and fantastic representations without scientific meaning were common; some unfortunate examples of this attitude can still be seen in the science exhibitions of London's Festival of Britain. A real understanding of the Periodic System only became possible after insight into the structure of matter had been gained, mainly as a consequence of the study of radioactive elements and their radiations. Radium was discovered by Pierre and Marie Curie in 1898, the theory of radioactive disintegrations developed by Rutherford and Soddy in 1902. From this work and from the discovery of isotopy in 1913 by Soddy, J. J. Thomson and Aston, three very important facts emerged which were in contradiction with the doctrines of classical chemistry: (1) elements are not immutable; (2) atoms are complicated structures containing a tremendous store of energy; (3) atomic weights are not fundamental constants. The recognition of these facts, and great strides made during the same period in experimental and theoretical physics, made it possible for Rutherford and Bohr to crown the old atomic theory by a theory of the atom. According to this theory the chemical character of

* Substance of a paper by Prof. F. A. Paneth, F.R.S., read on August 9 before Section B of the British Association meeting at Edinburgh.

an atom is determined primarily by the electric charge of the nucleus, not by its weight; atoms of different weight may belong to the same chemical element (isotopes), and atoms of the same weight to different elements (isobars). In this respect modern chemistry is nearer to Higgins's views than to the narrower ones of Dalton.

The advances made in the understanding of the nature of chemical atoms and of their mutual relationship were not only of theoretical interest. The study of the naturally occurring radioactive substances was followed by the artificial disruption of stable atoms, by the production of radioactive isotopes of inactive elements, and—most spectacular of all—by the creation of no less than nine chemical elements which are not to be found on our earth and of which one, plutonium, is the most important source of atomic energy.

The theory of the atom was also able to shed light on the question of chemical forces; in classical chemistry they were considered as something quite different from the forces dealt with in physics, and scarcely capable of further explanation. As atoms are now known to be structures built up of electrically charged particles, the combination of atoms to molecules is to be understood as the consequence of electric forces. All valency bonds are essentially electrostatic in nature, although the mechanism of interaction is different in the two cases of electrovalency and covalency. The exact mathematical treatment is difficult except in the simplest cases, but the possibility of explaining, in principle, all the so-called chemical forces by the laws known to physics can no longer be doubted.

The theory of chemistry is now a part of physics; but it must not be forgotten that many of the greatest advances in physics have been made on the basis of chemical discoveries. It is safe to predict that for a long time to come the deductive methods of theoretical physics will be supplemented by the inductive approach of the chemist.

IMPROVEMENTS IN CATHODE-RAY TUBE STORAGE: APPLICATION TO A PARALLEL TYPE OF DIGITAL COMPUTER

By G. H. PERRY

Telecommunications Research Establishment, Great Malvern

In recent publications[1-4], Prof. F. C. Williams and Dr. T. Kilburn describe a storage system for use with binary digital computers, using electrostatic charges on the fluorescent screen of a cathode-ray tube. In these papers, three possible forms of charge distribution are described, each having two states to represent the binary digits nought and one. These have been named: (*a*) dot–dash; (*b*) defocus–focus; (*c*) anticipation. The first of these has been described in detail and has been put into operation in the serial computer in the University of Manchester. In a parallel-operated computer all the digits of a number are used simultaneously, and hence its storage requirements are different from those in a serial machine.

Suppose we have a serial machine using n cathode-ray tubes; a number, of n digits, is stored at n points of a single line on a tube which is scanned serially. Adjacent lines store different numbers. If there are also n lines, and one number is required continuously in a computation, then its line will be regenerated n times compared with its neighbour, and this ratio will determine interaction and consequent spacing.

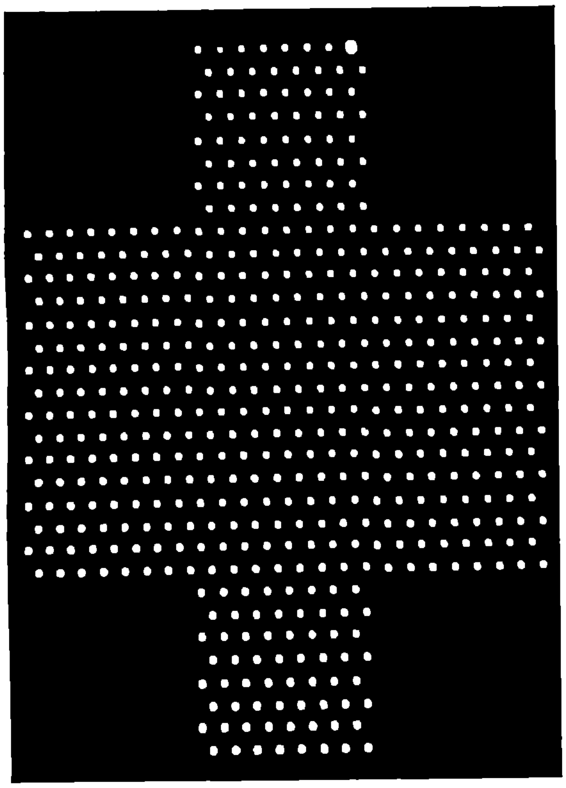
In a parallel machine of the same total capacity of n^2 digits in n cathode-ray tubes, a single number will be stored at n corresponding points on the n tubes. Again, if this number is required continuously, then each of its points will be regenerated n^2 times compared with its neighbour. It will be seen how much more serious is the interaction problem than in a serial machine.

When applying cathode-ray tube storage to the parallel computer now being built at the Telecommunications Research Establishment, Malvern, the dot–dash system was found to have several undesirable features. Although these features are all related, they may be considered under three main headings: (1) the interaction between elements of the store was such that the number of digits per cathode-ray tube had to be reduced to a point where it became impracticable for the requirements of a computer; (2) spurious signals due to imperfections of the fluorescent screen made selection of cathode-ray tubes necessary; with a high rejection-rate this was a costly process, and even then final anode voltages had to be limited to the order of 1 kV. in order to minimize these spurious signals; (3) the system was found to be extremely sensitive to variations of the deflexion voltages; even microphony of the valves producing the deflexion voltages could change the stored information.

Using the existing cathode-ray tubes, interaction could be reduced in two main ways: (*a*) reducing the net beam current; (*b*) increasing the final anode voltage of the cathode-ray tube, thus obtaining a finer-focused spot, and using a different portion of the secondary emission characteristics of the fluorescent screen.

A reduction in the net beam-current by about 20 per cent was first obtained by using what may be called a 'double dot' system, where the charge was re-established by a second dot placed a critical distance from the first. The refilling action of this system is slightly more efficient than the dot–dash method. Regarding final anode voltage, experiments showed that an increase reduced the interaction at the expense of signal strength; for example, an increase from 1 to 1·5 kV. enabled the separation between digits to be reduced from 1·8 mm. to 0·8 mm. for the same degree of interaction. This represents a fourfold increase in digits per unit area.

For about two years attempts have been made to manufacture cathode-ray tubes with screens which are free from storage imperfection; but so far as is known at the moment, no consistent results have been obtained. The majority of the imperfections were small compared with the cathode-ray tube spot, the diameter of which was 0·5 mm. In an effort to overcome their effect, the cathode-ray tube beam was modulated at 5 Mc./sec. at right angles to the line of the double dot. For six cathode-ray tubes tested, it was found that an amplitude of only 0·5 mm. was sufficient to make them work with a final anode voltage of 1·5 kV. All these tubes previously had only been satisfactory at 1 kV. A single cathode-ray tube store was now constructed



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with 256 digits using the above techniques. This was used in conjunction with an experimental portion of the computer.

On further consideration, however, the defocus–focus system appeared to have many advantages over the modulation system. These are: (1) the refilling process by means of the focused central dot is much more efficient than that using a displaced dot, being effected by electrons emitted in all directions, instead of by those emitted only in a particular sector; as a result, the net beam current may be reduced with a consequent reduction of interaction; (2) since the defocused inspection spot and the focused refilling spot are concentric, the chances that the charge barrier due to an impurity of the screen would prevent the re-establishment of the charge are very slight; (3) the charge of the digit is detected by a defocused spot, and the system is therefore less sensitive to errors of the deflexion voltage than when using a focused beam; (4) there should be an improvement in signal strength due to the increased quantity of charge in the defocused spot.

Experiments have confirmed these advantages. The duration of re-filling pulses can be reduced to 0·8 μsec. compared with about 2 μsec. with the double-dot system, and the total time for reading or writing a digit can be reduced to 2 μsec.

Many cathode-ray tubes have been tested to determine the effects of impurities on the screen, and all have proved completely satisfactory. One in particular, which had at least six large impurities and had been rejected for use in a dot–dash store at 1 kV., was found to be perfectly satisfactory in a defocus–focus system at 2 kV. No variation in signal strengths could be detected larger than those normally obtained due to the variation of screen surface.

Trouble previously experienced due to the microphony of the deflexion valves completely disappeared; consequently, reliability has increased and the stability requirements of the deflexion voltages have decreased.

The increased signal strength due to the increased charge per digit of the defocus–focus system tends to compensate for the reduction of signal due to the increase of final anode voltage, and satisfactory signal/noise ratios are still obtained with 2 kV. final anode voltage. An experimental cathode-ray tube store of 512 digits using the defocus-focus system has been functioning for about six months. Each storage element may have had at least 256 regenerations adjacent to it before being itself regenerated. This is the maximum requirement, provided instructions and numbers are used alternately and are stored in different areas of the cathode-ray tube. The digits are arranged with 2·5-mm. separation in a pattern as in the accompanying illustration.

The electrical and mechanical design of the store has been completed, and a prototype to this design tested. The twenty stores required for the computer are now in process of construction.

Experiments have also been carried out to determine whether this system is suitable for serial storage. It has been found that a square pattern of 1,024 digits can be stored, and that any digit may have its neighbours brightened-up at least 64 times before being itself regenerated.

The cathode-ray tubes used in the above work were of type *VCRX* 266. This is a convenient type of 6-in. tube with low beam current and small spot diameter. All those tested were found suitable for defocus–focus storage without the need of selection.

I wish to thank members of the Research Laboratory of the General Electric Co., Ltd., for their co-operation in the development of experimental cathode-ray tubes, and the Chief Scientist of the Ministry of Supply for permission to publish this communication. [April 18.

[1] Williams, F. C., and Kilburn, T., *Nature*, **162**, 487 (1948).

[2] Williams, F. C., *Proc. Roy. Soc.*, A, **195**, 265 (1948).

[3] Williams, F. C., and Kilburn, T., *Proc. Inst. Elec. Eng.*, 96, Part III, No. 40, 81 (1949).

[4] Kilburn, T., *Nature*, **164**, 684 (1949).

ABILITY OF BIRDS TO COUNT

THE masters of 'clever' horses and dogs are often sincere in their belief that their pets really display intelligence of the highest order; for they are quite unable to imagine that the animals can really perceive small involuntary signs and signals which tell them when the right answer has been reached and hence when they must stop barking or stamping, as the case may be. Yet it is now quite certain that that is precisely what these 'clever' animals are doing. It was not the stallion "Zarif" of Elberfeld which reproduced Descartes's "*cogito ergo sum*" in ill-spelt German, nor was it the dachshund "Kuno" which answered the professor's question as to what creed he had with the words "Mine is yours". These 'clever' animals only obey their master's signs which, given at the proper moment, stop the barking or stamping by which they spell out their answers in code.

In a recent article (*Bull. Animal Behaviour*, No. 9; March 1951) Prof. O. Koehler states that the achievements of certain birds with which he has experimented are examples of true learning and in no way dependent on clues, voluntary or involuntary, given by the experimenters.

During training and 'spontaneous' experiments the observer and the bird were always separated by a partition so that the experimenter was never seen by the bird; while at work he was able to watch it through the view-finder of a cine-camera fitted into the wall. Moreover, when a deterrent was required in conditioning, only one degree of punishment was used and this was always the same. It was thus impossible for the experimenter inadvertently to give signs by means of the punishing apparatus since the latter functioned along all-or-none lines.

Unlike circus animals, Prof. Koehler's birds were sometimes left entirely to themselves and the results recorded automatically so that all possibility of clues from the investigator was ruled out. The birds learned many tasks without any punishment and merely by self-conditioning. Often spontaneous experiments were made by the birds in the complete absence of any human being. The birds were often left alone with their task while the experimenter was kept far away so that even possible telepathic connexion between man and animal could be excluded. Nearly all the problems solved by the birds in spontaneous experiments were recorded automatically by film for later study.

Not even the cleverest of the birds showed inborn capacities like human beings; but they did learn unnamed numbers which were presented to them by two principal methods: (1) simultaneous presentation, and (2) successive presentation. The first of these abilities is that of being able to compare groups of units presented simultaneously side by side by seeing numbers of those units only, excluding all other clues. This problem was presented to birds in quite different ways, starting with only two groups of edible units (grains of corn, fruit, pieces of meat, etc.), the two groups differing by one unit only, and at the other extreme rising to choice according to pattern. A raven and a grey parrot were presented with five small boxes covered with lids bearing two, three, four, five and six spots each respectively—the key being a lid with one of these numbers of spots lying on the ground in front of the boxes. Both birds learned to open only that one of the five lids which had the same number of spots as the key pattern. As a control, everything was changed in a random manner from one experiment to the next. There were fifteen positions of the five boxes and very many different positions of the key pattern; the number of units in the key pattern changed with each experiment and there were five places for the "positive" number of spots on a lid corresponding to that of the key. Moreover there were twenty-four permutations of the four negative numbers. The relative situation of the spots of one group and, with the raven only, the size and form of those spots were also changed with absolute irregularity. In the final series of experiments, for each trial a flat 'Plasticine' cake was broken into pieces of highly irregular and broken outlines, the size of a piece varying from 1 to 50 units of surface area; care was taken to make the general patterns of the positive number on the lid as unlike as possible to that of the key pattern. In an experiment such as this it is believed that any clue foreign to the problem was excluded, and yet the raven solved the problem by choosing the positive lid according to the only item which was not changing through all the experiments, that is, the number of spots equal to that of the particular key pattern presented.

The second problem was to estimate, that is, to remember numbers of incidents following each other and thus to keep in mind numbers presented successively in time, independent of rhythm or any other clue which might be helpful. Here again many different methods were employed. At first birds were trained to eat only "x" grains out of many offered without any help being given from a figure. Another task was to eat only "x" peas which were rolled into a cup, one after another, at intervals ranging from 1–60 seconds. Here again there were no figures at all; the peas were delivered as if by a slot machine, one by one, the bird never seeing more than one pea in the cup. The same applied to opening lids of boxes standing in a long row until "x" baits had been secured; since the baits were arranged in the boxes in twenty or more distributions from one experiment to the next, the number of lids to be opened was constantly changing. Still more remarkable was the fact that birds learned to master up to four problems of this kind at the same time. For example, a jackdaw learned to open black lids until it had secured two baits, green lids up to three, red lids up to four, and white lids until it had secured five baits. Similarly, budgerigars learned to "act upon two" when the experimenter said "dyo dyo dyo" and upon three (take only three grains from the heap) when he uttered the words "treis treis treis . . .". A similar result could be obtained with a bell indicating two and a buzzer indicating three.

Since it would appear that, in this experiment, all external clues were carefully excluded, only an inner token could have been responsible for the birds ceasing action when the number was reached. The bird would appear to have made some inward marking of the units he was acting upon, and sometimes those supposed "inward marks" showed themselves in external behaviour in the form of intention movements.

The simplest explanation offered by Prof. Koehler for this inner marking is that it may be made up of equal marks, as if human beings were to give one nod of the head for one, two for two, and so on; it is suggested that this be called "thinking unnamed numbers". On the contrary, the most prodigal assumption which could be made is that the bird did the marking by unequal or qualitatively different marks in fixed order, as if human beings think 1, 2, 3, 4, 5, or, alternatively, a phrase of five different syllables. That, of course, would be named numbers, or real counting.

Apart from one case, Prof. Koehler's simplest assumption would appear to fit the facts best, there being no sign of "number intelligence" at all and no obviously progressive learning ability as in the case of children. Pigeons and budgerigars were considerably upset by changes in experimental conditions during training for a problem, whereas jackdaws grasped the transposition at once. One bird, after having learnt to open a lid with three spots and not touch a lid with four spots, was presented with three and four mealworms moving on the lids instead of spots. The bird hesitated a long time, but finally went to the three mealworms and left the four alone; instead of opening the lid it ate the mealworms from it without opening it at all.

It would thus appear that a given species of bird shows the same ability of grasping unnamed numbers whether they are presented simultaneously or successively; but the ability differs with the species. Thus, with pigeons it may be five or six according to experimental conditions, with jackdaws it may be six and with ravens and parrots, seven.

Similar tests of the same ability have been carried out with man. In this case the groups of figures were presented tachistoscopically by lantern slides, shown simultaneously and carefully timed so that, while they may be fully seen, the time is too short for counting to take place. It is remarkable that, when this is done with human beings, the limit of achievement is of the same order as that shown by birds. Thus, few persons reach eight and many, like pigeons, get no farther than five. Experiments are still being carried out to test the second ability; but there is no expectation that man may achieve better results than the birds, provided named counting is excluded.

LONG ASHTON RESEARCH STATION FIELD DAY

THE exhibits at the Long Ashton Research Station Field Day on July 10 included several of particular scientific interest. In the Pomology Section, Dr. L. C. Luckwill demonstrated methods used in the biological assay of growth substances and inhibitors, and showed the application of paper chromatography to the separation and identification of growth substances. The test objects used were sections of wheat coleoptiles, unpollinated tomato ovaries, and excised nodes of *Coleus*. The application of these techniques to the study of problems of fruit set and fruit drop in apples was also illustrated. Another exhibit dealt with the use of α-naphthalene acetic acid as a fruit-thinning agent. This substance applied to apple trees within three weeks of petal-fall has been shown to inhibit seed development, thereby leading to an increased drop of developing fruitlets. The method is likely to prove of value for improving fruit size in heavy-cropping varieties and in controlling biennial bearing.

Dr. D. J. D. Nicholas, of the Plant Nutrition Section, had exhibits elucidating the technique of employing *Aspergillus niger* (Mulder's strain) for the determination of metal micronutrients in soils and plant-tissue homogenates. The assay is specific and quantitative for each micronutrient and gives results which are often below the limits of chemical detection. The trace metal requirements of other species of *Aspergillus* and *Penicillium glaucum* were shown to be similar to those of *A. niger*.

Other aspects of the biochemistry of *A. niger* illustrated were sugar utilization, vitamin B_1 and B_{12} production, respiration-rates, amino-acid metabolism and dehydrogenase activity of spores, under various metal deficiencies.

Dr. Nicholas also demonstrated the incidence of iron deficiency in pot-soil culture plants of tomato given nickel, cobalt and zinc, singly and in combination, and in oat given copper only. The metals, including iron, are extracted from fresh leaf tissue with glass-distilled water in micro-mills made of 'Pyrex' glass. Cation exchange resins, for example, 'Zeokarb 215' or 'Amberlites I.R. 100' and '125', are used for concentrating the trace metals and for separating them from the anions. The metal contents of tissue homogenates before and after passage through ion exchange resins are determined as well as the total amounts in dry matter. The appearance of iron chlorosis is paralleled by a decrease in chlorophylls *A* and *B* as determined by a quartz spectrophotometer.

Another exhibit showed the degree of correlation between final yield of crop plants, grown in factorial experiments, and the mineral status determined for various plant portions, at intervals during the season. In this work, a fractionation of the total mineral nutrients is made by maceration techniques and deep-freeze methods. Correlation coefficients between the results of these methods and those of ash analysis were shown.

In the sand culture investigations under the direction of Dr. E. J. Hewitt, the main work demonstrated comprised a factorial study on cauliflower of the relationships of molybdenum supply to source of nitrogen. In this trial it was shown that leaf symptoms of molybdenum deficiency developed strongly with nitrate or ammonium nitrate but were less marked with nitrite or urea. Ammonium sulphate was toxic alone but not in the presence of added molybdenum-free calcium carbonate. Except for a slight ammonium toxicity, growth was good for all sources of nitrogen in the presence of a normal molybdenum supply.

Molybdenum toxicity (500 p.p.m.) was severe with urea or ammonium sulphate or citrate, but was barely evident with nitrite, nitrate or ammonium nitrate.

Ascorbic acid content of the plants was much reduced by molybdenum deficiency, independent of the type of nitrogen supply. These results suggest a role of molybdenum closely related to nitrogen metabolism but not entirely dependent on the source of nitrogen.

A feature of the work at Long Ashton is the extent of collaboration between the various sections. The Insecticides and Fungicides Section, for example, carries out conjoint work with the Sections of Organic Chemistry, Physical Chemistry, Entomology, Mycology and Pomology. Modifications of the structure of DDT were demonstrated in work by Dr. D. Woodcock, Mr. E. J. Skerrett and Miss P. M. James on the relationship between chemical constitution and insecticidal action. Dr. J. T. Martin's exhibit dealt with the extent and permanence of deposits of DDT and rotenone on apple shoots and on soft fruit. He showed also the progress of investigations on the active principles and methods of assay of derris root.

Dr. W. D. E. Thomas and Mr. S. H. Bennett illustrated the application of a radioactive tracer in following the absorption by apple, chrysanthemum, *Coleus* and bean plants of a systemic insecticide (*bis*dimethylaminophosphonous anhydride). The use of the radioanhydride has yielded information on the factors affecting the absorption of the insecticide by leaves, its translocation and its subsequent breakdown. Parallel biological experiments on aphids using the radio-inactive anhydride permit an evaluation of the lethal concentration within the leaves.

Other applications of the use of radioactive tracers were shown in pot culture studies on the phosphate uptake of tomatoes in cobalt-rich soil (Drs. Thomas and Nicholas) and on the effects of clean cultivation compared with grass cover on the phosphate uptake of apple root stocks (Drs. Thomas and C. Bould).

Miss A. Crang and Miss M. Sturdy, of the Domestic Preservation Section, had on view bottled fruit showing the effect of temperature of processing on the enzyme activity of pears and plums. Some varieties of both fruits have an oxidase enzyme system which is still active at temperatures which had been recommended for bottling as sufficient to prevent spoilage by micro-organisms. The result is that the uppermost fruits, in the headspace of the jar, become brown and this discoloration spreads over the rest of the fruit if left partly uncovered for any length of time after opening.

An investigation of the enzyme activity in these fruits shows that it varies considerably in the different varieties and stage of ripeness of the fruit. Higher temperatures or longer times of processing are being worked out to prevent serious discoloration without over-cooking.
R. W. Marsh

MIXING AND AGITATING

Although agitation constitutes one of the basic or unit operations of chemical engineering and finds application, in one form or another, in nearly every major industry, very little is yet known about its mechanism or about the efficiencies to be expected from well-designed industrial stirring equipment.

A conference on "Mixing and Agitating in Liquid Media", arranged by the Institution of Chemical Engineers and held at the Royal Institution on July 17, was opened by Sir Harold Hartley, president of the Institution of Chemical Engineers. Sir Harold emphasized the need for more research and practical data on the hydrodynamics of systems in turbulent motion; and he referred in particular to the factors governing the operation and efficiency of processes such as that of the catalytic hydrogenation of fats, in which the three-phase interface required for rapid reaction has to be produced by agitation.

The introductory paper to the conference was given by Prof. D. M. Newitt, G. C. Shipp and C. R. Black, and reviewed briefly recent theoretical developments relating to the conditions which must be imposed upon heterogeneous systems to give rise to, and maintain, dynamic uniformity. The extent to which existing equipment reproduces the 'ideal' flow pattern for rapid and complete mixing was discussed by B. N. Reavell, who showed how a knowledge of the flow properties and viscosities of suspensions can be made to serve as a basis for classifying the wide variety of mixing problems encountered by the chemical engineer.

The importance of the application of hydraulics and hydrodynamics to the study of mixing was referred to by several speakers. Describing the mixing action of free jets, H. Fossett advocated the use of models to enable the hydraulic criteria governing their action to be established. From a rather different point of view, Prof. F. H. Garner and A. H. P. Skelland illustrated, by a ciné-film, the conditions under which internal circulation can be produced in droplets of a dispersed liquid phase; their experiments lead to the conclusion that the surface viscosity of the fluid in the droplet is probably a major factor in determining the onset of circulation.

The more practical aspects of the subject were dealt with in two papers devoted to the special problems of the fuel and ceramic industries. R. A. A. Taylor, of the Fuel Research Station, described the processes by which coal is suspended in, or incorporated with, water, oil, tar and other liquids, while F. J. Goodson and Dr. A. E. Dodd discussed the manufacture of earthenware bodies by a method in which the ingredients—china clay, ball clay, calcined flint and Cornish stone, disintegrated and dispersed in water—have to be mixed in the correct proportions and as uniformly as possible In both papers the operational and economic factors governing the choice of equipment were stressed.

Among the visitors taking part in the discussion were Mr. Thomas Chilton, president of the American Institute of Chemical Engineers, and Prof. H. A. Kramers, of the University of Delft.

D. M. Newitt

ORIGIN AND IMPROVEMENT OF CULTIVATED PLANTS

A useful review by M. B. Crane of past and present methods used in crop improvement forms the text of the Masters Memorial Lectures of the Royal Horticultural Society for 1950 (*J. Roy. Hort. Soc.*, 75, Parts 11 and 12; November and December 1950). Most of the crops of gardens and farms in Great Britain have attained their present economic desirability either as gene-mutations, through autopolyploidy, or by selection of interspecific hybrids with or without chromosome doubling. The sweet pea, Chinese primula, tomato, raspberry and edible pea are examples of improvement by gene-mutations.

Periclinal chimæras combined with gene-mutations have given certain economically acceptable plants. The potato variety Golden Wonder is a periclinal gene-mutation of the older Langworthy, differing only in its skin. Raspberries, pears, apples, tulips, hyacinths and narcissi are examples of plant improvement by autopolyploidy; chromosome numbers of the 'wild' form have been trebled or quadrupled in the cultivated variant. The strawberry provides an example of interspecific hybridization between the species *Fragaria vesca*, *F. elatior*, *F. virginiana* and *F. chiloensis*. Plums have arisen as interspecific hybrids between *Prunis cerasifera* and *P. spinosa*; but here the hybrid has been subject to polyploidy.

Mr. Crane dealt in his second lecture with the use and extension of these methods in practice. Polyploidy can be induced by treatment with the drug colchicine, by heat shock of plant shoots at 45° C. for one or two hours, by decapitation, and by exposure to X-rays. The action and interaction of genes is now studied very intensively, though the effect is to reveal a complexity far more bewildering than the original Mendelian ratio. This knowledge is put to practical use, however, in such problems as that of raising the vitamin A content of maize. The gene affecting this is related with endosperm colour. Octaploid organization of the dahlia makes possible the fascinating variations of the flower; the expression of dominance is more variable than in diploid plants. Vegetative propagation is a method of perpetuating hybrid vigour, and this fact could be used more consciously by plant improvers. Several examples were given of breeding for resistance to fungal diseases and insect pests. This problem is, however, complicated by the occurrence of strains in the disease-producing fungi, but several examples of valuable degrees of resistance are now known. They contribute significantly to the economy and food of nations.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Measurements of Mass Ratios in Nuclear Emulsions

In an earlier communication in *Nature*[1], we have described a method of measuring photoelectrically the density of tracks in nuclear emulsions. It is analogous to the method of grain counts and can be used with electron-sensitive emulsions where the overlapping of individual grains prevents the use of the latter method. We have compared the residual ranges of particles from regions of their tracks which show the same projected area per unit length, that is, the same average track width. From these comparisons we have calculated the mass ratios. This corresponds to the method used by Lattes, Occhialini and Powell[2] in grain counting.

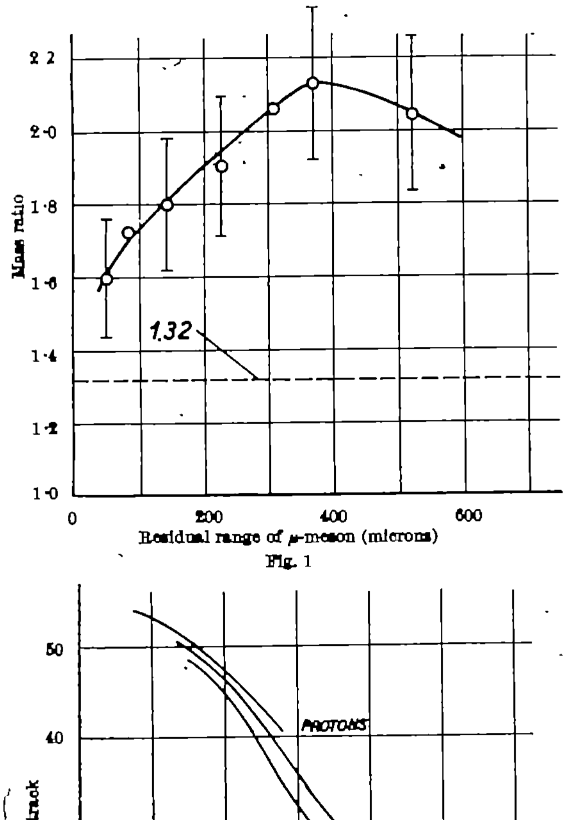

Fig. 1

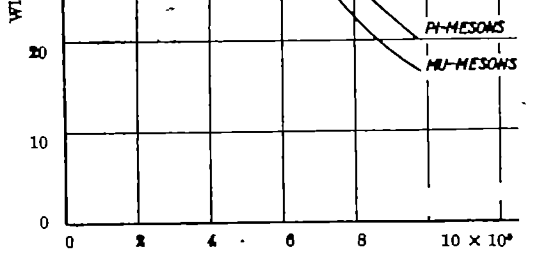

Fig. 2

Fig. 1 shows the ratio between the π- and μ-meson masses obtained in this manner. Fig. 2 shows the velocities corresponding to equal track widths, taking for the masses of protons, π-mesons and μ-mesons the values 1,840, 276 and 212 electron-masses respectively on the assumptions which have been made by Lattes, Occhialini and Powell. Our diagrams show a mass ratio which differs from the value 1·32 given by measurements in Berkeley and varies along the tracks. In this connexion it may be of interest to remember that Lattes *et al.* found the value 1·65 from measurements in nuclear emulsions. The explanation of the anomaly which we have found must be looked for either in an effect connected with the photographic process, or in some effect of the interaction of the particles with matter to which no attention has so far been paid.

A detailed account of the experiments will be given elsewhere (see also the letter by Prof. T. Gustafson which follows).

STEN VON FRIESEN
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June 15.

[1] *Nature*, 166, 686 (1950).

[2] *Nature*, 160, 453 (1947)

Density of Tracks of Protons and Mesons in Photographic Emulsions

The experiments by von Friesen and Kristiansson described in the preceding communication indicate that, at the same velocity, π-mesons give a smaller track width than protons, and μ-mesons smaller than π-mesons. The pertinent velocities, $c/5$-$c/3$, lie below those of the Čerenkov effect.

In investigations with photographic emulsions, the assumption is made that the track density, or the probability of making a certain fraction of the grains traversed developable, depends only on the ionization. According to the well-known work of Bohr, Bethe, Bloch, etc., the ionization of electrons by a particle with velocity v, charge e and mass M depends essentially on v and e. The mass M occurs only as a small, and in this connexion unimportant, correction.

We will first discuss the possibility of an explanation connected with the photographic process. According to current photographic theories, the developability of the silver bromide crystals depends on the ionization of the electrons and on certain small lattice defects in the silver bromide. Interstitial silver ions and vacant silver ion lattice sites are supposed to play the most important part in chemically non-sensitized emulsions. The number of such silver ions in a grain is, in our case, supposed to be of the order of 1,000.

It is important that very few silver atoms, perhaps of the order of 10, may be supposed to form the latent image making the grain developable. To form an interstitial silver ion, an energy transfer of about 1 eV. is needed. We have calculated the probability that one of the silver ions in a grain of diameter 0·6 μ gains at least 1 eV. by Coulomb interaction. For a velocity of $c/3$, this probability is only 0·07. For $c/5$ the corresponding figure is 0·19. Even considering the very great sensitiveness of the photographic process, these figures seem to be small. Further, they are in the first approximation independent of mass, so that the difference for protons and mesons is very small. Also other effects, such as the temperature rise in the vicinity of the track, seem to be small and essentially independent of mass. Interactions of the particle with protons in the gelatine are mass-dependent but very small, and it seems difficult to connect them with effects on the grains.

Thus it seems reasonable also to discuss the possibility of specific properties of the mesons, namely, specific interactions between μ-mesons and electrons, and between π-mesons and electrons, which then must be different. In the ionization by electromagnetic forces, distant and near collisions contribute about equally. The assumption of additional short-range interaction has to provide for a reduction of the effect of the near collisions of about 15–20 and 30–40 per cent respectively to be able to account for the experiments. If both positive and negative mesons occur in the experiments, the interaction has to change sign with meson charge. An interaction can exist only for charged mesons.

Further experimental and theoretical work is in progress.

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Mechanical Properties of α-Solid Solutions of Copper, with Zinc, Gallium, Germanium and Arsenic

THE strengthening of metals by alloying elements in solid solution is often attributed to the local distortions of the lattice due to the difference in size between the solute atoms and the solvent atoms. In 1942[1], Hume-Rothery and Frye showed that in a series of silver alloys the ultimate Meyer hardness brought about by a given percentage of solute atoms was proportional to the square of the lattice distortion for solutes in the same row of the Periodic Table. In 1950, Dorn, Pietrokowsky and Tietz[2] published the results of tensile tests on a series of aluminium alloys, and showed that the increase in strength was not attributable solely to the lattice strain; but that effects due to the difference in valency between solvent and solute must be taken into account. Thus, they suggest that the hardness of the alloys is given by the equation

$$F = \Delta a + K \Delta v,$$

where F is hardness; Δa is change in lattice constant; Δv is $\frac{\text{atomic per cent solute}}{100} \times$ (valency of solute — valency of solvent); K is constant (approximately 1). In their work the unexpected valency of 2 was assigned to aluminium.

We have examined the tensile properties of copper–zinc, copper–gallium, copper–germanium and copper–arsenic solid solutions. When these alloys are produced by identical methods in the form of soft annealed wires of approximately equal grain-size, the ultimate tensile strength and resistance to plastic deformation appear to be almost entirely governed by the electron–atom ratio of the alloys. Fig. 1 shows, for example, the true stress/strain curves of a copper–zinc alloy with 9·00 per cent by weight of zinc, a copper–gallium alloy with 4·65 per cent of gallium, a copper–germanium alloy with 3·34 per cent of germanium, and a copper–arsenic alloy with 2·48 per cent of arsenic. All these alloys have electron–atom ratios (assuming the usual valencies of the metals) of about 1·087, and their stress/strain curves are as nearly alike as those of four samples of the same wire would be. Fig. 2 shows the 0·5 per cent proof stresses of all the alloys, plotted as a function of electron concentration.

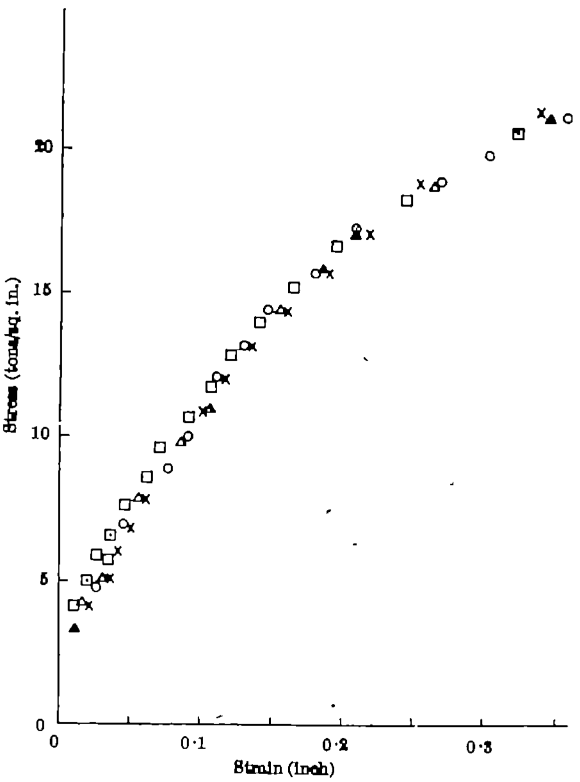

Fig. 1. True stress–strain curves for copper–zinc, copper–gallium, copper–germanium and copper–arsenic alloy wires of approximately the same electron atom ratio

○, 8·78 at. per cent Zn; □, 4·26 at. per cent Ga; ×, 2·95 at. per cent Ge; △, 2·12 at. per cent As. Electron concentration = 1·087 approximately

In this case the alloys behave as if the solute atoms were completely ionized. The increase in the concentration of free electrons in the alloys in Fig. 2 is not more than 18 per cent, and may not account directly for the increased proof stress of the alloys. It seems probable that the high positive charges associated with the solute ions are in some way the

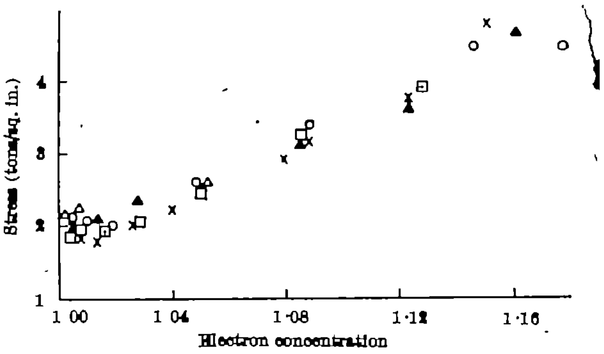

Fig. 2. 0·5 per cent proof stress. ○, copper–zinc; □, copper–gallium, ×, copper–germanium; △, copper–arsenic

cause of the increased resistance to plastic deformation of the solid solutions.

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Changes in Lattice Constants of Cr_2O_3 near the Curie Temperature

It has been pointed out[1] that there is a correlation between magnetic and structure transition temperatures for certain antiferromagnetic materials. In the case of Cr_2O_3, with a Curie temperature of approximately 314° K., it was reported that the $4\bar{2}2$ reflexion was resolved into a doublet below the Curie temperature. This communication presents additional information concerning the nature of the structure change responsible for the doublet formation mentioned above.

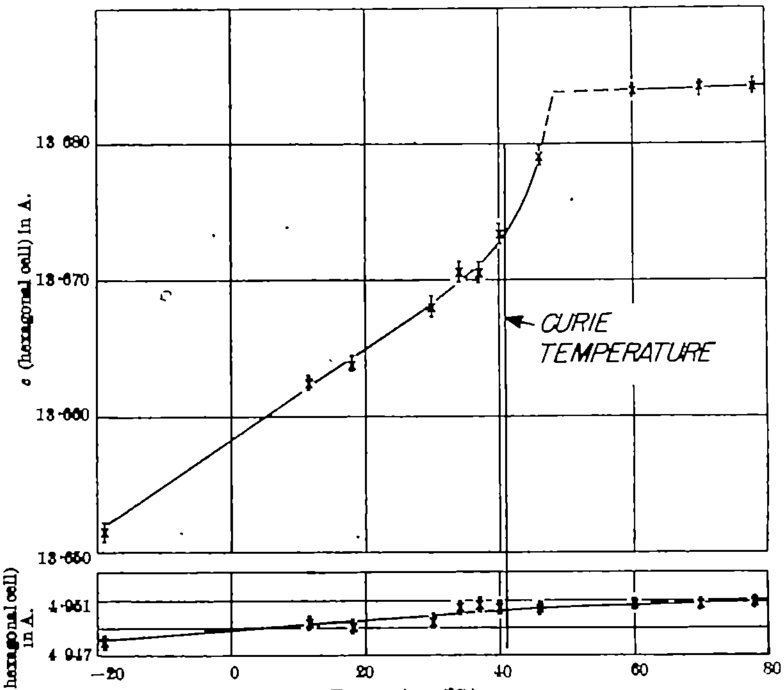
A 10-cm. diameter symmetrical back-reflexion camera was used to provide the high resolution required. An arrangement was made for varying the temperature of the sample from 250° to 360° K. to within ± 1° K. The powdered specimen was mounted on a copper block which had been machined to the proper radius of curvature. For low-temperature measurements, various liquids were circulated through holes in the copper block, which was secured to a 'Bakelite' section to ensure thermal insulation of the photographic film. For high-temperature measurements a heating element was attached to the block. Filtered molybdenum, chromium and copper radiation were used. In the case of copper radiation, a nickel foil (0·001 in.) was placed directly over the photographic film to reduce fogging due to secondary scattering.

Back-reflexion photographs with chromium or molybdenum radiation showed no pattern changes throughout the temperature-range investigated. In the case of copper radiation, the $4\bar{2}2$ and 652 reflexions, which coincide above the Curie temperature, separate into two clearly resolved reflexions as the temperature is lowered. This is the result which was reported as the splitting of the $4\bar{2}2$ reflexion. Calculations for the $\sin^2\theta$ range covered by the camera for molybdenum or chromium radiation show that there should be no superposition of reflexions if a rhombohedral angle of 54° 45′ is assumed for Cr_2O_3. For copper radiation, however, the $4\bar{2}2$ and 652 reflexions coincide. If the rhombohedral angle is appreciably changed, then the condition for superposition of the two reflexions no longer holds. The observations show that above 320° K. the rhombohedral angle is essentially constant and that in a 13°-range below this there is a sharp increase of 2′. An additional increase of 2·5′ occurs as the temperature is reduced to 255° K.

As Cr_2O_3 goes through the transition temperature, the unit cell contracts markedly in the [111] direction, whereas in the direction perpendicular to this the contraction is almost normal.

For ease of calculation the transformation to a hexagonal cell was made. The c- and a-dimensions of the hexagonal unit cell are shown in the accompanying graph as a function of temperature.

The chromium atoms in Cr_2O_3 each has one nearest neighbour at a distance of approximately 2·8 A. Néel[2] has suggested a magnetic structure for Cr_2O_3 in which the atoms in the closely spaced pairs (which lie along the [111] direction) tend to have antiparallel spin alignments. The spin directions of a given pair are also correlated with the spin directions of neighbouring pairs. In such a structure there are ferromagnetic sheets of atoms in the (111) planes with spin directions alternating from plane to plane. An explanation for the correlation between the magnetic structure and the anomalous contraction along the [111] direction has been suggested in a previous paper[3].



The c- and a-dimensions of the transformed hexagonal unit cell of Cr_2O_3 as a function of temperature

There is no indication of a discontinuity in the unit-cell volume as a function of temperature. This is in agreement with the concept that the Curie temperature transition is a second-order phase transition.

This work was supported in part by the U.S. Office of Naval Research.

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Cube-Edges of Uraninites as a Criterion of Age ?

I have suggested that there is a progressive reduction in the size of the unit cell of uraninite-thorianites with time[1]. The ionic radius of Pb^{4+} is appreciably smaller than those of U^{4+} and Th^{4+}. The decay of the parent element causes its substitution by radiogenic lead within the crystal lattice ; because of the differences in sizes of the ions, a shrinkage results. It is therefore likely that this factor can be utilized for indicating the relative ages of uraninites after these have been subjected to an X-ray powder examination. No great accuracy can be envisaged, but such a method would be more accessible to geologists than the highly refined mass-spectrographic one, which can be practised in very few laboratories in the world.

There is a dearth of reliable X-ray data. The recently published values by Arnott[2] are not acceptable, as the systematic errors, inherent particularly in the X-ray determinations of uraninites, were not considered. His results are not correct to the number of significant figures given. I have used the well-known graphical extrapolation method evolved by Bradley and Jay[3], as previously advocated[4]. The only value found in the literature that can be considered accurate is the one recorded by Ingerson[5] for a uraninite from Connecticut. The limits of error are given as ± 0·006 A. in Ingerson's paper ; this is about double the error with which the new determinations were made in this report. Temperature, although observed, has not been considered further, as its effect is thought to be well below the limits of error in this investigation.

In order to assess the reductions of the unit cell, and also to arrive at a correction for the thoria content in uraninites, the cube-edges of specially purified uranium oxide (UO_2) and thorium oxide (ThO_2) were determined, giving respectively 5·470 and 5·599 ± 0·002 A. Assuming Vegard's law for the series UO_2—ThO_2, an approximate correction was applied according to the ratio of uranium oxide to thorium oxide in the uraninites. In order to do this, only material which had been analysed was examined by X-rays, except the Belgian Congo samples, which are known to be nearly free from thoria ; here two samples were tested. The work rests largely on specimens described by Mountain and Holmes[6-8]. The main objective is to measure the effect of the substitution by lead, and the selection of samples is such that other substitutions are of very minor importance.

All the cube-edge values (a_0) in the accompanying table are new observations except the Connecticut one (*op. cit.*). The results show that when allowance for the expansion due to thorium is made, uraninites have a lower cube-edge than pure, lead-free uranium oxide ; this is taken as proof that the lead substitutions take place as postulated above. The first five results (above the line) support the thesis that a progressive reduction in the unit cell does take place with the passing of time. This shrinkage ranges from 0·0025 A. to 0·0041 A. per hundred million years, and such segments of time can be recognized by this method—even with the present limits to accuracy. The narrow variation in the 'shrinkage rate' of four widely differing samples is significant.

Sample	Age (million years)	a_0 determined	a_0 corrected for thoria
UO_2, artificial	0	5·470 A.	5·470 A.
Connecticut (as Ingerson)	280	5·465 A.	5·463 A.
Belgian Congo	600	5·453 A.	5·453 A.
Bisundni (as Holmes)	730	5·448 A.	5·446 A.
Namaqualand (as Mountain)	1,000 ↓ Increase	5·444 A. ↓ decrease	5·429 A.
Gaya (as Holmes)	950	5·481 A.	5·464 A.
Wilberforce (as Holmes)	1,000	5·482 A.	5·460 A.
Namaqualand (as Holmes)	1,000	5·485 A.	5·460 A.

The last three results appear to negative the other results—as a group : among themselves they show the agreement one might expect from the premises set out. The high thoria content common to these samples cannot alone be responsible for their anomalous (?) position, for both groups have a similar, if not identical, Namaqualand sample. The frequently observed loss of thorium D, that is, lead, in thorium-rich minerals may contribute here to give the anomalous (?) high results determined.

The results are considered encouraging, and suggest a method of limited application ; but further study is indicated and is proceeding. A more detailed account is also being prepared for another journal.

It is difficult to refrain from trying to apply the little that seems established so far to local geological problems, for example, the age and origin of the Rand gold deposits. Uraninite concentrates from three different gold mines of the Witwatersrand have yielded cube-edge values ranging from 5·440 to 5·454 A. ; reduction due to a minor thorium content brings these values within the range 5·436–5·449, with an average near 5·442 A. These uraninites are totally different from those from Namaqualand but somewhat comparable to the Bisundni material. The more pronounced shrinkage of the Rand uraninites indicates, however, a greater age which would be about 850 million years. This age would be in harmony with the 'placer origin' of the uraninite, along with the gold, in the pre-Cambrian sediments of the Witwatersrand system.

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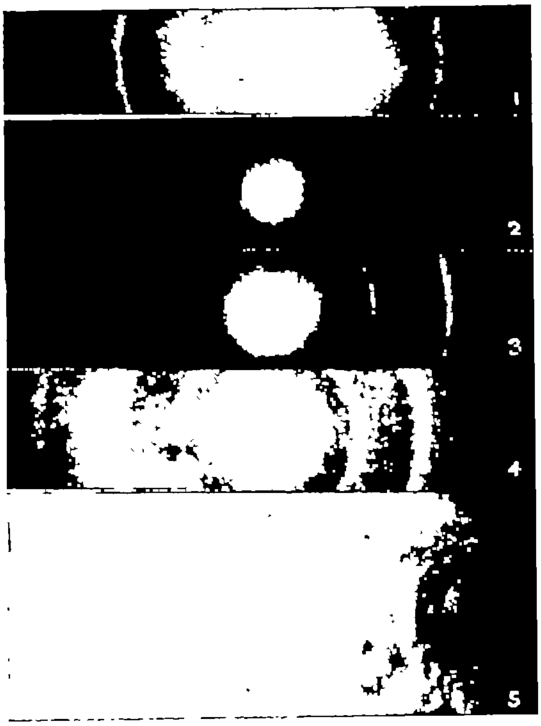
Electron Diffraction by Clay Minerals with a Fibrous or Rod-like Habit

Clay particles deposited from a suspension on to a cellulose film are usually strongly orientated with their basal (001) planes parallel to the film. Electron diffraction patterns obtained with the beam normal to the film reveal only the (*hk*0) diffractions. For most types of clay the corresponding spacings are so alike that such diffraction patterns do not help in identification.

Recently, however, we have found that, of the layer-lattice type clays, halloysite is an exception in this respect. Electron microscopy reveals a rod-like habit of halloysite in contrast to the hexagonal plates of its close chemical analogue, kaolinite. Electron diffraction patterns* of these two clays obtained in transmission with normal beam incidence are also significantly different and not only distinguish clearly between these two but also enable halloysite to be identified with certainty (Figs. 1 and 2). The innermost ring in the halloysite pattern corresponds to the characteristic (001) basal spacing of 7·4 A. This ring is not present in the pattern obtained from kaolinite. Its appearance in the halloysite pattern is due to the effect of the rod-like habit in determining the crystal orientation.



(1) Kaolinite. (2) Halloysite. (3) Attapulgite. (4) *Argilla esmectica verde*. (5) Electron micrograph of *argilla esmectica verde* (×10,000)

Another fibrous clay mineral, attapulgite, which, however, has not a layer-lattice structure, also gives a characteristic normal transmission pattern (Fig. 3) distinct from that of the other clay minerals. The innermost ring corresponds to the (110) spacing of 10·48 A.[1]. Dehydrated montmorillonite and illite have a basal spacing of this order; but this spacing does not appear in their patterns obtained by normal transmission. A Spanish clay, *argilla esmectica verde*, clearly shows this spacing, and its electron diffraction pattern (Fig. 4) as a whole resembles that of attapulgite. Its electron micrograph (Fig. 5) definitely indicates a fibrous habit.

The specimens of halloysite and the Spanish clay were obtained from Dr. D. M. C. MacEwan, of Rothamsted Experimental Station; that of kaolinite from Mr. R. Scott-Russell, of the Department of Agriculture, University of Oxford; and that of attapulgite from Attapulgus, Georgia, through the courtesy of Dr. S. P. Raichaudhuri, of the Indian Agricultural Research Institute, Delhi.

We should like to thank Prof. G. I. Finch for his interest; Mr. H. I. Matthews for the electron micrograph of the Spanish clay; and the Agricultural Research Council, which is supporting the work.

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An Interference Spectrometer for the Infra-Red

THE Fabry–Perot interferometer can be used for examining absorption spectra provided that there is no overlapping between successive orders of interference. This means that the range between orders must be equal to, or greater than, the spectral slit-width of the primary monochromator[1]. Suppose that, using a given interferometer, it is possible to resolve a fraction Δm of a fringe order, then under the above condition the resolving power of the combination of interferometer and primary monochromator is more than $1/\Delta m$ times that of the latter alone.

It can be arranged that the diameters of the fringes are very large compared with the height of the monochromator entrance slit on which they are projected, so that the slit embraces only a small fraction of an order. By rotating the interferometer about an axis parallel to the length of the slit, the fringe pattern is passed over the slit, and its structure can be analysed by placing a detector behind the exit slit. In this manner, the Fabry–Perot interferometer may be employed to study *absorption* in spectral regions where photography is not possible. In particular, it can replace the diffraction grating for certain work in the infra-red, leading to a cheaper and more compact spectrometer.

We have constructed an instrument of this kind with glass optics and used it to study absorption spectra under moderately high resolution. For example, the prism monochromator alone just resolves the rotational structure of the harmonic band of HCl at 1·76 μ. When crossed with a Fabry–Perot interferometer having a range between orders of about 16 cm.$^{-1}$, the isotopic fine structure[2] of each rotational band is clearly revealed.

The relatively long wave-lengths of the infra-red region make it possible to use for the interferometer optical flats which are less perfect than those normally required for the visible region. Furthermore, the order of interference is rather low and, as a consequence, the plate separation is small, so that the interferometer is very stable and robust. Antimony seems to be a suitable material for semi-reflecting films, having moderate reflexion and satisfactory transmission coefficients in the range[3] between the visible region and 25 μ. Other possible materials are being examined.

An attempt is being made to link together the motions of the prism and interferometer plates in such a way that the order of interference of the fringe falling on the slit is held constant as the prism is rotated. By this means, it will be possible to record an extended region of the spectrum directly, instead of in steps each of which is equal to the spectral slit-width of the primary monochromator.

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April 13.

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Statistical Theory of Solutions

The report of a discussion on this subject[1] prompts me to publish a simple equation which I obtained some time ago for the water vapour pressure isotherm of sulphuric acid solutions. Sulphuric acid is the only liquid that gives heats of mixing with water which are comparable with the heat of wetting of wool, and because the solution is free from mechanical restraint, I set out to determine how far the solution deviated from the regular solution formula[2].

The first step was to determine ω in the equation :

$$\Delta H = \frac{N_A N_B}{N_A + N_B}\,\omega. \tag{1}$$

This can be written :

$$\Delta H = \frac{i/x}{i + 18/x}\,\omega, \tag{2}$$

where i is the number of grams of water per gm. of dry sulphuric acid, and x is the effective 'molecular weight' of sulphuric acid in the solution. Equation (2) is identical with that used by Katz[3] to express his observed heats of mixing. His empirical constants give x as 55—not far removed from one-half the true molecular weight of sulphuric acid—and ω as 16·5 kT.

The second step was to find the vapour pressure relationship from :

$$\frac{p}{p_0} = \frac{N_A}{N_A + N_B}\exp\left\{-16{\cdot}5\left(\frac{N_B}{N_A + N_B}\right)^2\right\} \tag{3}$$

taking the molecular weight of sulphuric acid as 55 and that of water as 18.

On proceeding to evaluate p/p_0, I found that the term

$$\xi = \exp\left\{-16{\cdot}5\left(\frac{N_B}{N_A + N_B}\right)^2\right\} \tag{4}$$

gave the water vapour pressure isotherm for all concentrations, possibly to within the limits of experimental error. The comparison with Wilson's[4] pressure data at 25° C. is given in the accompanying table.

H_2SO_4 (%)	5	10	20	30	40	50	60	70	80
ξ	0·99	0·98	0·91	0·77	0·58	0·37	0·17	0·047	0·005
p/p_0 (obs.)	0·99	0·96	0·89	0·76	0·57	0·37	0·17	0·052	0·008

A superficial interpretation of this coincidence is that two water molecules become attached to each sulphuric acid molecule, which is not unreasonable, and that there is no entropy of mixing. Such a conclusion, if true, should be of general application to solutions with large heats of mixing, but these seem to be few in number. The scanty data available for phosphoric acid show equally good agreement with ω as low as 4·5 kT, but glycerine with 0·73 kT does not obey this relationship.

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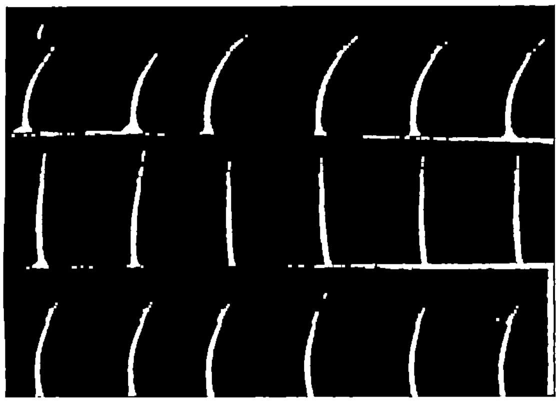
Growth Hormones of Rice Grains Germinated at Different Temperatures

Knowledge of hormone concentration in rice is very meagre. So far as we are aware, systematic attempts have not been made to assay and to ascertain the nature of hormones in rice grains. Avery, Berger and Shalucha[1], in their work on auxin yields from various plant materials, mentioned the auxin content of rice endosperm. Since the publication of their results, improved methods of extraction with greater yield of hormone from plant tissue have been suggested. Hatcher[2] has assayed the hormone content of several grains and studied the relation of its concentration with vernalization response ; but in his list rice grain was not included. The importance of hormone and its relation to vernalization and photoperiodic response has been emphasized by Gregory and Purvis[3], and Cholodny and Cailahjan[4].

It has been suggested previously[5] that the concentration and distribution of the hormone have been the cause of the variation of the flowering duration of tillers and main shoot of rice, var. *Rupsail*. The influence of low temperature is not obligatory for flowering, but its influence on increased vegetative growth as indicated by tillering and height has been noted[6]. The effect of low-temperature stimulation leading to increased vegetative growth and the photoperiodic response emphasizes the need for the knowledge of growth hormones in rice. It would be interesting to find out how far auxin production in rice is related to increased vegetative growth by low-temperature stimulation and to photoperiodic response. In this work the auxin content of rice grains germinated at two different temperatures are noted.

A chamber recently devised by us[7] for the assay of growth hormones in the tropics was used for determining the auxin content of grains of rice and other cereals, and different methods of hormone extraction were compared. An appreciable quantity of hormone has been detected in water extraction. It appears that water extraction alone is effective for the removal of auxin from the endosperm of rice. Higher auxin content by sodium hydroxide extraction is due to slow hydrolysis of auxin precursors as shown by Avery, Berger and Shalucha. In this variety of rice auxin yield is 0·17 million T.D.C. in water and 0·50 million in alkali extraction per gm. of dry endosperm. Avery, Berger and Shalucha noted hormone content to be 0·25 million of T.D.C./gm. in alkali extraction.

The increased auxin content in the present



Avena curvatures for the hormone extract from the endosperm of rice. Top, 0·60 million T.D.C./gm. from dormant endosperm; middle, 0·069 million T.D.C./gm. after 5 days germination at 26° C.; bottom, 0·228 million T.D.C./gm. after 5 days germination at 10° C.

investigation is possibly due to varietal difference and the modification of the extraction method employed.

The assay of the hormone content of rice grains germinated at different temperatures shows that a marked inhibition of the consumption of auxin from the endosperm tissue takes place at 10° C. together with the inhibition of the seedling growth, while at 26° C. a large amount of hormone, about 88 per cent of the total content, disappears from the endosperm within five days (see accompanying illustration). A comparison of the growth of the seedlings shows that during five days the seedlings cultured at 26° C. have two unfolded leaves with 6·2-cm. root and 4·2-cm. shoot length, whereas at 10° C. they have 0·2–0·3-cm. root and shoot length is only noticeable. High auxin content of the seeds germinated at 10° C. was due to the interruption of the hydrolytic reaction yielding auxin from its precursor. Temperature appears to have an effect on the hydrolysis of auxin precursor contained in the endosperm tissue, and the disappearance of hormone from the endosperm has been found to be due to the activity of the growing embryo, as the hormone content is very little changed after the excision of the embryo (see accompanying table).

Exp.	Average degree of *Avena* curvature	Millions of T.D.C./gm. in alkali extraction
Temperature of hydrolysis		
27° C.	27·3	0·60
22° C.	22	0·44
10° C.	16	0·32
5° C.	9	0·18
Endosperm after 48 hr.; 24 hr. with embryo and 24 hr. without embryo	23·6	0·225
Endosperm after 24 hr. with intact embryo	24·2	0·262
Endosperm after 48 hr. with intact embryo	18·7	0·155

In order to ascertain whether the gradual disappearance of hormones from the endosperm was due to the presence of growth inhibitors, the activity ratio of the endosperm extract was assayed by the Skoog's deseeded and Went's standard methods as suggested by Avery, Berger and Shalucha. The ratio found, 3 : 1, is suggestive of the absence of growth inhibitors in the rice endosperm.

We desire to express our sincere thanks to the University of Calcutta for facilities for carrying out this work in the Department of Botany, and to Dr. B. P. Pal, director, Indian Agricultural Research Institute, New Delhi, for his interest and the supply of pure seeds of oat.

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Chromosome Elimination in *Saccharum*

IN the sugar-canes there are two cytological features of interest. First, it has been noticed that two types of egg gametes, one with the reduced haploid number of chromosomes and the other with the unreduced diploid number, are formed. From a study of chromosome numbers in certain hybrids (Table 1), it can be seen that in some crosses one or other of these types of gametes, or both, have functioned.

Recent investigations by Bremer[1] have shown that the restoration of the somatic number in the megaspores takes place by a process of endomitosis in the innermost megaspore cell after normal meiosis had taken place. Secondly, it is known that the unreduced gametes of the female parent are capable of developing without fertilization. This is particularly the case in wide crosses such as *POJ* 2725 × *Imperata*[2], and *Co.* 421 × *Coix lachryma-jobi* or *Bambusa arundinacea*[3].

In addition to the two features referred to above, another interesting point was also noticed. The anomalous chromosome numbers of certain seedlings among the hybrids (Table 2) indicated that egg gametes with chromosome numbers different from the haploid or the diploid number had functioned, since the male parents, the meiosis of which was known to be normal, could have contributed only the regular haploid number of chromosomes.

Co. 421, a male-sterile commercial cane, was used as a female parent in a number of crosses and was also selfed under bag. From these, both in wide crosses and in selfs, two types of seedlings were obtained, one type with thick canes having $2n = 118$ chromosomes and the other with thin canes having $2n = 86$ chromosomes. Subramanium[4] has recorded in *Co.* 421, besides normal meiosis, abnormal features in some of the egg mother cells. In these cells the bivalents were found in two groups at the first metaphase, one at the equatorial region with 43 bivalents and the other with 16 bivalents towards the micropylar end. The formation of gametes with 86 chromosomes was inferred to be either from the union of the two nuclei derived from the cell of the dyad with $n = 43$ chromosomes, or by the union of the divided nucleus of the egg cell.

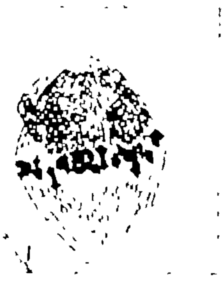
Table 1

Parentage		No. of hybrid seedlings examined	Chromosome number of parents		Chromosome number of hybrids 2n =	Chromosome number of gametes functioning	Nature of female gamete functioning
Female	Male		Female n =	Male n =			
Saccharum officinarum Kaluthai Boothan	*S. spontaneum* ,, (Coimbatore form)	6	40	32	112	(40+40) × 32	Unreduced only
Chittan	,,	6	40	32	112	(40+40) × 32	,,
Lakhapur	,,	6	40	32	112	(40+40) × 32	,,
Vellai	,,	1	40	32	112	(40+40) × 32	,,
D.74	,,	0	40	32	112	(40+40) × 32	,,
S. officinarum Vellai	*Sclerostachya fusca*	5	40	15	55	40 × 15	Reduced and unreduced
,, ,, Commercial cane	,,	1	40	15	95	(40+40) × 15	
POJ 2725 (complex of *officinarum* × *spontaneum*)	,,	16	53	15	68	53 × 15	Reduced only

Table 2

Derivation of the hybrids	No of hybrids examined	Chromosome numbers of			Remarks
		Female parent n =	Male parent n =	Hybrids 2n =	
Co. 421 selfed	3	59	—	86	Parthenogenetic
Co. 421 × *Coix lachryma-jobi*	2	59	10	86	,,
Co. 421 × *Bambusa arundinacea*	3	59	35	86	,,
Co. 421 × *S. officinarum* (Poovan)	1	59	40	126	
S. officinarum (Vellai) × *Sclerostachya fusca*	1	40	15	60	
S. officinarum (*D* 74) × *S. spontaneum*	1	40	32	60	
POJ 2725 selfed	2	53	—	96	Parthenogenetic

On a re-examination of the slide in 1947, it was noticed that the two groups of bivalents referred to above were clearly in two different spindles (Fig. 1). Fig. 2 shows the polar view of another cell showing two different metaphase plates in the same cell. It is evident that during the first metaphase two spindles are organized in the same egg mother cell, with the result that two metaphase plates with 43 and 16 bivalents are formed. That only the bigger group with 43 bivalents afterwards takes part in the formation of the egg and therefore in fertilization is inferred from the study of the chromosome numbers of the hybrids (Table 2). Although the fate of the smaller group of chromosomes could not be traced further, it is evident that they do not take part in the formation of gametes and that they are eliminated as a group. The formation of gametes with 86 chromosomes can, therefore, be explained as the result of two processes. First, the elimination of 16 bivalents by the formation of two spindles in metaphase 1, and secondly the cell with 43 chromosomes undergoing endomitosis as seen by Bremer[1]. Instances of chromosome elimination through spindle abnormalities have been recorded before in *Ribes nigrum*[5] and in *Eruca sativa*[6].



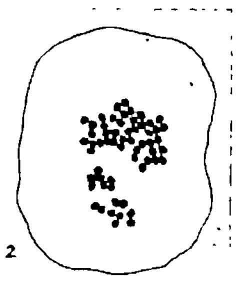


Fig 1. Equatorial view of meiotic metaphase in the egg mother cell of *Co.* 421 showing two groups of chromosomes on two different spindles. In the bigger group all the chromosomes are not shown in the diagram. × 1,400

Fig. 2. Polar view of a similar cell showing two different metaphase plates with 43 and 16 bivalents. × 1,250

Considered from the evolutionary point of view, such chromosome eliminations *en bloc* in polyploids are very significant. They establish the reversible nature of polyploidy. Hitherto, reversal of polyploidy has been known to be due to parthenogenesis. Elimination of chromosomes has been confined to one or two chromosomes only; elimination of chromosomes *en bloc* has been rare. It is possible that this specialized mechanism, which facilitates such chromosomal eliminations, prevails in *Saccharum* because of its high polyploidy. This high polyploidy not only allows the loss of groups of chromosomes, a loss that would be of serious consequence in a diploid, but also provides for evolutionary changes by such special genetic devices; for this reduction releases and exposes to selection new chromosomal races exhibiting a high range of variability. It is also interesting to note that the reduction of chromosome numbers is followed by an increase of the same through endomitosis. Hence, there are two opposing tendencies in operation, yet leading to a genetic balance; for after the elimination, the egg gametes with 43 chromosomes do not function always as such, but undergo a process of endomitosis. This device leads to the fertility of the progeny. The elimination of chromosomes noted in the cane *Co.* 421, therefore, gives us an idea of the evolutionary steps that are in operation in the complex genus *Saccharum*. It also provides an explanation for the existence of different chromosomal races as in the north Indian sugar-canes[7].

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The Cement Block, an Improved Block for Spore-formation in Yeast

The gypsum blocks generally used for the production of yeast spores[1] often become infected, on repeated use, with spore-forming bacteria, since they will not tolerate the strong heating necessary for adequate sterilization. We have attempted to prepare a block which can stand such sterilization. After trials with various materials, we finally chose a block cast of Portland cement and kieselguhr, which after hardening in carbon dioxide is sufficiently porous.

The procedure is as follows: 2 parts by weight of kieselguhr and 3 parts of super-rapid Portland cement are mixed carefully; 7–8 parts of water are then added until the mixture is of a plastic consistency. This mixture is poured as a layer about 2 cm. thick into moulds consisting of a cardboard ring placed on a glass plate covered with thin 'Cellophane'. The filled moulds are put in a carbon dioxide atmosphere to harden, for example, in an autoclave. Hardening for three to four days is sufficient, although the blocks appear to be stronger after hardening for a longer period. The blocks are then rinsed in running water for four to eight days until alkali is no longer present.

The blocks can be hardened in air instead of in carbon dioxide. This makes the blocks much stronger; but on account of poor porosity they are not so useful for the present purpose.

The cement blocks may be sterilized by autoclaving at 121° C. for an hour, followed by drying in a hot oven at 80–90° C. for some hours until half-dry. The cooling of the blocks must be carried out slowly as they crack easily on sudden changes in temperature.

The cement blocks are seeded in the same way as gypsum blocks and cleaned by washing under the tap and possibly rinsing for a few hours in running water.

SPORE-FORMATION IN YEAST FOAM AFTER 48 HR. (MEAN OF 6 BLOCKS)

	Vegetative cells	1-spored	2-spored	3-spored	4-spored asci
Cement blocks	44	1	22	25	8 per cent
Gypsum blocks	55	0	19	22	4 ,, ,,

We have used yeast foam (*Saccharomyces cerevisiae*) to test spore-formation on the various blocks which we have investigated. This yeast gives (see table) somewhat better spore-formation on cement blocks than on gypsum blocks; the number of 4-spored asci especially is increased. Other types of yeast which we have tested have also given better spore-formation on cement blocks.

A more detailed account of this work will appear in *Compt. rend. Lab. Carlsberg*, Sér. physiol.

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Copenhagen. April 16.

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Source of 'Serotonin' in Serum

RAPPORT *et al.*[1] prepared from beef serum a vasoconstrictor substance which was called 'serotonin'. By following the pharmacological activity through various stages from serum itself to the final product, it was considered that the substance finally isolated is, in fact, that responsible for the well-known vasoconstrictor activity of serum. The latter substance, which elsewhere[2] has been called 'thrombocytin', depends on the presence of platelets in plasma at the time of clotting[3,4]. For this reason we have repeated Rapport's procedure, applying it to serum prepared from highly centrifuged plasma, on one hand, and to serum prepared from platelet-rich plasma, on the other.

Blood was collected from cattle at the abattoirs into silicone-coated vessels, using sodium citrate as an anticoagulant. It was spun lightly in a Jouan centrifuge (500 *g* at tip, 340 *g* at surface) to throw down the bulk of the red and some of the white cells; the plasma was removed, pooled and respun in a refrigerated international centrifuge (Conical Head No. 845; 650 *g* at tip). The resultant plasma ('platelet-rich' plasma) was opalescent, and microscopic examination showed that its cellular content was mainly platelets. A portion of this plasma was spun a third time (2,000 *g* at tip) to throw down the platelets and obtain a clear ('platelet-free') plasma. The sediment from the third centrifugation was added to the platelet-rich plasma. By these procedures two plasmas were obtained from the same sample of blood, one clear and cell-free, the other opalescent and rich in platelets. Each was clotted by the addition of calcium chloride, and the sera so obtained (1–2 litres in volume) were extracted in parallel in five stages[1], obtaining as the final product a nitrobarbiturate complex for testing on the isolated carotid artery ring of sheep, dog or ox.

The results were clear-cut. Active preparations were obtained in every case (seven) in which the original serum was made from whole blood or platelet-rich plasma. The average yield from 23 litres of serum was 270 mgm./litre, with losses ranging from 52 to 80 per cent. Isolated arterial rings in 10-ml. baths responded to 50 μgm. or more. (Probably less than 1 per cent of the complex is active substance[1].) On the other hand, serum from 'platelet-free' plasma yielded preparations which were almost devoid of activity, whereas serum from the corresponding 'platelet-rich' plasma yielded preparations sixteen or more times as active. A similar ratio between the activity of such paired preparations was also seen in their stimulating actions on the isolated guinea pig gut or rat uterus, in their ability to liberate adrenaline from the suprarenal gland of the cat, and in their ability when injected into the carotid artery of the cat to cause contraction of the nictitating membrane or miosis.

Serum made by clotting platelet-free plasma to which an equal volume of red cells had been added was inactive.

These results show that the appearance of Rapport's serotonin in serum depends on the presence of the lighter elements of the blood (probably platelets) at the time of clotting. They also suggest that the pharmacological actions of serum, on the test objects referred to above, are due to one and the same substance.

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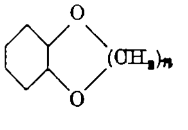
A Novel Connexion between Electrostatic Interaction and Intramolecular Configuration

More than a year ago, we reported that the catechol derivatives (I) were being investigated in these laboratories with the object of increasing our knowledge of the relationship between chemical reactivity and intramolecular configuration[1]. At that time we knew that 3 : 7-dioxa-1 : 2-benzo*cyclo*heptene (I, $n = 3$) brominates less readily in glacial acetic acid than do 1 : 3-dioxaindan and 1 : 4-dioxatetralin (I, $n = 1$ and 2 respectively)[2]. This difference in reactivity has also been observed in their rates of hydrogen exchange[3] and is a consequence of the puckered configuration of the seven-membered ring when $n = 3$; the O—CH_2 bonds are oriented out of the plane of the benzene ring and electromeric interaction between this ring and the oxygen atoms is partially inhibited. We expected this interaction to be a maximum in the essentially planar molecules of (I) ($n = 1$ and 2 respectively)[4] and were surprised to find that both these substances are less reactive in the bromination and hydrogen-exchange reactions than is veratrole (II)[3,4].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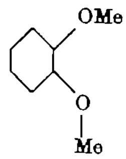
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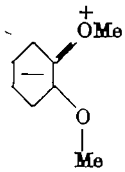
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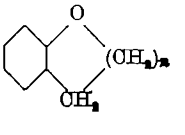
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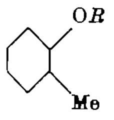
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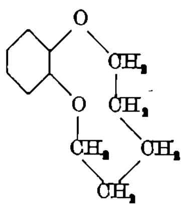
VI

We assumed that this anomaly was due to direct electrostatic interaction between the two oxygen atoms; we argued that the electric potential of the oxonium ion obtained by electromeric release of electrons from one of the oxygen atoms might be related to the orientation of the neighbouring ether group. The potential should be a minimum when the unshared electrons of this ether group are directed towards the positive charge as in (III), and a maximum when they face in the opposite direction. Thus we considered (II), in which the lower ether group is described as 'facing' the other, to be the configuration which provides ready electrophilic substitution in veratrole, and related the comparatively low reactivities of (I) ($n = 1$ and 2 respectively) to the fact that their ether groups face outwards[5].

We have substantiated this argument in the following two ways: (*a*) Should the anomalously slow bromination of (I) ($n = 1$ and 2) be due to electrostatic interaction between the oxygen atoms, coumaran and chroman (IV, $n = 1$ and 2 respectively) should behave normally. In fact, they are more readily brominated than are the methyl and ethyl ethers of *o*-cresol (V, R = Me and Et respectively), and in this their behaviour is consistent with the enforced planarity of their molecular structures. (*b*) When the heterocyclic ring in (I) includes a sufficiently large number of methylene groups to enable one of the ether groups to face the other, the latter should direct ready electrophilic substitution. We have observed that 3 : 9-dioxa-1 : 2-benzo*cyclo*nonene (VI) is brominated even more readily than veratrole[5]. The pertinent data are assembled in the accompanying table.

Relative Rates of Substitution

	Bromination	Hydrogen exchange		Bromination	Hydrogen exchange
Anisole	1	1	V, R = Me	8	1 5
II	4	3	V, R = Et	16	—
I, $n = 1$	0 2	2	IV, $n = 1$	53	—
I, $n = 2$	0 2	1	IV, $n = 2$	28	—
I, $n = 3$	0·09	0 3			
I, $n = 4$	—	1·5			
I, $n = 5$	16				

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Crystal Structure of 'Quinaldil'

The substance of empirical formula $C_{20}H_{12}O_2N_2$ prepared by Brown and Hammick[1] by the action of potassium cyanide on quinoline-2-aldehyde, or by the decarboxylation of picolinic or quinaldinic acid in quinoline-2-aldehyde, has been found[2] to be identical with that obtained by Buehler and Harris[3].

A sample of Brown and Hammick's material crystallized from pyridine in forms illustrated in the photomicrograph. They belong to the orthorhombic system, and their characteristic consistent face development with dissimilar terminations shows that they are of the crystal class *mm*.

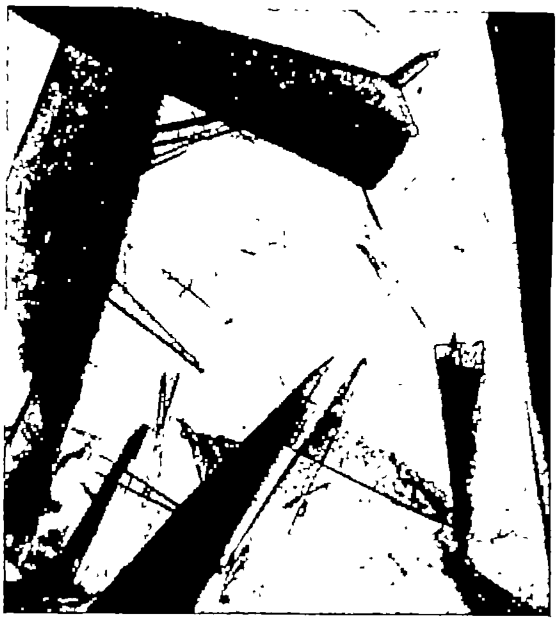
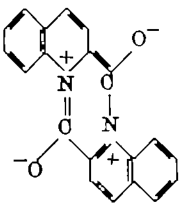


Fig. 1. The crystals in outline resemble a kite or wedge which has its longer axis parallel to the 5 24-A. cell edge, that is, the polar axis *c*. × 30

Examination of the crystals by X-ray methods with copper $K\alpha$-radiation gave the unit-cell dimensions $a = 24·8$, $b = 22·5$, $c = 5·24$ A. This cell contains eight molecules. The absent spectra indicate the space group *Fdd*, a result consistent with the crystal class derived from morphology.

In the space group *Fdd* the general point position *xyz* has 16-fold multiplicity, and the eight molecules must therefore lie on 2-fold symmetry axes in the only special position, repeating at 00*z* and its seven equivalents. The molecule, therefore, itself has a 2-fold axis which coincides with a crystal symmetry axis parallel to *c*, along which the repeat distance is only 5·24 A. The suggested planar molecule I, which has the symmetry axis perpendicular to its plane, would therefore have to lie in a plane at right angles to the short *c*-spacing. However, trial shows that flat molecules of this kind cannot be fitted into the available space. Further, a structure consisting of such molecules in parallel array would have strong negative birefringence with the smallest refractive index parallel to the short axis; but the crystals do not behave in this way. The refractive index for vibrations parallel to the length of the wedge is slightly greater than that for vibrations across the wedge. Form I should be planar; but in attempts to overcome these difficulties it was modified by tilting the quinoline parts out of the plane so as to produce a V-shaped molecule. Fourier syntheses based on the atomic positions for such distorted molecules did not develop the structure. Calculated structure factors did not agree with observed, and what partial indication of atomic positions was given arose from the placing of the quinoline ring systems approximately in the positions which they were later found to occupy.



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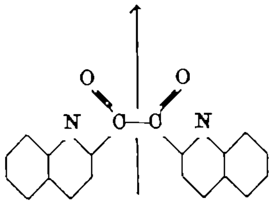

II

The form (II), however, leads to the solution of the structure illustrated in the electron density map (Fig. 2). This is an approximation only and is in process of refinement; but it clearly shows all atoms of the molecule separately resolved. The molecule, which is not planar, has a form only roughly indicated by (II). It is non-centrosymmetric and highly polar in the direction of the two-fold axis denoted by the arrow. The arrangement of such molecules, all pointing in the same direction, accounts for the polar character of the crystal, and the fairly steep inclinations of the planes of the aromatic ring systems to (001) are in agreement with the observed optical behaviour.

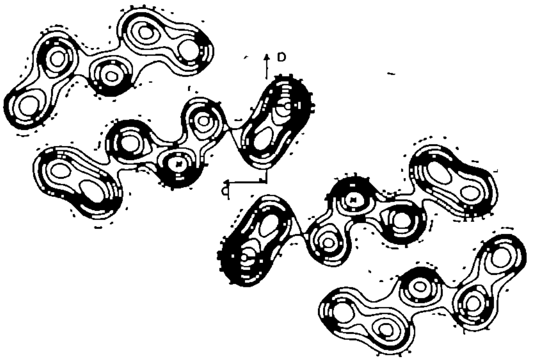

Fig. 2. Electron density map showing molecule projected on a plane perpendicular to the two-fold symmetry axis. Nitrogen (N) and oxygen (Ox) peaks are shown by lettering. All other peaks represent C or CH. The two central carbon atoms are in the plane of projection. Their bonds to the quinoline system slope down from the plane, and those to oxygen are directed above it

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Activity of the Chromium–Aluminium Oxide Catalyst System in the Nitrile–Diene and *n*-Heptane Cyclizations

THE chromium–aluminium oxide catalyst system is one most commonly used in the aromatization of paraffinic hydrocarbons. In practice, mixtures containing up to 20 per cent chromium oxide are used, this being regarded as the region of greatest catalytic activity. The work of Eischens and Selwood[1] on this catalyst system established the close relation between the activity, magnetic susceptibility, and state of dispersion of the chromium oxide on the alumina. It was shown that at low chromium oxide content, the chromium oxide aggregates into clusters or islands which build up into two and even three layers in thickness, and which have high magnetic susceptibility and high catalytic activity.

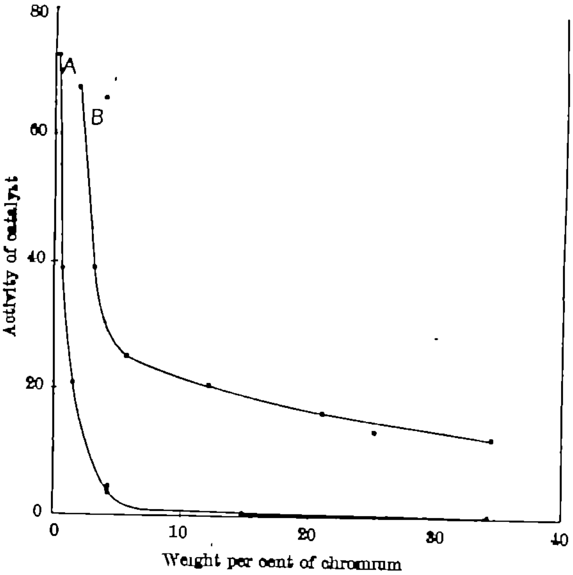
The catalyst activity measurements in these studies were made using the *n*-heptane to toluene reaction, which is an example of a 'one-reactant' cyclization–dehydrogenation reaction. Hawkins and Janz[2] used this catalyst system in their studies of the reaction of simple organic nitriles with 1,3-dienes to form pyridinic compounds. This nitrile–diene cyclization may be considered as an example of a 'two-reactant' cyclization-dehydrogenation reaction. It is of interest to compare the activity–composition relation for this catalyst in the more complex system with that found for the one-reactant case.

Composition and Activity of the Chromium–Aluminium Oxide Catalyst System in (*A*) the Nitrile–Diene Cyclization, and (*B*) the *n*-Heptane Cyclization ·

(*A*) Benzonitrile + Butadiene = 2-Phenylpyridine + H_2.
(*B*) *n*-Heptane = Toluene + $3H_2$.

Catalyst	Activity of catalyst	
Wt. per cent of chromium	Space–time–yield of 2-phenylpyridine (mol. × 10^4/hr./gm. chromium)	Space–time–yield of toluene (mol. 10^4/ hr./gm. chromium)
0 34	72 5	
0·68	39·2	
1·54	20·8	
1 9		67 9
3 2		39 3
4·38	3 45, 4·33, 4 50, 3 96	
5·7		25 4
12 2		20 8
15·4	0·10, 0 07	
21·1		16 5
27·2		13 7
34·2	0 38, 0 10	12·6

A comparison of the activity–composition relation in these two reactions is possible if the results are calculated as activities per unit weight of chromium in the mixed catalysts in each case. For this purpose the results in the nitrile–diene and *n*-heptane reactions have been recalculated in terms of space–time–yield of product per gram chromium. These results are summarized in the accompanying table. A comparison shows that the activities are significantly lower throughout in the nitrile-diene case than in the *n*-heptane case. This is not unexpected in view of the rather different temperatures at which these studies were made (400° C. and 490° C. respectively), and also because of the rather different chemical nature of the reactants in the two systems. It is noticeable, however, that just as in the *n*-heptane case, the activity of the catalyst in the nitrile-diene reaction is high for mixtures containing only small amounts of chromium, and falls rapidly as the amount of chromium increases.



This similarity between the activity–composition relationship emerges more clearly when these data are compared graphically. If the activities of the *n*-heptane cyclization are adjusted by a factor of 10^{-1}, these data can be compared easily with the data for the nitrile–diene reaction (see graph). In the curve for the *n*-heptane case, there is seen a rapidly decreasing activity with increasing percentage chromium in the catalyst, and a noticeable change of slope at about 6 per cent chromium. This 'point' of change of slope and change in activity was shown by Eischens and Selwood to be closely related to similar changes in the magnetic susceptibility of the chromium in this catalyst system. For the nitrile–diene cyclization, the activity–composition relation is strikingly similar. There is the same rapid decrease in the activity with increasing chromium content, and 'point' of change of slope occurs also at approximately 6 per cent chromium. The curve seems to be essentially the same in type as found for the *n*-heptane to toluene reaction.

Hence, the activity–composition relation of the chromium–aluminium oxide catalyst system found in the more complex case of a cyclization–dehydrogenation reaction involving two reactants is quite similar to that observed in the simple case involving only one reactant.

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Relationship between Base Saturation and Crop Response to Phosphate in Acid Soils

In an attempt to relate phosphate responses in the field with soil analyses, the most significant correlations I have yet obtained have been between response and the percentage saturation of the base exchange capacity. It should be noted that all the soils, with one exception, lay within the range *p*H 4·7–6·3. In three groups of experiments (fifty-six observations) on wheat, grass and millet, the regressions of crop response (percentage increase in yield due to superphosphate over control) on the percentage saturation of the base exchange capacity were highly significant ($P < 0{\cdot}01$) in spite of the fairly wide variation in soil types. The relationship was an inverse one, and the equations indicated that phosphate responses are not to be expected when base saturation exceeds about 80 per cent. A similar relationship was found between response and exchangeable calcium expressed as a percentage of exchangeable calcium plus exchangeable hydrogen, that is, in units similar to the percentage saturation of the base-exchange capacity.

These results indicate that the percentage saturation of the base exchange capacity (or exchangeable calcium expressed as above) are, in acid soils, a measure of the availability of the soil phosphate. Additional support for this is given by the fact that the control yields were significantly and directly related to the percentage saturation of the base exchange capacity, while the phosphate response was significantly and inversely related to the control yield. On the other hand, the amounts of acid-soluble phosphate (Truog's method and phosphate soluble in 0·1 *N* hydrochloric acid), adsorbed phosphate (extractable with 0·5 *N* neutral ammonium fluoride) and water-soluble phosphate (Burd's method)[1] showed no such conclusive correlations with response or control yield. Typical results, selected from the grass experiments (see Table 1), are illustrative.

A few discrepancies were found between the magnitude of phosphate response and the degree of base saturation, but these could well be referred to adverse field conditions and the different effects of the soils on the efficiency of the added phosphate.

Table 1

Soil No.	p.p.m. P_2O_5.			Per cent sat. base exchange capacity	Per cent resp.	Control yield (tons/acre)
	Ads.	Acid sol.	Water sol			
6708	29	49	4·3	44	50	0 7
6621	18	10	4 1	54	21	1·6
6577	27	5	1 3	60	15	2 7
6025	27	22	5 0	64	12	1·8
6633	16	48	1 2	68	9	1 9
6585	24	8	2 5	74	6	3·1
6645	134	155	9·4	81	−2	3·8

Table 2

Per cent saturation of the base exchange capacity	Average percentage response to phosphate		
	Wheat	Grass	Millet
60 and below	111	26	125
61 to 70	44	11	27
71 and above	21	4	5

On the whole, however, the dependence of response on base saturation was well defined, as shown in Table 2.

There is considerable evidence in the literature that exchangeable bases, notably calcium, can retain appreciable amounts of phosphorus in a readily accessible form for plant use. Allison[2] found evidence of such retention as a $H_2PO_4^- - Ca -$ micelle linkage over the pH range 4·0–6·0, which approximates closely to that for the soils in these experiments. Such phosphate may be considered as saloid-bound, that is, existing as ions in the diffusible ionic atmosphere outside the soil micelle. Saloid-bound phosphate can undergo secondary reactions in the soil to the less available colloid-bound form which is directly associated with the micelle and is non-diffusible.

Such transformations have been reported by Barbier and Chabannes[3], while Ravikovitch[4] has demonstrated that as the degree of base saturation decreases, the proportion of colloid-bound to saloid-bound phosphate increases. A high degree of base saturation in acid soils implies, therefore, that conditions are favourable to the retention of part at least of the soil phosphate, in the available saloid-bound form. With decreasing saturation there is an increasing probability of the soil phosphate existing in the less available colloid-bound form. The percentage saturation of the base exchange capacity is, therefore, directly related to phosphate availability and inversely to phosphate response.

In acid soils a study of base-saturation data offers a logical approach to the problem of relating chemical tests with phosphate response and availability. In conventional methods a number of forms of phosphate of different degrees of availability are usually measured, or secondary reactions may take place during the extraction procedure, making the resultant value in either case difficult to interpret. In contrast, the percentage saturation of the base exchange capacity refers to the conditions governing the existence of a single form of available phosphate. It is more important to know whether available phosphate is likely to be present than the amount of some form arbitrarily, but often incorrectly, assumed to be available. I have not yet attempted to measure the amount of saloid-bound phosphate present because it is doubtful if, in fact, such a procedure is necessary. All the soils so far investigated appear to have an adequate amount of native soil phosphate for satisfactory plant growth, provided only that the degree of base saturation is sufficiently high.

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March 29.

---

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[2] Allison, L. E., *Soil Sci.*, 55, 333 (1943).

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Determination of Sodium Gentisate by Chromatography and Fluorescence

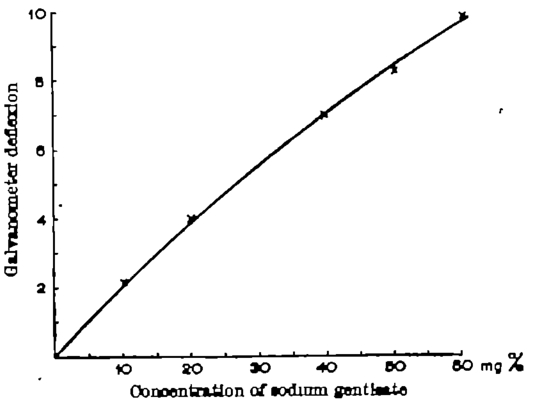
The determination of sodium gentisate (2 – 5 dihydroxybenzoate) in urine is important because of the use of gentisate as a therapeutic in rheumatic fever, and the presence of sodium gentisate in urine after administration of sodium salicylate[1].

We have devised a quantitative method for the determination of gentisate in urine. Portions of 10 c.mm. of the urines are placed on Whatman No. 1 filter paper at a distance of 5 cm. from the edge of the paper; also some spots of known gentisate concentrations are applied. A chromatogram is developed using the ascending technique[2] with the upper layer given by a mixture of two parts of benzene, two parts of glacial acetic acid, one part of water (cf. ref. 3). After 18 hr. at room temperature under an air-tight cover the paper is dried in the air. The gentisic acid is now made visible by its strong blue fluorescence in ultra-violet light, using a Philips *HPW* lamp, which emits the wave-length 3655 A. The R_F value of gentisic acid in these conditions is 0·1–0·2. For quantitative determination it is necessary to be sure that the ultra-violet intensity is the same for each spot.

The fluorescent spots are measured with a selenium cell (diameter 1 cm.). The cell is placed under a piece of lead glass 5 mm. thick (the same glass as used in X-ray screens). Above the cell, which is mounted in a wooden frame, a zinc plate is mounted with a circular diaphragm above the cell and of the same size as the cell. The ultra-violet lamp is mounted in a frame about 17 cm. above the plate and perpendicularly above the diaphragm. The strip of paper with the spots is cut out (perpendicular to the direction of development) and is drawn between the plate and the wooden frame, so that each spot passes under the diaphragm. The lead glass does not transmit the ultra-violet, as is seen by the absence of fluorescence behind the glass.

The largest spot must be smaller than the area of the diaphragm. The deviation of the galvanometer plotted against the concentration of known solutions of pure gentisic acid treated in this way proved to be nearly a straight line (below 60 mgm. per cent) (see graph). This line passes through the origin if the blank given by the paper under the ultra-violet lamp is taken as the zero point. This blank value is due to transmission of a little violet light.

At higher concentrations than about 60 mgm. per cent a photocell of at least 2 cm. diameter should be used, as the (elliptical) areas of the fluorescent spots become otherwise larger than the photocell area.



We believe that with such photocells the linearity should be valid up to higher concentrations; the accuracy is about 1 mgm. per cent.

By dissolving gentisate in normal urines it was found that this method of determination of gentisate is not disturbed by other substances present in urine.

Confusion with substances such as salicylic acid and salicyluric acid is impossible because they move faster in the chromatogram (R_F ± 1·0 and 0·3–0·4). Furthermore, the gentisic acid is characterized by its strong blue fluorescence, and by the fact that standard concentrations of gentisate are always chromatographed on the same paper.

For urine this method is more specific than colour reactions with phenol reagents[4,5], especially when salicylic acid is also present.

The present method is a simplification of a more complicated method, which was used formerly in our Laboratory[1]. With this method it was found by Winkel[1] that up to 30 per cent of a given dose of salicylate is recovered in the urine as the gentisate in rheumatic fever.

The accuracy at low concentrations can be increased by applying more than one quantity of 10 c.mm. to the chromatogram paper.

The method may be useful for determination of other fluorescent substances.

Our thanks are due to Prof. E. Gorter for his interest in the development of this method of determination.

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B. Bink

Laboratory of the Children's Clinic,
Academic Hospital, Leyden. April 17.

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Destruction of Dinitrophenyl Amino-Acids by Tryptophane

The only dinitrophenyl amino-acids revealed by paper chromatography[1] and the use of silica columns[2] during an attempt to identify and estimate the free amino groups of lysozyme by the method of Sanger[3] were ε-dinitrophenyl-lysine and *bis*-dinitrophenyl-lysine. The recovery of the former from hydrolysed dinitrophenyl-lysozyme, using silica columns, suggested that lysozyme contains five non-terminal lysine residues; but the amount of *bis*-dinitrophenyl-lysine recovered was only one-third of that to be expected from one N-terminal amino-group. Similar results were obtained when lysozyme was first treated with urea[4], or when the conditions of reaction with 1 : 2 : 4-fluorodinitrobenzene were varied.

Control experiments showed that whereas *bis*-dinitrophenyl-lysine alone could be recovered almost completely after refluxing with 20 per cent hydrochloric acid for six hours, only 60–76 per cent was recovered when lysozyme was also present. Similar values were obtained when the lysozyme was first hydrolysed for six hours, the *bis*-dinitrophenyl-lysine added and the mixture again refluxed for six hours. The intact protein was therefore not responsible for the destruction of the dinitrophenyl amino-acid. The amounts of lysozyme and dinitrophenyl amino-acid used in these experiments were equivalent to those present during normal hydrolysis of dinitrophenyl-lysozyme.

The original tests of Porter and Sanger[4] for the recovery of dinitrophenyl amino-acids were carried out in the presence of globin. A striking difference between globin and lysozyme is the relatively large amount of tryptophane (10·6 per cent)[5] in the latter protein. It was found that refluxing *bis*-dinitrophenyl-lysine in the presence of tryptophane gave low recoveries of the same order as those obtained in the presence of an equivalent amount of lysozyme. On the other hand, the dinitrophenyl amino-acid could be recovered almost completely (Table 1) after refluxing with other representative amino-acids (alanine, arginine, serine, tyrosine and aspartic acid).

Table 1. Recovery of *bis*-Dinitrophenyl-lysine
(1·28 mgm. dinitrophenyl amino-acid, 6 hours refluxing with 5 ml. 20 per cent hydrochloric acid)

Substance	Amount added (mgm.)	Per cent recovery
—	—	97
Lysozyme	40	68
Tryptophane	4·4	73
Alanine	2·9	96
Arginine hydrochloride	6·85	96
Aspartic acid	8·23	93
Serine	3·23	95
Tyrosine	3·8	94

The amounts of amino-acids were equivalent to 40 mgm. lysozyme except in case of tyrosine

The rate at which *bis*-dinitrophenyl-lysine (1·28 mgm.) is destroyed when refluxed with tryptophane (4·4 mgm.) is shown in Fig. 1 and the effect of increasing the amount of tryptophane in Fig. 2. It will be seen that with sufficient tryptophane the destruction of the dinitrophenyl amino-acid is nearly complete in 24 hr.

Control experiments showed that the loss of *bis*-dinitrophenyl-lysine is not due to adsorption on the humin formed from tryptophane during hydrolysis.

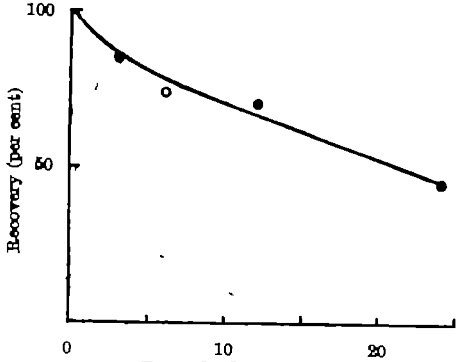

Fig. 1. Rate of destruction of *bis*-dinitrophenyl-lysine

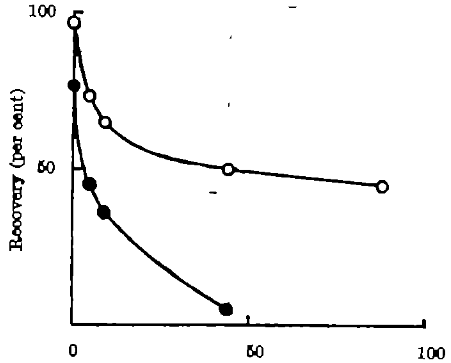

Fig. 2. Effect of added tryptophane on recovery of 1·28 mgm. *bis*-dinitropheny-lysine; ○, refluxing for 6 hr.; ●, refluxing for 24 hr.

It is almost certainly due to chemical reaction between *bis*-dinitrophenyl-lysine and tryptophane (or breakdown products of tryptophane) and, after removal of the unchanged dinitrophenyl amino-acid by ether extraction, a coloured compound can be extracted from the aqueous solution with butanol. On paper chromatograms run with chloroform-ammonia, this product travels almost with the solvent front and cannot, therefore, be another dinitrophenyl amino-acid; it appears to run faster than 2 : 4-dinitro-aniline.

The presence of tryptophane also led to the destruction of certain amounts of other dinitrophenyl amino-acids (Table 2).

Table 2. Recovery of Dinitrophenyl Amino-Acids in the Presence and Absence of Tryptophane

($2 \cdot 67 \times 10^{-6}$ moles of dinitrophenyl amino-acid; 6 hr. refluxing with 5 ml. 20 per cent hydrochloric acid)

Dinitrophenyl amino-acid	Per cent recovery No tryptophane	 4·4 mgm. tryptophane
DNP-alanine	96·5	66
DNP-leucine	100	91
DNP-phenylalanine	99	88·5
DNP-glycine	58	44
DNP-valine	101·5	91

It is clear that quantitative recoveries of dinitrophenyl amino-acids cannot be expected from proteins with a high proportion of tryptophane to the N-terminal amino-acid, especially if a long period of hydrolysis is given. Probably few proteins, however, contain as many as eight residues of tryptophane per polypeptide chain (the number present in lysozyme[5]), so that, in general, the losses would not be so serious as those described above.

Even when allowance was made on the basis of these control experiments for the destruction during hydrolysis of *bis*-dinitrophenyl-lysine, the amount recovered from dinitrophenyl lysozyme corresponded to little more than half the amount expected from one N-terminal lysine residue. This might indicate the inadequacy of these control experiments in assessing the degree of breakdown of the dinitrophenyl amino-acid while in peptide linkage, or the heterogeneity of the protein preparation. Similar results were obtained with crystalline lysozyme prepared by me and that from a commercial source. Electrophoresis of the latter seemed to indicate its purity, though, if the electrophoresis was prolonged, a small second peak appeared.

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[2] Sanger, F., *Biochem. J.*, 39, 507 (1945).

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Fermentation of Malt Extract

AN investigation is being carried out on a sample of malt extract which, after standing for some months, was found to have fermented. As the extract contains about 50 per cent of sugars, mostly maltose, any organism capable of ferment must be highly osmophilic.

Various organisms have been isolated from both fresh and fermented samples of malt extract, but of them only certain yeasts were found capable of fermenting the yeast-free malt when pure cultures were inoculated back into it. With one exception, these yeasts have been found to be species of *Zygosaccharomyces*, a genus which contains many osmophilic species capable of fermenting substances such as maple syrup[1], honey[2], and the intermediate products of sugar manufacture[3].

Five of the isolates were sent to the Centraalbureau voor Schimmelcultures at Baarn, Holland, where all were identified as *Z. japonicus* Saito, though they differed slightly in minor cultural characteristics. *Z. japonicus* was originally found by Saito in "products of fermenting Soya"[1], and has since been recorded by Fabian and Hall in maple syrup and by Fabian and Quinet in honey.

That the organism can grow on substrates of considerably higher osmotic pressure than malt extract is shown by its power of fermenting almost saturated solutions of maltose, and glucose solutions of as high a concentration as 90 per cent w/v.

Studies on the biology of the fermentation are continuing.

My thanks are due to Dr. S. W. F. Underhill for his encouragement, and to the Directors of The British Drug Houses, Ltd., for permission to publish this communication.

MARY P. ENGLISH

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[1] Fabian, F. W., and Hall, H. H., *Centralbl. Bakt.*, Abt. II, 89, 31 (1933).

[2] Lochhead, A. G., and Farrell, L., *Can. J. Res.*, 5, 665 (1931).

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Absence of Hydrogen Radiation of Wave-length 21 cm. in the Sun

OBSERVATIONS have been made at the Kootwijk Station of the Dutch Organization for Radio Astronomy, in order to ascertain whether hydrogen radiation of 21 cm. wave-length, detected in the galaxy, would be found also in the sun. The 7·50-metre mirror and the receiver technique were the same as used for the investigations of the Galaxy*. No indication of a spectral line was found. The apparatus was sufficiently sensitive to detect a variation of 1/260 in the continuous radio spectrum.

The line, if present, ought to be an emission line, since the temperature in the corona is decreasing with depth. Collisions would not prevent the emission of the line: for its excitation potential is so very low that half the hydrogen atoms are always on the excited level. Calculation shows that for this wave-length the solar layers are only transparent up to about 9,000 km. above the photosphere; and that in the whole corona and upper chromosphere above this level the number of neutral hydrogen atoms is so small that less than 1/1,000 of the amount necessary for detection is present. The absence of the line is thus entirely understandable.

C. DE JAGER
M. MINNAERT
C. A. MULLER

Dutch Organization for Radio Astronomy,
Kootwijk Radio, Holland. Aug. 1.

* See p. 356 of this issue of *Nature*.

FORTHCOMING EVENTS

Monday, September 3—Saturday, September 8

British Interplanetary Society (at Caxton Hall, Westminster, London, S.W.1).—Second International Congress on "Astronautics".

Tuesday, September 4—Thursday, September 6

British Institution of Radio Engineers (at Earls Court, London, S.W.5).—Radio Conference, Session 6. "Audio Frequency Engineering".

Sunday, September 9—Friday, September 14

International Union of Leather Chemists' Societies (in the Portland Hall Annexe, Regent Street Polytechnic, Little Titchfield Street, London, W.1).—Second International Conference.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (biophysicist or physicist with experience of radioactive isotopes) in the Department of Surgery—The Secretary, The University, Edinburgh (September 8).

Assistant in Experimental Physics—The Secretary, The University, Aberdeen (September 10).

Assistant Lecturer in Applied Optics, and an Assistant Lecturer in Chemical Engineering—The Registrar, College of Technology, Manchester 1 (September 10).

Assistant Lecturer in Chemical Engineering—The Registrar, The University, Leeds 2 (September 10).

Lecturer, and an Assistant Lecturer, in the Department of Chemistry—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4 (September 10).

Physical Chemist or Biochemist (with a good honours degree or its equivalent in chemistry with either a special interest in physical chemistry or experience in spectroscopy) in the Chemistry Division, Soil Bureau, Wellington, to develop techniques of spectroscopic analysis for a minor element survey of New Zealand soil types—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting A/B.3/64/85 (September 10).

Senior Experimental Officer (with pass degree, or equivalent, in engineering, agriculture or natural science, and with previous experience of work of a similar nature) to take charge of an information unit comprising library, abstracts, publications and a small film and photographic studio—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds (September 10).

Senior Lecturer in Electrical Engineering—The Secretary, South-East London Technical College, Lewisham Way, London, S.E.4 (September 10).

Research Assistant (graduate in geography) in the Department of Geography, to undertake an investigation within the field of Economic Geography on 'The Journey to Work on Merseyside'—The Registrar, The University, Liverpool (September 12).

Assistant Civil Engineer, and an Assistant Mechanical Engineer, in connexion with the design, maintenance and construction of dock and harbour works—The Secretary, Tyne Improvement Commission, Bewick Street, Newcastle-upon-Tyne 1 (September 15).

Chief Examiner in Hygiene—The Registrar, University Office, 46 North Bailey, Durham (September 15).

Curator in Geology—The Director, City Museum, Bristol 8 (September 15).

Lecturer to teach Physics to degree standard, and an Assistant (Grade A) to teach Elementary Physics up to the standard of the General Certificate of Education (Advanced level)—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (September 15).

Chief Coal Survey Officer at the Coal Survey Laboratory in Birmingham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/367 (September 22).

Physicists or Mathematical Physicists, Physicists, Mathematicians or Engineers, at the Royal Aircraft Establishment, Farnborough: (Ref. A.133/51A/BD) Principal Scientific Officer with experience of radar systems analysis and war-time operational research, a strong mathematical bias is desirable, (Ref. A.134/51A/BD) Senior Scientific Officer for theoretical investigations; a knowledge of statistical methods is desirable, (Ref. C.217/51A/BD) Senior Scientific Officer with experience in planning and analysis of flight trials and application of results to project design; a knowledge of servo mechanism theory and practice is required, (Ref. A.135/51A/BD) Senior Scientific Officer with research experience involving arithmetical applications of mathematics in the analysis of physical data and the formulation of problems for solution by automatic computing machinery, (Ref. A.136/51A/BD) Senior Scientific Officer with wide experience of methods of measurement in physics or engineering research, experience and up-to-date knowledge of electronics—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 22).

Specialist Technical Editor (with honours degree in mathematics and/or physics, or in mechanical engineering; experience of teaching, writing or editing of textbooks on such subjects, etc.) at a Ministry of Supply establishment at Chessington—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.242/51A (September 22).

Lecturer in Gas Chemistry—The Registrar, The University, Leeds 2 (September 26).

Chemists and Metallurgists (Experimental Officer grade) at a Ministry of Supply research establishment in Berkshire: Metallurgist (Ref. F.591/51A) with research experience in electrodeposition or in the investigation of the properties of metallic films and coatings, and a Physical Chemist or Physicist (Ref. F.592/51A) with interest and preferably experience in work on ceramic materials—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 29).

Lecturer or Assistant Lecturer in the Department of Zoology, University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 29).

Technical Authors at Ministry of Supply establishments at Chessington, Malvern and Farnborough, for the preparation of official instructional publications on the theoretical and practical (including servicing) aspects of airborne and ground centrimetric radar or radio communications equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D 375/51A (September 29).

Engineer (Class 3), and an Assistant Engineer (Class 1), in the Research Section of the New South Wales Department of Road Transport and Tramways—The Agent General for New South Wales, 56 Strand, London, W.C.2 (October 1)

Mechanical Engineer, with headquarters in London, to test and report upon various items of mechanical equipment—The Secretary, Forestry Commission, 25 Savile Row, London, W.1 (October 1).

Principal Scientific Officer (with a first- or second-class honours degree in physics and some knowledge of electro-acoustics and electronics, with experience in the planning of research), R.A.F. Acoustics Laboratory—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4063/51 (October 4).

Scientific Adviser (with a first- or second-class honours degree in mathematics or physics, or mathematics and physics) in the Ordnance Survey Department, Chessington, to advise the Director General on all physical and mathematical matters that arise from the various activities of the Ordnance Survey—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4062/51 (October 4).

Lecturer in Metallurgy in the Department of Mining Engineering, University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 6).

Scientific Assistant (with a university degree in electrical or mechanical engineering or physics) in the Department of Science and Industry—The Director, City Museum and Art Gallery, Birmingham 3 (October 15).

Director (of highest professional and organizational ability, capable of directing physico-chemical and technological research)—The Secretary, Ahmedabad Textile Industry's Research Association, P.O. Box 170, Ahmedabad, India (October 31).

Abstractors for the *Veterinary Bulletin* particularly for literature on chemistry, biochemistry, physiology and pharmacology, in French, German, Italian, Spanish and Scandinavian languages—The Director, Commonwealth Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge, Surrey

Adviser in Agriculture (Ref. M.27741/A) and an Adviser in Horticulture (Ref. M.27742/A) for the Iraq Development Board—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting the appropriate Ref. No

Assistant in the Department of Physics and Optics at the College of Technology—The Director of Education, 14 Sir Thomas Street, Liverpool 1.

Assistant (female) with honours degree in physiology (zoology considered) in department chiefly concerned with clinical electroencephalography, also E.M.G., E.C.G., etc., with opportunities for human research—The Secretary, National Hospital, Queen Square, London, W.C.1.

Assistant (Scientific) with practical farming experience and experience of handling machines in the field—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds.

Assistant Lecturer in Physiology—Prof. D. S. Torrens, School of Physic, Trinity College, Dublin.

Assistant Physicist to the Leicester Regional Centre for Radiotherapy at the Leicester Royal Infirmary—The Secretary, No. 1 Hospital Management Committee, 38a East Bond Street, Leicester.

Chemists, Metallurgists and Physicists (Scientific Officer grade) at a Ministry of Supply research establishment near London and the Royal Aircraft Establishment, South Farnborough: Physical Metallurgists (Ref. 582/51A) for the determination of thermal and physical properties of metals and alloys, Physical Chemist or Physicist (Ref. F.583/51A) with an interest in metallurgy or ceramics, for research investigations connected with the preparation of novel ceramic materials, and a Physical Chemist or Physicist (Ref. F.584/51A) for work on surface phenomena and for research investigations into the properties of metallic films and coatings—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

Civil Engineers (Main grade) (Ref. H.251/51) and Assistant Civil Engineers (Recruitment grade) (Ref. H.252/51) in the Directorate-General of Works, Air Ministry, in London and the Provinces—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

Curator in Anthropology at the Raffles Museum, Singapore—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27456/51 Appts.

Director of the Government of Iraq Chemical Laboratory at Baghdad, and an Assistant to the Director—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.27714.G.

Educational Psychologist for research work in connexion with mental deficiency—The Physician-Superintendent, Royal Eastern Counties' Institution, Abbeygate House, Colchester.

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EDUCATION IN THE COLONIES

NOT many years ago those charged with educating the people of the Colonies often came in for considerable criticism. They were frequently told to leave well alone because the Colonial peoples were happy as they were. To-day it is generally realized that Colonial peoples are not happy as they are; they are demanding education, and it should be wisely conceived and generously provided.

Modern conceptions of education in the Colonies usually fall into two main classes, and these have been discussed in an article by W. E. F. Ward (*Universities Review*, 23, No. 3; May 1951). The first conception is political. The Colonies are being educated for self-government within the British Commonwealth of Nations. Self-government is the accepted aim of British Colonial policy; but it is a difficult art, and it would be a mockery to grant political power to people who were not educated to use it. Moreover, a politician, however familiar he may be with Plato, can do little these days without technicians. He needs not only engineers and medical men, but also trained administrators, actuaries, statisticians, and, possibly, public relations officers. To make self-government possible, these men must be trained, and the educational system must be designed to train them. To put self-government as the aim of the educational system takes us a good way in educational thinking and practice.

The second conception of education arises out of the poverty of the Colonies. Their mineral resources are far from being explored; their agriculture could be more productive; their communications are inadequate; they have little manufacturing industry. Their prime need is to develop their natural resources. For this they will need three things: capital, hard work, and knowledge; and two of the three, the hard work and the knowledge, should come from their education, which should be devised to bring rapid economic and social development.

Both these conceptions of Colonial education must be considered in relation to existing circumstances and show that they need to be vigorously pursued. More and more educated Colonial peoples are demanding political responsibility; the remainder must be educated to make self-government possible. More and more natural resources are being devastated through ignorance; the Colonial peoples must be educated both to use and conserve their resources wisely. Colonial educationists are thus fighting not only against human ignorance and wilfulness but also against time.

After paying generous tribute to the work of Christian Churches in Colonial education, Mr. Ward shows that to-day it is men and women of the Colonial Education Service who have most of the responsibility for planning and directing education in the Colonies.

The Colonial Education Service is a unified service: that is to say, its members can pass from one Colony to another, their service being counted as continuous, and their pensions, calculated on a uniform basis, accumulating as the years go by. On the other hand, the Service is far from being unified in the way that the Fighting Services are. It is not appointed and paid from London. Its members are selected by the Secretary of State for the Colonies; but they are appointed by the Governor of the Colony in which they serve, and are paid salaries, fixed by the Colonial Government, from taxes raised in the Colony. It would no doubt be simpler to pay everybody from United Kingdom funds, with suitable local allowances, and to post a man where he is needed. But that would be most unwelcome to Colonial Governments. They like to be masters in their own house: to appoint their own servants, to pay them, and (subject to certain Civil Service safeguards) to control them.

Every British Colonial territory has an educational system, though there are patches in some of them, like the nomadic Somali and Masai tribesmen, where education has not penetrated. Everywhere there is an education department, presided over by a director of education with some sort of educational advisory board. There are primary schools, a few good infant schools (but no nursery schools), secondary schools, teacher training centres and some technical schools or colleges. There are seven Colonial university colleges; but these are not staffed by the Colonial Education Service. Britain does not believe in Government universities.

Except in a few of the smallest territories, there is no compulsory education, for neither the Government nor the Churches can afford to provide schools and teachers for all the children. This is where the Colonies are handicapped by their poverty, by sheer lack of taxable resources. In the big African territories, only a minority of the children can go to school at all. The quality varies. A few of the schools are very good, some are mediocre, many are just bad. There has not been money to provide adequate buildings, especially expensive buildings like science laboratories, workshops and libraries. Consequently, education tends to be much too 'bookish'; this puts severe limitations on the training of local teachers. Nor is there enough money to provide an adequate staff of teachers from overseas.

Yet it would be wrong to imagine that these schools are useless. There is nothing wrong with them that could not be put right by a grant of £50,000 for buildings and equipment, and an annual grant for additional staff salaries. The trouble is that the local Governments have not got the money. They prefer to have one or two really good schools, which can serve as models for the others to copy, and can be used as training centres for teachers from elsewhere. These schools are often very good indeed, as regards staffing, building and equipment.

All this means that the man in the Colonial Education Service, whether teacher or administrator, is kept on the alert. He is always making bricks with the minimum of straw. He has to turn his hand to anything, to improvise. His work is exhausting; but immensely stimulating and worth while.

Teaching and administration are the two main functions of the Service. People often pass from teaching to administration, and sometimes back from administration to teaching. In most territories, the primary school teachers are all locally born. In the infant schools there are still some head teachers with a Froebel or similar qualification who are recruited in Great Britain and are members of the Colonial Education Service. In the secondary schools, and still more in the teacher training centres, there are in the aggregate large numbers of graduate teachers, and it is the normal practice for all newly appointed members of the Service to be posted first to classroom teaching.

The bush education officer has no exact counterpart in Britain. He may be responsible for the general educational efficiency of a district which may be as big as Scotland or as small as Rutland. There may be in his district a Government or Church secondary school with one or two Europeans on its staff, or even properly qualified locally born teachers. There will certainly be other professional colleagues—a district commissioner, an agricultural officer, and a medical man. He may be able to persuade them to help him now and again in some special project, such as a holiday refresher course for the primary school teachers. His work will be a never-ending round of visiting schools, inspecting the state of equipment, listening to the teaching, advising and helping the teachers and often giving a demonstration lesson himself, assessing the schools' eligibility for grant and checking the finances, planning extensions to buildings and planning new schools and collecting the teachers for holiday courses.

The bush education officer is in some ways the key man in the educational system. It is very largely a matter of his personality whether the schools in his area are active or stagnant. This is mainly due to the inadequate education and professional training which most of the staff have received. Many of them have excellent capacities; but too often they have had so little opportunity that they have been able to do nothing but acquire knowledge and a few stereotyped ideas on method and technique. The education officer has to draw out of them what he feels they have in them.

He is like the local education authority's representative in that he is the superior officer of the Government teachers, and has scarcely less power over the teachers in the assisted or unassisted Church or native authority schools. He is in close touch with the mission or other employing body; he can recommend that the school's grant be increased or diminished, that an unassisted school be placed on the assisted list or told to wait. In dealing with missionaries or local government bodies, he is like British school inspectors in being able to give them advice on the condition of their schools. If they need to spend money he cannot compel them to do so; like the divisional executive in Britain, he has to persuade them. The man who can keep his teachers up to scratch, keep on good terms with his Government colleagues in half a dozen different departments and with the representatives of half a dozen assorted missionary societies, persuade a group of canny village elders that if they want a school they must build it themselves, lay his plans for educational expansion and get them accepted by his departmental chiefs and the advisory board at headquarters, could fill most positions in the educational world adequately enough.

The curriculum in schools and colleges is often determined by two considerations: the first, that the pupils have to be prepared for all the multifarious techniques that a modern civilized State requires; the second, that education must be rooted in the pupil's ancestral culture. To some extent these two considerations come into conflict. The dominant European culture has such an attraction for the pupils that they tend to resent anything which diverts their attention from the full-time occupation of studying it. It is not that in general they are hostile to their own culture, though such hostility is a phase which some of them pass through; but most of them would gladly be learned in the lore of their own people if they could become so without giving up the new learning which comes to them from the West.

Hence the greater part of the curriculum reads like a copy of the curriculum in Great Britain—as, in fact, it is. Here and there it is possible to make minor local modifications. Local history and geography play a part in the courses, and are offered in the Cambridge examinations. There was a time when English earthworms and dandelions were sent out on ice to be dissected by African candidates in biology examinations; but they have long since been replaced by local types. Work in art, music and housecraft is often based on local conditions and local culture. But it is not possible to make much variation in an educational system which has to train engineers, medical men, lawyers, accountants, professional men and technicians of all kinds. Students in the Colonies naturally demand professional qualifications that are recognized in Great Britain. The place for local culture seems to be rather in the study of the local languages and literatures, and in school organization and out-of-class activity, than in the study of subjects which are designed to lead to the acquisition of distinctively Western skills. There is no doubt that indigenous culture will have to play a larger part in Colonial education in the future than it does now. One of the great services which the new Colonial universities will be able to render is in undertaking the necessary study of indigenous cultures and in building up a new civilization based on a blend of the indigenous culture with that of the West.

The lack of cultural background is felt over a much wider field than the study of the arts. Except in a few special cases such as the Caribbean, Western education tends to draw the children away from their own social background. Many of them come from illiterate homes, and their parents aspire to see them appointed to a well-paid Government post, preferably one which does not involve hard physical work. The first effect of schooling is thus often to take a child right out of touch with the primitive life in which his parents still live. As a result many critics say that in a territory where agriculture must for many years remain the principal industry and source of revenue, people ought to realize that they are needed on the land; and there must be something wrong with an educational system which enables—or even encourages—people to leave the land and flock to the towns.

The critics, of course, are crediting the school-teacher with a good deal more influence than he has, and they are ignoring a good deal of human nature. To get boys into the mines in Britain one thinks in terms of wages, holidays with pay, housing, pit-head baths and canteens. It will have to be the same in the Colonies. Young people will never be kept on the land by setting school-teachers to preach at them about the importance of agriculture.

Nevertheless, the educationist must do what he can to avoid this unhappy cleavage between educated young people and their rural background. There is little that he can do in modifying his curriculum; but he can set up various adult-education movements and various types of youth work to enable ignorant parents to comprehend the purpose of school education and to enlighten those who remain behind in the villages. This side of education is still in its infancy.

Enough mass education work has already been done, however, to show the possibilities that are waiting to be realized if men and women can be found to undertake it. Tribesmen in Nigeria have built themselves roads and bridges and all sorts of public buildings, from market halls and co-operative shops to maternity clinics. The demand for reading-matter in six different languages among recent illiterate workers in the Rhodesian copper belt kept the printing presses on the strain. In the Caribbean and in East Africa people have begun by realizing with a shock that the school could teach them something even on their own subject of farming, and they have gone on to profit by this discovery in improving their nutrition, their health, their home life, and their general community spirit. Mass education has great possibilities, and might, in fact, go a long way towards healing the rift between formal education and real life. But there is nothing like enough of it yet.

Mr. Ward also shows that educational research in the tropics is an almost untouched field. Visual aids, intelligence tests, English as a foreign language, curriculum and organization, relationship between school and home are only a few of the outstanding topics on which many people have views based on experience, but on which scarcely anyone has yet done any proper research. There is great need of research workers, and this, too, is a field in which it is hoped that the new Colonial university colleges with their institutes of education will be able to help.

THE ESSENTIAL OILS INDUSTRY

The Essential Oils

By Dr. Ernest Guenther. Vol. 4: Individual Essential Oils of the Plant Families Gramineæ, Lauraceæ, Burseraceæ, Myrtaceæ, Umbelliferæ and Geraniaceæ. Pp. xiv+752. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1950.) 90*s*. net.

THIS volume follows the same plan, and achieves the same excellence, as its predecessor (see *Nature*, 166, 753; 1950). The oils here dealt with, however, being predominantly products of the eastern hemisphere, and indeed of the Far East, illustrate in a much more striking fashion the contrast between highly modernized and wholly primitive methods of production, which is so marked a feature of the essential oils industry as a whole.

Palmarosa, cassia and lemongrass provide examples of oils in which the organization and technique of production can have altered little since the era of bulging galleons and buccaneering raids, so pleasantly touched into the background of Dr. Guenther's account of cinnamon and clove. Such oils, obtained from herbs or small shrubs, are highly seasonal in output, and produced in scattered locations, defined partly by ecological suitability for the oil-bearing crop, and partly by unsuitability for any more immediately profitable husbandry. These factors, added to the bulky nature of the crop, and the low weight-proportion of the oil, which is the only valuable part of it, preclude the steady flow and concentration of raw material which alone could offset the capital expense of a modern processing plant. So far as such oils are concerned, therefore, production of essential oils remains a peasant industry, based on the most unambitious standards of living and the crudest distillation equipment, and liable to great unevenness or total interruption of output when political unsettlements compel the peasant's attention more exclusively to his immediate needs of livelihood. The connexion is clearly illustrated by the decline of the Algerian geranium oil industry, linked with the progress of Algiers from colonial status to that of a department of France. In Réunion, under social conditions which Dr. Guenther judiciously describes as "feudal", production of geranium oil maintains its economic equilibrium.

In contrast are the developed industries based on camphor and eucalyptus, each so completely a subject in itself that even such a coinage as "eucalyptologist" must be accepted as a necessary evil; and Dr. Guenther has been wise and fortunate in leaving the appropriate monographs in the hands of specialists, co-ordinated by Dr. T. Hiraizumi, of the Takasago Chemical Industry Co. of Tokyo, and Messrs. A. R. Penfold and F. R. Morrison, of the Museum of Technology and Applied Science, Sydney. The camphor industry, it is true, can show a lineage comparable with that of cinnamon itself; to the Formosan woodcutter, the largest camphor tree in the forest is still a shrine, and each lesser tree a spirit, not to be insulted without offerings of propitiation; but between the forest and the market, Japanese activity, in response to the challenge of artificial camphor, has interposed an organization of singular completeness. The status of the tree as a vegetational dominant over large areas permits of a more systematic harvesting and replacement, and a more thorough study of botanical variations, than is possible with grasses and herbs. To this has been added the utmost possible utilization of all constituents of the crude produce, export or consumption of which without fractionation was prohibited by the Japanese Monopoly Bureau. The number and variety of 'cuts' and isolates from camphor oil may indeed become confusing, and Dr. Hiraizumi's clarification of the subject is accordingly welcome.

Except in respect of its antiquity, the eucalyptus industry stands on a similar footing. Potentially it is capable of even wider expansion, since the very numerous species of the genus show a greater variety among themselves than is often found between oils from different genera or even different families. As examples may be quoted *E. polybractea*, yielding medicinal oil with up to 90 per cent of cineole; *E. numerosa*, with up to 80 per cent of phellandrene, used industrially in ore flotation; and the perfumery oils of *E. macarthuri* and *citriodora*, containing respectively up to 70 per cent of geranyl acetate and 80 per cent of citronellal. Even morphologically indistinguishable trees growing within a few feet of one another may yield wholly different (cineole-rich or piperitone-rich) types of oil. Confusion may be increased by commercial practice in giving a blended oil the name of a single species if it is of the type traditionally associated with that species; for example, *E. globulus*, even though it is well recognized that unmixed oil of that species is not, in fact, marketed from Australian sources. Penfold and Morrison's painstaking comparative review of some two hundred and fifty specific names in the genus is therefore not the least valuable part of their contribution.

The future of the primitive types of essential oils industry is obviously somewhat problematical. A fuller utilization of the raw material would seem to be the first condition of survival. Uses can be found even for the spent material, as, for example, the production of paper in Guatemala from lemongrass leaves after distillation. Improved distillation technique may multiply the number of products, as with the fractions of camphor oil, or improve the yield of specially valuable constituents such as the citral which, through the intermediate stage of β-ionone, hitches the wagon of lemongrass oil to the commercial star of synthetic vitamin A. It may be that in some cases such a degree of development implies no less than the bodily transplantation of the old industries to distant sites where they will constitute staple instead of spasmodic occupations, and where lay-out and transport are specifically adapted to their purposes; and Volume 3 of this work affords evidence that such a solution is physically possible. Dr. Guenther's book will then seem out of date; but scarcely, one may suppose, before then.

E. G. Kellett

FRESHWATER PHYTOPLANKTON

Die Binnengewässer

Band 16: Das Phytoplankton des Susswassers; Systematik und Biologie. Von Dr. G. Huber-Pestalozzi. Teil 3. Cryptophyceen, Chloromonadinen, Peridineen. Pp. ix+310+69 plates. (Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung, 1951.) 67 D. marks.

THE great importance of freshwater phytoplankton in limnological studies has long rendered desirable a taxonomic treatment of the organisms involved. Such a phytoplankton flora was indeed planned by those responsible for the publication of the valuable "Susswasserflora Deutschlands, Oesterreichs, etc.", although it never reached completion. Huber-Pestalozzi's work, forming part of the series of Thienemann's "Binnengewässer", thus fulfils a useful purpose in supplying this long-felt need. The parts already published (Teil 1, 1938; Teil 2 in two separate portions, in 1941 and 1942), which, apart from containing a general introduction, have dealt with the Myxophyceæ, Bacteria, Fungi, Chrysophyceæ, colourless Flagellata, Xanthophyceæ and Diatoms, have not been available for review. The entire work to date costs about 260 D. marks (upwards of £20) unbound, and three further parts are planned. It will be clear that the cost is almost prohibitive for the private individual, and it may be questioned whether a treatment on a less ambitious scale would not have been more valuable. The need is for a work of a less-expensive character that could be published at a price which would render it accessible to more than libraries and institutions.

The particular part under review deals in the first place with the Cryptophyceæ and Chloromonadineæ, of which no detailed systematic treatment has appeared since that of Pascher in the "Süsswasserflora" (1913). Scherffel's problematical genera *Monomastix* and *Pleuromastix*, the affinities of which are hard to assess, are grouped as a sub-class Monomastigineæ, the remaining Cryptophyceæ forming the sub-class Cryptomonadineæ. The latter are urgently in need of a critical revision, as Pringsheim (1944) has pointed out, and the material brought together by Huber-Pestalozzi will afford a basis for future work on the group. The author provides a useful key to the thirty-two described species of *Cryptomonas*. In the treatment of the Chloromonadineæ no reference is made to recent French work (Chadefaud 1937, Hovasse 1945), especially that relating to *Gonyostomum*, from which better figures than that of Stein of *G. semen* could have been obtained. The author appends to the account of the Chloromonadineæ a discussion on trichocysts which both French authors have studied in some detail. The greater part of the volume is concerned with the important planktonic group Peridinieæ, of which Schiller has comparatively recently (1931) given a detailed systematic account in Rabenhorst's "Kryptogamenflora". The restriction to freshwater species and the provision of detailed keys for such large genera as *Gymnodinium*, *Glenodinium*, and *Peridinium* will make Huber-Pestalozzi's treatment useful to workers on freshwater plankton.

The majority of the 350 illustrations are reproductions and, especially among Cryptophyceæ and Chloromonadineæ, the absence of fresh figures is disappointing. The bulk of the figures are grouped as plates on stiff paper, which must have added to the cost of the work, although most of them could equally well have been reproduced in the text.

F. E. Fritsch

TECHNOLOGY OF ALUMINA PRODUCTION

Tonerde und Aluminium

Ergebnisse und Erfahrungen aus der Betriebspraxis, 1920–1950. Von Dr. Wilhelm Fulda und Dr. Hans Ginsberg. Teil 1: Die Tonerde. Pp. viii+226. (Berlin: Walter de Gruyter und Co., 1951.) 26 D. marks.

THE publisher's notice of this authoritative work states that it is intended to provide what has as yet been lacking—a comprehensive account of the actual working practices of the alumina and aluminium industries. The present volume, on alumina production, certainly fulfils this intention.

While omitting mention of many processes now only of historic interest, it contains much more quantitative information on current operations than did Edwards, Frary and Jeffries's standard work, published in 1930.

After reviewing in detail the properties of European bauxites and to a less extent those of other countries, the book devotes nearly eighty pages to the development in Germany, during a period in which German aluminium production was expanded from about 14,000 tons (in 1920) to 260,000 tons (in 1943), of the classical Bayer process for extracting alumina from bauxite with caustic lye, and its modification the so-called 'tower process'. There follow some fifty pages describing the alternative 'sinter-alumina' process in which the bauxite is heated with sodium carbonate in a rotary furnace; methods of extraction, due to Pedersen and others, in which lime is the extracting agent and still higher temperatures have to be used; and such processes as that due to Haglund, which have as their object the removal of impurities from the bauxite rather than the direct extraction of the alumina itself. The remainder of the book is devoted to processes for extracting alumina from clays and other aluminosilicates.

The book is systematic, essentially practical from the point of view of the chemical engineer, and engagingly clear. It is well provided with flow diagrams and other illustrations. It has behind it the authority of two authors well known in the industry. Dr. W. Fulda died in September 1950; and while the surviving author acknowledges the collaboration of colleagues in the Vereinigte Aluminium-Werke A.G., the book achieves a noteworthy unity of presentation.

All who are concerned with the technology of the primary aluminium industry will welcome this book and will look forward keenly to the appearance of the succeeding volume, which is to deal with the production of the metal.

PRODUCTION OF GLASSHOUSE CROPS

Science and the Glasshouse

By William J. C. Lawrence. Second edition, revised. Pp. xiv+176+4 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1950.) 15*s*. net.

THIS book is divided into three parts: (1) the John Innes composts, (2) methods of cultivation, and (3) natural illumination in glasshouses, and gives an account of work done at the John Innes Institution on these subjects. Indeed, it is a progress report on experimental work carried out by Mr. Lawrence and his colleagues.

So far as Part 1 is concerned, little need be said; the John Innes composts for seedlings and growing plants are now widely used by growers, and there is no doubt that considerable improvement in plant production has thereby been brought about.

Part 2 deals with several fundamental aspects of plant production, for example, size of pot, firm or loose soil, watering, soil temperature for potting, type of benching in the glasshouse, etc. These are all factors in which tradition has decided the correct way, and tradition dies hard. Moreover, it is probable that tradition will govern many of these factors for some years to come, for to many growers of the 'old school' these new ideas are not welcome. Apart from this diehard attitude, there are several considerations which must be taken into account by the commercial grower. For example, the size of pot into which a plant is potted is very often governed by the space available; this is particularly true in the case of the grower of decorative plants for sale in pots.

The skill of the worker under whose care the plants are placed is a most important factor which cannot be assessed experimentally, but which has a profound influence on the ultimate result. It has frequently been said that the horticultural worker who cannot use the watering can or hosepipe efficiently and intelligently cannot grow a good plant or produce a good crop. There are many similar variable factors in plant production which cannot be standardized except by the most elaborate equipment, but which are controlled to some extent by the human factor. Therefore, however far the fundamental processes of horticulture are standardized the human factor will ultimately decide the quality of the plant.

Mr. Lawrence has, in the experiments described, blasted tradition; he has opened up new lines of approach to many problems; but it is very necessary that the experimental results shall be linked with the economics of plant production, and further experiments on these lines are necessary.

In the last part of his book Mr. Lawrence has explored new ground and has collected together a vast amount of data on the natural illumination of glasshouses. The information given is of great value and has already influenced the design of glasshouses. The importance of light in the production of winter crops is emphasized and suggestions are made for obtaining improved winter illumination. It is difficult to understand why work has not been done previously on this and many other problems concerning glasshouse construction.

This is a book which is stimulating and, in many ways, provoking. It should be read by all who are interested in the production of glasshouse crops, for in it they will find considerable food for thought.

Mr. Lawrence is to be congratulated on the production of this book, which is a contribution to the fundamental knowledge of glasshouse crop production of very real value. WILFRED CORBETT

TECHNOLOGICAL RESEARCH IN SWITZERLAND

Industrial Research in Switzerland

Its Institutional and Economic Background. By Prof. Ronald S. Edwards, in collaboration with Charles La Roche. Pp. ix+111. (London: Sir Isaac Pitman and Sons, Ltd., 1950.) 21*s*. net.

PROF. R. S. EDWARDS has followed his earlier study of the economic aspects of the research associations in Great Britain with a study, in collaboration with Dr. C. La Roche, of the Federal Institute of Technology, Zurich, of the organization of industrial research and development in Switzerland. The book is based on a survey of Swiss industrial research institutions, together with discussions with firms, research institutions, universities and government departments, and includes some information not elsewhere available. There is a select bibliography, prepared by Dr. C. La Roche, and much useful information is collected in the appendixes, dealing with research foundations, the scientific societies and the government research institutes.

The book appears to be designed as a contribution to current discussions on the increases of industrial productivity. It first briefly outlines the industrial pattern of Switzerland and the extent to which research is fostered in industry. This is followed by a chapter on the universities and industry, in which some comparison is made between Swiss and British universities, and the relations between industry and the universities in Switzerland are discussed. A chapter on institutions for co-operative industrial research makes good a gap; the remaining chapters deal with the Federal Government as a sponsor of research, and with research, taxation and the patent system, and finally Prof. Edwards attempts to outline the general influences in Swiss life that must be taken into account in seeking the root causes of Swiss industrial achievement.

One merit of this book is that, although it makes many suggestive comments on the differences between the pattern and practice of industrial research in Great Britain and in Switzerland, Prof. Edwards never attempts to push the comparison too far. He is fully aware of the differences in definition, for example, which may make comparison between one industry or one country and another misleading, even where figures exist as a basis. The chapter on the universities and industry may well prove to be the one of most general interest, and its account of science and technology in the universities has a bearing on discussions on higher technological education in Britain. It appears from the analysis presented here that, out of its relatively larger university population as compared with that of Great Britain, Switzerland has a higher proportion of students reading applied science and technology, and that the difference has become more marked since the Second World War. On the other hand, Great Britain spends more per student and the ratio of staff to student has increased slightly, whereas in Switzerland it has decreased appreciably since before the War.

Prof. Edwards's comparison between Switzerland and Great Britain is not unflattering to the latter; but it does not encourage complacency. He points to some weaknesses in the Swiss system, particularly in regard to fundamental research and the lack of openings in academic life. He suggests that a full-scale study of Swiss technical schools, and especially of the Federal Institute of Technology, their organization, administration, curricula and relations with industry, both in regard to training and research, would make a more important contribution to the current debate in certain circles in Britain on the future of technological education than a study of the relations between industry and the universities in the United States now being investigated by a team under the Anglo-American Productivity Council. The great problem, in his view, which Great Britain has not yet fully solved, is how to adapt middle and higher education to meet the needs of the large number of students who must find—and who it is hoped will want to find—their careers in the middle and upper ranks of industry and trade. Prof. Edwards does not claim that his present essay is more than a sketch. Whether or not it stimulates the further inquiry he suggests, it should at least assist in keeping on a factual and practical basis future discussions on productivity and on technological education.

R. BRIGHTMAN

Physical Chemistry

By A. J. Mee. Fourth edition. Pp. xix+753. (London: William Heinemann, Ltd., 1951.) 25s.

THIS well-written book has for years been recognized as a standard introduction to physical chemistry for university students. By resetting the type and by some rearrangements, the publishers have shortened the book by twenty-nine pages: otherwise there is very little alteration from the 1947 edition. The new matter amounts in the aggregate to two pages only; of these, one page is given to chromatography and the other is made up of some additions to a few chapters each too small to be of much value. Further, the author has deleted two adversely criticized pages dealing with the theory of ionic discharge and has not filled the gap. With the uneven advance of knowledge this policy of leaving well alone is highly questionable. For example, the small and unchanged section devoted to artificial radioactivity is now out of all proportion to the very numerous papers appearing on this subject. Again, as the author has left his discussion of nuclear fission unchanged from 1947, he still makes no mention of plutonium and neptunium, of Powell's work on mesons, of the production and use of radioactive tracers, or of polarography. Accordingly, it is astonishing to read the publishers claim that the book has been "revised throughout" and that the treatment of nuclear fission is "up-to-date". Finally, throughout the book the bibliographies are now behind the times.

G. Fowles

Intermediate Practical Chemistry

By Sylvanus J. Smith. Pp. vii+248. (London: Macmillan and Co., Ltd., 1951.) 8s. net.

TO the text-books already to his credit Mr. S. J. Smith has now added a complete practical chemistry intended for the advanced course in schools and for classes of a similar standard. In selection and treatment the author keeps mostly to the classical tradition; but he occasionally introduces a novelty. Thus in the section on volumetric analysis (83 pages), students are encouraged to prepare standard sodium carbonate by a laboratory modification of the Solvay process. Mr. Smith gives 21 pages to gravimetric and colorimetric analysis, and 35 pages to physical chemistry; organic chemistry, mostly preparations, gets 55 pages and qualitative analysis 52. An appendix contains directions for the preparation of reagents and a table of logarithms. The scheme contains more experiments than can usually be done in a school course, but does not contain any on the colloidal state, or on the determination of gas-volume ratios, and few on inorganic preparations. Still, the book contains a good course of work, and the author is obviously an experienced teacher who knows the limitations of a school laboratory.

Inorganic Syntheses

Editor-in-Chief, Ludwig F. Audrieth. Vol. 3. Pp. xi+230. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 32s.

THIS volume continues a series intended to provide chemists with a compilation of tested methods for the synthesis of inorganic compounds. Any such series is likely to have the limitation evident in this volume—that it provides only for a restricted number of specialists in particular fields of research. The wide variety of techniques common in modern inorganic chemistry tends to bring discontinuity into any text covering selected compounds rather than chosen experimental methods.

In addition to a number of specially selected single substances, this volume covers several interesting groups of inorganic compounds such as alkali phosphates and fluo-phosphates, a number of anhydrous metal fluorides, and several organo-silicon derivatives. The special techniques required for the preparation of strontium sulphide and selenide phosphors are fully detailed, and a particularly interesting section outlines the extraction and separation of zirconium and hafnium from cyrtolite. Further sections deal with the preparation of boron trichloride and tribromide, rendered particularly difficult by the ease of hydrolysis of these compounds.

The descriptive detail of this volume maintains the high standard set by volumes 1 and 2, and the whole work gives evidence of careful selection and testing of the prescribed methods. It is a worthy addition to any reference library, although the frequency of its use will largely depend on the particular interests of inquiring readers. The book also provides useful material for a neglected aspect of university work—the teaching of preparative inorganic chemistry.

A. J. E. W.

Inland Waterways of Great Britain and Northern Ireland

Compiled by Lewis A. Edwards. Pp. xvi+440. (London: Imray, Laurie, Norie and Wilson, Ltd., 1950.) 30s.

THIS book contains much valuable and detailed information about the canals and rivers of Great Britain and Northern Ireland. The bulk of the text consists of an alphabetical account of each canal and river at present open to navigation, giving areas served, distances, maximum dimensions for craft using the waterway, speed regulations and other information essential to users. In addition, there is a valuable appendix containing short sections on such matters as the history of inland waterways, locks and lifts, aqueducts, bridges and types of commercial craft. There are also navigation hints, tides and tidal information and a list of rivers suitable for canoeing. Particularly useful is the glossary of canal terms, with its definitions ranging from the so-frequently misused term 'barge' to 'chalico' (the mixture used for dressing the timbers of wooden boats) and to the 'gongoozler' (an idle and inquisitive person who stands staring for long periods at anything out of the common).

In a foreword, Mr. R. F. Aickman, chairman of the Inland Waterways Association, stresses the point that the two thousand miles of navigable river and canal in Great Britain offer unlimited possibilities for pleasure traffic, and argues that what has been done on the Norfolk Broads can be done throughout the country.

Under the provisions of the Transport Act, 1947, our navigable rivers and canals have become national property, and the great interest now taken in the possibilities of using these waterways for pleasure traffic, together with the efforts of the Inland Waterways Association, is leading to considerable developments. In addition, it is clear that local water shortages, coupled with serious flooding in many areas, make the maintenance and improvement of the inland waterways of Great Britain a national necessity.

K. G. Fenelon

THE DEVELOPMENT OF TAXONOMIC THEORY SINCE 1851*

By J. S. L. GILMOUR

Director, University Botanic Garden, Cambridge

THE early 1850's as a starting point for the examination of the development of taxonomic theory are appropriate not only because of the centenary aspect of the Edinburgh meeting of the British Association but also because they have an intrinsic importance as the culminating point of pre-Darwinian taxonomy, when the natural system had triumphed completely over the Linnean. What basic assumptions, then, were held by taxonomists at this period ? What, to put it crudely, did men like Robert Brown and William Hooker have at the back of their minds when they described one of their countless new species, genera or families ? A good answer can be obtained from John Lindley's preface to his "Natural System of Botany" (1836).

Lindley's basic concept was that of natural affinity. He looked upon classification as a process of discovering such affinity between different species, the degree of affinity being measured by the degree of resemblance. The concept of affinity itself is nowhere specifically defined ; but it is clear, I think, that Lindley did not regard it as identical with degree of resemblance, but rather as something distinct which was indicated by resemblance. In so far as Lindley did attempt to characterize further the concept, he linked it with the then commonly held belief in the existence of a plan of creation laid down, once and for all, by a Creator, and he regarded affinity between species as, in some way, an expression of such a plan. He was, however, not altogether whole-hearted in his support of this view. "We must suppose," he writes, "that one plan only has been observed in the creation of living things, and that a natural system is the expression of that plan." Immediately afterwards, however, he qualifies this by adding that "it must not be forgotten that such a plan may be represented in many ways". This gave scope for his strongly held conviction that, above the rank of species, which he regarded, of course, as fixed and unchanging, taxonomic categories are man-made, and that it is quite impossible for us ever to construct one universally agreed natural classification, not only because of our varying degree of skill in the recognition of affinity but also because species are connected in, so to speak, many different planes, thus making it impossible to represent their relationship in a single, one-dimensional scheme.

We can take it that Lindley's concept of natural affinity, more or less modified, of course, as regards emphasis, was the generally accepted assumption underlying biological classification immediately before Darwin, in 1859, put forward his theory of evolution based on natural selection. Before considering the effects of Darwin's work, I would like to point out, in passing, that the natural affinity concept inevitably placed biological classification in a category quite apart from the classification of non-living things and that there was very little attempt at that time, by biologists, to consider what common principles, if any, there might be between the classification of, say, books on one hand and buttercups on the other.

As is well known, the acceptance of evolution led Darwin himself, and taxonomists in general, to give a new meaning to natural affinity. Lindley's rather vague and mystical concept was re-interpreted in evolutionary terms, and identified with what was variously described as genealogical relationship, phylogenetic relationship, true relationship, or simply relationship. Darwin himself, for example, in the famous Chapter 14 of the "Origin of Species", laid down that all true classification is genealogical and that "community of descent is the hidden book which naturalists have been unconsciously seeking", and the majority of later taxonomists have taken the same view. George Bentham, for example, in his address to the British Association in 1874, on "The Recent Progress and Present State of Systematic Botany", expounds it at length, and most modern text-books echo the same interpretation. Dr. Swingle, for example, in his "Text Book of Systematic Botany" (1946) writes : "The *ideal* classification . . . must show actual phylogenetic relationships", and many other similar expressions of this view could be quoted.

Interrupting and disturbing, however, this stream of doctrine flowing from the "Origin of Species", there have been an increasing number of rocks and islets of opinion which have criticized, in one way or another, the simple identification of Lindley's natural affinity with post-Darwinian 'relationship'. Such criticism has not, of course, been directed for one moment against either the fact that evolution has taken place, or that genealogical relationship is clearly one of the prime factors influencing similarity between living organisms. The criticism, rather, has been directed against the over-facile picture that has been built up of the existence of one single, vast, phylogenetic tree of living organisms, analogous with a genealogical family tree of individuals, and against the view that the prime and ultimate aim of taxonomy is to discover and embody this tree in one ideal system of biological classification. Many botanists and zoologists have shared in this critical attack ; but I have space to mention only F. A. Bather's masterly analysis in his address to the Geological Society of London in 1927 on "Biological Classification, Past and Future", and W. B. Turrill's comprehensive survey in *The Botanical Review* of 1942. Further, those who took part in the Systematic Association's discussions just before the War on this subject will not easily forget the arguments put forward on both sides, nor the heat they engendered, and this year at Leeds the battle was joined again under the auspices of the same Association (see *Nature*, 167, 503 ; 1951).

What, then, has been the substance of these criticisms ? Broadly speaking, they have emphasized the extreme complexity of evolutionary change, the impossibility of extracting from the welter of actual evolutionary history (including polyphyletic origins in both time and space) any single, simple factor that can be called genealogical or phylogenetic relationship, and the folly, even if such a factor could be isolated, of regarding morphological resemblance as an exact index of it.

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* Substance of a paper read on August 14 before Section K (Botany) of the British Association meeting at Edinburgh.

There is no doubt, to my mind, that such criticism is amply justified, but I would like to suggest that it has somewhat misfired owing to the lack of any positive proposal put forward as an alternative to the admittedly very attractive and simple picture of one ideal classification based on "true relationship".

To understand the reason for this lack of alternative we must go back, for a moment, to Lindley and the pre-Darwinian taxonomists. Their concept of natural affinity, expressing the plan of a Creator, lifted biological classification right out of the realm of the classification of non-living things, and the Darwinian re-interpretation has, of course, further emphasized this separation. The fact is, however, that biologists have almost completely ignored, or dismissed as irrelevant, the fundamental principles of classification which apply to all objects, whether living or non-living, and which have been discussed and re-discussed by philosophers from the time of the Greeks until the present day. This isolation of biological from general classification has, in my view, been fatal to a proper appreciation of the aims and methods of taxonomy and is largely responsible for the confusion that exists to-day.

These general principles may be studied in many text-books of philosophy and scientific method. Perhaps the most satisfactory for our purpose is "The Principles of Science" by W. S. Jevons, first published in 1874. From this and other sources the following highly simplified elementary principles may be extracted.

(1) Classification is a fundamental prerequisite of all conceptual thought, whatever the subject material of that thought. Thus, as soon as we call an object 'hot', we are creating a class of hot things and assigning the object to that class.

(2) The primary function of classification is to construct classes about which we can make inductive generalizations. Thus, having constructed the class of hot things, we construct a further class of 'things that hurt', and, based on experience, we can make the inductive generalization that hot things hurt.

(3) The particular classes we construct always arise in connexion with a particular purpose. The class of 'things that hurt' clearly springs from a universally important purpose to human beings—the avoidance of suffering; the class of, say, "botanists whose fathers had beards", does not, and hence has not, so far as I know, been constructed before this moment.

(4) The classification that we adopt for any set of objects depends on the particular field in which we wish to make inductive generalizations. Different fields of generalization call for different classifications. Thus, if we wish to investigate the connexion between female authorship and murder stories we would make quite a different classification of books from that required for generalizations about, say, American publishers and limited editions.

(5) Clearly some classifications are of more general use than others. Thus a classification of books, based on subject-matter, into such classes as dictionaries, novels, biographies, etc., is of wider use than one based on the colours of bindings. The reason for this is that the basis of the first classification, namely, the contents of the book as conceived by the author, affects more of its characteristics than does the basis of the second classification, namely, the colour of the book as conceived by, presumably, the publisher. In short, subject-matter has a stronger influence on the total characteristics of books than has binding design. In the general theory of classification, classifications which serve a large number of purposes are called natural, while those serving a more limited number of purposes are termed artificial.

(6) It is clear from the above that there cannot be one ideal and absolute scheme of classification for any particular set of objects, but that there must always be a number of classifications, differing in their basis according to the purpose for which they have been constructed. One classification may, of course, be more natural than another in the sense defined above, and if there is one factor influencing a group of objects more powerfully than any other, then a classification based on that factor will be more natural—that is to say, useful for a greater number of generalizations—than any other; but the difference between this and other classifications is one of degree only, and not of kind. In the classification of books, for example, an arrangement based on subject-matter is probably more natural than any other, but one based on authorship must run it fairly close, bringing in, as it does, the factors of date and style, as well as, to some extent, that of subject-matter.

The view just outlined of the general nature and function of classification as a basic process in the making of inductive generalizations is the one generally accepted by students of scientific method. What is its relevance to biological classification? Its relevance is, I suggest, two-fold. In the first place, it can perhaps help us to understand more clearly the history of taxonomy, its aims and its methods, during the past hundred years; and, secondly, it can, I think, lead to a view of the aims of taxonomy more in line than at present with modern philosophical thought in general and more useful in solving some of the problems now confronting taxonomists—notably those problems concerned with the incorporation of recent data from experimental taxonomy into suitable taxonomic categories.

As regards history, we can see how a failure to appreciate the general principles of classification, and to apply them to living things, has led biologists to seek other aims for taxonomy in order to fill the vacuum created. The form which these aims have taken, namely, the construction of one ideal classification based, at first, on natural affinity and, later, on 'true relationship', is a particularly attractive one to the human mind. It has the comforting qualities of all 'absolutes', and the concept of true relationship undoubtedly bears, emotionally, a strong family resemblance to the concepts of beauty in æsthetics and goodness in ethics. Recently there has been a widespread element in philosophical thought tending to examine critically these absolute concepts in æsthetics and ethics, and I suggest that the time has come for the same healthy breeze to be directed towards the concept of true relationship in taxonomy.

This brings us to our second point of relevance. Let us suppose, for a moment, that we have abandoned as chimærical the aim of constructing one ideal classification of living things based on true relationship. What aim, grounded in the general principles of classification, can we put in its place, and how would such an aim help us to solve present problems in taxonomic practice?

Clearly, the primary aim of taxonomy, on this basis, must be the construction of classes of living things about which scientifically useful inductive generalizations can be made. Further, there must be a number of different classifications, each based on different characters, and each equally valid for its own purpose.

It is true that there will be one, as it were, general-purpose classification, more natural than others, in the sense that more inductive generalizations can be made about its classes—and this general-purpose classification is, of course, the normal taxonomic arrangement into species, genera, families and so on. This classification should not, however, be regarded as an approximation towards a single, ideal scheme, but as a permanently flexible arrangement, changing as new knowledge is acquired and incorporated in it. It can be called phylogenetic only in a secondary sense, namely, that the reason why a particularly natural biological classification can be made at all is of living things—and, further, phylogenetic studies can, of course, be made regarding the origin and development of its groups; but both these considerations are very different from regarding a natural classification as essentially and primarily phylogenetic.

One may well ask, what difference does it make in practice whether we regard a natural classification of living things as—to put it briefly—'logically' natural or 'phylogenetically' natural. Are we not just splitting hairs, with no practical result? I do not believe that this will prove to be the case. I believe it is possible that, if we can once and for all lay the bogey of the existence of true relationship and realize that there are, not one, but many kinds of relationship—genealogical relationship, morphological relationship, cytological relationship, and so on—we shall release ourselves from the bondage of the absolute in taxonomy and gain enormously in flexibility and adaptability in taxonomic practice. Instead of the present rigid separation between the normal categories on one hand and those of experimental taxonomy on the other, we shall realize that they differ in degree and purpose only, and are all equally valid for the overall purpose of making inductive generalizations about living things. To take a concrete example, Turesson's geneological classification and its later modifications, or Danser's categories of *Comparium*, *Convivium*, etc., based on capacity to interbreed, should not be regarded as possible rivals of the orthodox categories, but as special classifications equally valid for their own particular purposes. In the same way, a truly phylogenetic classification, based on known lineages, would also take its place as a special classification constructed for its own particular purpose.

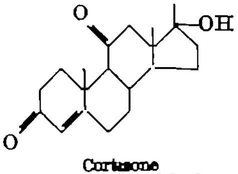
An ever-increasing volume of data is now being produced in the field of experimental taxonomy, data showing the great complexity of the units comprising the ebb and flow of evolutionary change. Recently, Dr. W. H. Camp, in a stimulating paper entitled "Biosystematy" (*Brittonia*, 7, 113; 1951), has emphasized forcibly the difficulty of fitting the dynamic concepts of modern experimental taxonomy into the orthodox categories of genus and species, conceived, as they were, against the static background of special creation. He hints that these categories may have to be abandoned completely for the special purpose of classifying the actual units of evolutionary change, and I would strongly support this view. Such a course would seem almost sacrilegious if we regard the orthodox taxonomic categories as an attempt at expressing 'true relationship'; but on the view that I have been outlining, that they are human contrivances constructed for human purposes, there is, of course, nothing shocking in abandoning them if they do not serve the particular purpose we have in mind at the moment.

I do not claim that what I have said here is more than the outline of an approach to present taxonomic problems, and I hope that others may be persuaded to join in working out its implications more fully.

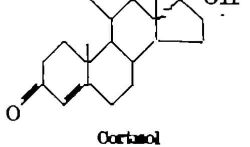
ORGANIC CHEMISTRY IN THE SERVICE OF MEDICINE

ONE of the sessions of Section B (Chemistry) of the British Association, during the recent Edinburgh meeting, was devoted to a symposium on "Organic Chemistry in the Service of Medicine." Notwithstanding the title, two of the three papers which were presented had a distinctly biochemical flavour, which perhaps serves to emphasize that organic chemistry and biochemistry are inextricably intermingled, in spite of those who would have it otherwise. The chair was taken by Prof. G. F. Marrian, who suggested that one of the main reasons for the selection of the subject of the discussion was a desire to honour the memory of the late Prof. George Barger, his predecessor in the chair of chemistry in relation to medicine in the University of Edinburgh. Prof. Marrian recalled some of Barger's outstanding chemical contributions to medical science, and referred also to the important work carried out by some of the pupils whom he inspired.

The first paper in the symposium was read from the chair by Prof. Marrian, who described recent work on the adrenocortical steroids. He pointed out that the discovery by Hench, Kendall and their collaborators of the treatment of rheumatoid arthritis and certain related diseases by cortisone, or by administration of the adrenocortical stimulating hormone of the anterior pituitary, no longer seems to be the great discovery in practical therapeutics that at first it appeared to be. But to the medical scientist, who takes a longer view than his clinical colleague, the discovery appears to be even more important than it did two years ago, on account of the way in which it has stimulated chemical, biochemical and clinical research on the adrenocortical hormones. The work of Kendall and Reichstein, and their collaborators, on the 'life maintenance' principle of the adrenal cortex, led to the isolation, during the period 1936–40, of six active steroids and to the determination of their structures. These are 11-deoxycorticosterone (now known as cortexone), corticosterone, 11-dehydrocorticosterone, and their respective 17-hydroxy derivatives. Two of the latter are cortisone and the related compound cortisol, both of which are therapeutically active in the treatment of rheumatoid arthritis. Cortisol is likely



Cortisone
(17-Hydroxy-11-dehydro-corticosterone)



Cortisol
(17-Hydroxy-corticosterone)

soon to be more readily available, and is believed to be preferable to cortisone in some respects.

Cortisone appears to influence rheumatoid arthritis and related diseases by suppressing the inflammatory symptoms in the mesenchymal tissues; this is in contrast with the function of adrenocortical hormones in the treatment of Addison's disease, where the effect is to make good a deficiency or absence of the endogenous hormones.

Prof. Marrian thought that, from a biochemical point of view, one of the most interesting and challenging facts about the adrenocortical hormones is the multiplicity of the physiological and pharmacological effects which they are able to produce. He suggested that there may be some common biochemical factor underlying these, possibly the interaction of the hormone with some particular chemical grouping which is present in a number of different enzymes. Several groups of workers have demonstrated effects *in vitro* of some of the hormones on the carbohydrate metabolism of preparations of liver and muscle tissue. It has also been found that granulation tissue from healing wounds or embryonic tissues maintained *in vitro* are able to fix sulphate in insoluble organic combination, possibly due to the synthesis of sulphated mucopolysaccharides. This fixation of sulphate can be entirely inhibited by the addition of cortisone to the culture medium. Another group of workers has found that hyaluronidase can be inhibited by cortisone.

One of the most outstanding recent achievements has been that of Pincus and his collaborators, who have shown conclusively, by using cholesterol labelled at C_4 with carbon-14, that under the influence of adrenotrophic hormone the adrenal gland is able to manufacture the adrenocortical hormones by degradation of cholesterol. By using various steroids these workers were also able to show that the gland (without adrenotrophic hormone) can effect hydroxylation at positions 11, 17, and 21, and they obtained evidence that progesterone is an intermediate in the conversion of cholesterol to the adrenocortical hormones. Thus progesterone, which has been isolated from the adrenal gland, was converted into corticosterone and cortisol.

In conclusion, Prof. Marrian referred to current work aimed at the total synthesis of cortisone, which may conceivably satisfy the requirements of the hormone for clinical use. He recalled the recently announced total synthesis of *epi*androsterone by Sir Robert Robinson and his collaborators, an achievement which also represents the total synthesis of androsterone and testosterone. Almost simultaneously, Woodward and his collaborators announced the total synthesis of the methyl ester of *dl*-3-keto-$\Delta^{4,9(11),16}$-*aetio*cholatrienic acid. This has since been resolved and converted into cholestan-3β-ol, which had already been converted into cholesterol. Among other steroids the total synthesis of which has been completed by this work is the adrenocortical hormone cortexone (the total synthesis of cortisone has also just been reported (Woodward *et al.*, *J. Amer. Chem. Soc.*, 73, 4057; 1951)).

Dr. F. L. Rose followed with an interesting and authoritative account of the extensive co-operative researches carried out during the Second World War on the synthesis of new antimalarial drugs. The most outstanding advances in this field were those of Dr. Rose himself and the late Dr. F. H. Curd and their collaborators, culminating in the discovery of the most effective antimalarial drug so far known, namely, 'Paludrine'. The importance of this service to medicine and to mankind may be gauged by Prof. Marrian's comment that it has been estimated that a quarter of the population of the world suffers from malaria. In his contribution, Dr. Rose pointed out that malaria is unique among the diseases of micro-organismal origin in that it has a history of chemotherapy extending over the past three hundred years, arising from the use of the cinchona alkaloids. Quinine is not the perfect antimalarial drug, however, and the search for improved synthetic agents began in the past century. Dr. Rose showed how the observation by Ehrlich and Guttman in 1891 of the slight therapeutic effect in man of methylene blue opened the way for future developments. Exploitation of this early lead was delayed until new preparations, based on this dyestuff, could be assayed in the laboratory. This came in the early part of the present century with the discovery and use of the avian malarias. By then, the significant features of the structure of quinine had become clear, and this knowledge led in 1926 to the synthesis in Germany of the related 6-methoxyquinoline derivative pamaquin (originally called 'Plasmoquine'). The continued search for a drug having schizonticidal activity resulted, a few years later, in the acridine derivative mepacrine ('Atebrin'), and it was this substance that was selected for process study in Britain in 1938 as an insurance against a break in quinine supplies resulting from war, which then seemed imminent. At that time, the use of mepacrine was still in the experimental stage, and although its availability from 1940 onwards was of vital military significance, careful clinical investigations established its limitations and disadvantages. As a result, intensive co-operative searches for new and improved agents were begun, co-ordinated in Great Britain by the Medical Research Council, and in the United States by the National Research Council. The objectives were freedom from colour (skin pigmentation) and reduced toxicity, ease of manufacture, and an action at the exoerythrocytic phase of the life-cycle of the causative parasite. This last had by the early 1940's assumed paramount importance in the minds of workers looking for new antimalarial drugs, since only through the control of the tissue forms could true causal prophylaxis be obtained.

A vast screening programme in the United States dealt with some fourteen thousand compounds, and led to the discovery of antimalarial activity in experimental infections (including prophylactic action) in a number of previously unconsidered chemical types. The most important outcome of this search was the establishing of the therapeutic value of the 4-aminoquinoline derivative chloroquin, a substance which under its name 'Resochin' is now known to have been undergoing field-trials at the hands of its German discoverers in 1939.

In Britain, a more modest programme led to the preparation and assay of, perhaps, two thousand substances in all. The majority of these were based on the discovery, early in the work, of laboratory activity in a chloroanilinopyrimidine. Exploitation of this lead also resulted in the elaboration of a wide variety of compounds, mostly heterocyclic, exhibiting similar behaviour, of which one at least, *p*-chlorophenylguanidinopyrimidine, was active clinically. An attempt to get away from the use of heterocyclic systems, while yet retaining other features considered structurally significant, led in 1944 to an investigation of certain diguanide derivatives. These proved active, not only against erythrocytic but also against the exoerythrocytic forms of the experimental avian parasites, and one such derivative, proguanil ('Paludrine': N^1-*p*-chlorophenyl-N^5-*iso*propyldiguanide), has passed into extensive clinical use on this basis.

As a result of these war-time endeavours, the objectives initially postulated have been largely attained. The causative organisms of malaria are so numerous in variety and drug susceptibility, however, that some forms of the disease inevitably remain resistant to therapy if only in degree, and the existence of these, together with the problem of relapse in certain cases, provide the challenge for the future.

In the concluding paper of the session, Mrs. R. V. Pitt-Rivers described recent work on the thyroid gland. She pointed out that the biosynthesis of thyroxine depends on the ability of the thyroid gland to collect iodide from the plasma and to fix it in organic combination. In the normal animal, the iodine-concentrating mechanism is largely controlled by the thyrotrophic hormone of the anterior pituitary, and fails in hypophysectomized animals. Thiocyanate inhibits the iodine-concentrating mechanism and, in fact, causes the discharge of iodide already collected by the gland. The second function of the thyroid, the synthesis of thyroxine, is generally assumed to occur in three stages: (*a*) oxidation of iodide to iodine, (*b*) iodination of tyrosine, and (*c*) coupling of two molecules of diiodotyrosine. The first stage requires enzymic activity, but this is not necessarily so for the coupling reaction, as coupling can occur *in vitro* in the absence of any enzyme system. Dr. Pitt-Rivers has found that if the amino group is protected by acylation and the carboxyl group by peptide combination, then the yield of thyroxine formed by incubating diiodotyrosine aerobically can be raised to 35 per cent. The coupling is an oxidative one, but its mechanism is not known, nor is the fate of the three-carbon chain which is lost from one molecule of diiodotyrosine.

Dr. Pitt-Rivers outlined experiments with antithyroid drugs of the thiourea group and also with aniline derivatives which include *p*-aminobenzoic acid and some of the sulphonamides; these have led her to conclude that the formation of thyroxine from diiodotyrosine is an oxidative reaction brought about *in vitro* by small amounts of iodine liberated from the diiodotyrosine. In *in vivo* experiments, too, the formation of thyroxine is invariably accompanied by loss of iodine from diiodotyrosine. The remarkable inhibition of thyroid function by iodide is possibly due to an inhibition by excess of iodide of the enzyme system which is responsible for its own oxidation.

Finally, Dr. Pitt-Rivers showed how the use of new techniques, in particular the use of radioactive iodine and partition chromatography, has enabled several groups of workers to localize reactions in which iodine plays a part, and to detect iodo compounds which are present in the gland only in traces. Apart from diiodotyrosine and thyroxine, the only iodine compound present in the gland which has been unequivocally characterized is monoiodotyrosine. All three compounds are present in the thyroid in very small amount as free amino-acids, and three new iodine-containing compounds of unknown constitution have been detected in the gland. Evidence has been provided that the circulating hormone in the plasma is free thyroxine.

AUTOMATIC CONTROL

A CONFERENCE organized by the Department of Scientific and Industrial Research, on the subject of developments in the field of automatic control, was held at the College of Aeronautics, Cranfield, during July 16–21, under the presidency of Sir Ben Lockspeiser. It was attended by some three hundred engineers, mathematicians and teachers of engineering, including members from most of the leading industrial countries.

The purpose of the present article is to give an impression of the state of developments in the field of automatic control as revealed by the papers and the discussion at the conference. The broad principles of automatic control involving feed-back are now very well known, and many useful methods for the analysis of the behaviour of control systems are quite familiar. The conference was concerned with those aspects of the subject that go beyond these well-established principles and methods and in which further progress is required. The chief topics may, perhaps, be broadly classified as follows: first, educational problems arising from the growing importance of feed-back systems, and the rapid increase in the demand for personnel having specialized knowledge and skills in this field at all technical levels; second, the development and co-ordination of improved methods of mathematical analysis for such systems; third, the extension of the methods to a widening range of technical and other problems; and finally, the attempt to deal more adequately with such problems as systems with non-linearities and with intermittent data. In attempting to give a summary of the present state of progress as revealed by the conference, it will be convenient to consider these four topics in turn.

Educational problems. New requirements in respect of instruction in the principles of automatic control are arising over the whole educational spectrum, from the shortage of instrument mechanics in the chemical industries to the need for more men of the highest engineering and mathematical competence to carry on development work in such fields as the control of aircraft or the development of combined analogue-digital calculators.

The opening paper of the conference by Prof. Gordon Brown, of the Massachusetts Institute of Technology, made a striking plea for the recognition of the "feed-back engineer" as a new professional category corresponding with a new type and perhaps a new standard of professional competence. The specification for a feed-back engineer is for a man capable of synthesizing many technical specialisms and capable of eliciting co-operation at all technical levels. Prof. Brown described the postgraduate school in control engineering at the Massachusetts Institute of Technology, which has an annual output of approximately fifty postgraduate students. This figure was referred to by a member from a leading American instrument firm as "merely a drop in the ocean of America's requirements". Prof. Brown described how students are trained at the Massachusetts Institute as working engineers participating in large-scale research projects, accepted by the Institute on contract. Such forms of advanced technical training are unknown in Great Britain, where it is noteworthy that the research establishments of government departments and of the research associations have no specific educational functions and not even in organized liaison with higher education.

Progress in methods of mathematical analysis. The analysis of the behaviour of linear systems with feed-back corresponds with the discussion of the implications of a set of simultaneous linear differential equations. Since complex as well as real roots are in question this naturally leads to representation on the complex plane. The types of analysis that have been developed for application to feed-back amplifiers, networks and filters are generally applicable to linear automatic control systems. Developments now being made in this type of analysis, as indicated by one group of papers presented at the conference, may be described as the exploration of the geometry of poles, zeros and 'transfer loci' on the complex plane, in the attempt to obtain various kinds of information about the behaviour of the system, such as its modes, their kind and degree of damping, and the conformity with various criteria of stability and minimum error. A particularly interesting development arises from the fact that the functions involved are usually regular functions, and such functions of a complex variable have a correspondence with the flow-lines and equipotentials for current flow in a conducting sheet. This fact has been ingeniously exploited by A. R. Boothroyd and J. H. Westcott, who described and demonstrated the use of the electrolytic tank as an analogue interpreting a logarithmic transformation of a complex variable, by the use of which the design of both control systems and filters may be facilitated.

An important problem requiring distinct treatment arises when control systems are subject to random disturbances. Two papers, respectively by M. J. Pélégrin and S. Jones, dealt with the application to control systems of the method based on statistical ideas and correlation that was originally developed by Wiener.

The view was expressed by several contributors that, important as these improvements in analysis may be, they must, by their nature, be deficient in meeting the basic problem of the selection and design of control elements, because they do not bring under consideration the physical limitations of the elements that are essentially related to power handling and the interchange and flow of power. One paper only grappled with this problem of relating the design of machine elements to the specified power amplification and the limitations of rating. This was the paper by J. M. Layton, in which some useful first steps are taken in this direction, by introducing the relationship that arises between the time constants and the power amplification in any element (such as an electric generator) in which there is energy storage proportional to the power output.

Extension of control system theory to a wider range of problems. One of the most important and rapidly expanding fields for the application of automatic regulation and control is the chemical and process industries. A complete day of the conference was devoted to this field. This was deliberately placed in the middle of the conference programme, because the organizers thought that one of the needs of the moment is to throw 'process engineers' and 'servo engineers' into intimate contact. This plan resulted in a vigorous discussion, somewhat hampered by difficulties of language, and by the unfortunate fact that each party appears to the other to plot all its diagrams back to front and for the inverse variable. It may be unfortunate that those now attempting to establish standardization of terms have abandoned the effort to reconcile those of process engineering with those of 'servos', and propose to perpetuate the differences. Perhaps a few years of delay and more such joint meetings would convince both parties that a common nomenclature would be both possible and useful.

The papers presented under the general heading of process control dealt mainly with the calculation and measurement of the transfer functions of pneumatic controllers and of plant elements such as pipe-lines and heat exchangers, in a form that permits of the use of this information in the familiar 'frequency-response' type of analysis.

Automatic-control principles are constantly finding application in new and somewhat surprising contexts. For example, A. Garde, of Stockholm, described an experimental investigation of the response of frequency to power load for a complete power system that involved the artificial imposition of a sinusoidal variation of power of 15 MW. as the test signal.

The theory of control systems is mainly a discussion of systems in which a number of variables, often a large number, are interdependent or inter-related, that is, some of the sequences of dependence are closed. This situation arises in many scientific fields, and when it is required to discuss the behaviour of such systems the methods of the theory of control systems may be useful. A good example is in economics, where much recent work concerns the implications of given inter-relationships between 'macro-economic' variables such as total income and total investment. This topic was the subject of an informal evening lecture given by J. R. N. Stone, of Cambridge, with a short addendum from an engineer's point of view by Prof. A. Tustin. It was urged that the interpretation of the implications of the rather complex 'models' necessary to give adequate representation of an economic system might be assisted by the use of physical analogues, as is often done in the case of complex engineering problems.

Special problems : intermittent data and non-linear systems. Groups of papers were devoted to the two chief aspects of control system analysis which the usual linear theory omits.

The first type of problem is that in which the system may be linear in the sense that it satisfies the principle of superposition, but where the operation is essentially discontinuous. One familiar example arises when 'clamped' or 'chopper bar' regulators are used, that measure a continuous variable at fixed equi-spaced instants, but between these instants merely hold or 'clamp' the value from the preceding measuring instant. A very analogous problem arises when incoming data is in digital form, giving effectively the value of a set of equi-spaced ordinates of the input curve. The handling of such problems will be greatly facilitated by papers included in this conference. The contributions by Prof. C. Holt-Smith, D. Lawden and A. E. Bailey, and the papers by Dr. R. C. Oldenbourg and Dr. H. Sartorius from Germany, make a noteworthy advance on previous work.

One day of the conference was given to the different problems that arise when systems are non-linear. Among those present for this discussion were such well-known authorities as Prof. B. van der Pol, Dr. N. Minorsky and Dr. Mary L. Cartwright, and the discussion was on a high level even if it mainly showed once more the unfruitfulness, so far, of attempts to deal with most non-linear systems except to seek specific numerical solutions to specific problems. A possible point for future progress lay in the paper by C. Cherry, in which he returned to fundamentals, and showed by adapting the equations of Lagrange that in certain systems the part played by energy in linear systems is played by areas under a curve in the case of non-linear systems.

Manual-control as distinct from automatic control was not forgotten. The paper on this subject by J. D. North included a thorough analysis of a 'model' that may provide a useful approximation for the response of hand to eye in some simple situations such as target tracking or car driving.

The discussions throughout the conference were vigorous and sustained. It appeared to be the opinion of all who attended that the conference has helped to lay foundations on which much further progress may now be based.

The papers presented, together with selected material from the discussions during the conference, will be published in due course as a single volume by Butterworths Scientific Publications, Ltd.

A. Tustin

STRUCTURE OF RIBONUCLEIC ACID

By Dr. ROY MARKHAM and Dr. J. D. SMITH

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Molteno Institute, University of Cambridge

In the past few years the basic constitution of several ribonucleic acids has been established[1-4], but so far there has been little evidence as to the way in which the constituent nucleotides are arranged in the molecules. Hydrolysis of ribonucleic acids by alkali and by cold dilute acids gives rise to isomeric nucleotides which are probably 2′ and 3′ nucleoside phosphates[5-7], and Cohn and Volkin[8] have recently also identified 5′ nucleoside phosphates in ribonucleic acids digested successively with both ribonuclease and alkaline phosphatase. In the work which we propose to describe, we have attempted to isolate the larger fragments produced by ribonuclease action, and we have succeeded in establishing the structure of certain of the dinucleotides which were formed.

Anhydrides of the Pyrimidine Nucleotides

In our investigation of the products of digestion of ribonucleic acids, our attention was drawn at once to the presence of two substances which we have called *C* and *U*[9]. These substances are digested slowly by ribonuclease to give free cytidylic and uridylic acids respectively, and each contains one atom of phosphorus per pyrimidine residue. They differ from the nucleotides in that they have higher R_F values in 70 per cent v/v *iso*propanol–water–ammonia (solvent *a*), and lower R_F values in 80 per cent saturated ammonium sulphate in water, 2 per cent *iso*propanol, 18 per cent *M* sodium acetate (v/v/v) (solvent *b*). These properties led us to believe that they contained less free hydrophylic groups than exist in the corresponding nucleotides, possibly because they were dinucleotides or dinucleoside pyrophosphates. When we were doing this work, we were fortunate in having a discussion with Prof. A. R. Todd and Dr. D. M. Brown, and they were kind enough to disclose their theory of the formation of the isomeric nucleotides of Carter and Cohn. This theory[7] necessitates the existence as intermediates during the chemical hydrolysis of ribonucleic acids of cyclic anhydrides of the nucleotides, which have the phosphoric acid residue esterifying the ribose at positions 2′ and 3′. Such substances would have the properties of our *C* and *U*, and, in addition, would have the same electrophoretic mobilities as the corresponding nucleotides at *p*H 3·5, as do *C* and *U*, while, as we will show, the electrophoretic mobility of a dinucleotide should be about 1·54 times that of a mononucleotide having the same constituents. Synthetic samples of the anhydrides of cytidylic and uridylic acids prepared by Mr. D. Magrath were chromatographed by us in several solvent systems and could not be distinguished from *C* and *U* in any of these, while they too were digested slowly by ribonuclease to give the free nucleotides. It seems very likely that *C* and *U* are the 2′, 3′ anhydrides of cytidylic and uridylic acids respectively. The analogous adenine derivative was not digested by ribonuclease, and it seems probable that the guanine derivative is also resistant to digestion.

Free Nucleotides and Polynucleotides

For preparing these substances we have digested purified yeast ribonucleic acids with ribonuclease in dialysis sacs at 20° and also at 4° with stirring, so that any fragments liberated should have a chance to escape further digestion. After concentration *in vacuo*, the dialysate has been chromatographed in solvent *a* on Whatman No. 3 paper in bands. The developed chromatograph shows a residue at the top (band 0) and six main bands numbered 1–6 in order of their R_F values. Band 6 contains *C* and *U* only. Bands 1, 2 and 3 contain compounds of all four bases, while bands 4 and 5 have no guanine derivatives. Band 4 contains only adenylic acids *a* and *b*, cytidylic and uridylic acids. Free guanylic acids *a* and *b* are found in band 2. Bands 3 and 5 contain substances having properties similar to *C* and *U*; that is, they are digested by ribonuclease to give substances running faster in solvent *b* and slower in solvent *a*, but without changing their gross analytical composition. The analyses, however, show that each band contains several substances, as the purine and pyrimidine bases are not present in simple proportions.

Electrophoretic Separation

After trying without success a number of solvent systems for separating the substances in each band, we decided to try electrophoresis on filter paper strips, immersing the wet filter paper in carbon tetrachloride to cool it and to prevent evaporation. Strips of Whatman No. 3 paper 56 cm. long and 8 cm. wide were used, and the material was applied about 12 cm. from one end. A voltage gradient of 20–25 V./cm. was used and the average run was two hours (Fig. 1).

Before attempting the separation, we calculated the probable relative electrophoretic mobilities of all mono-, di-, and some tri-nucleotides at several *p*H values, using the dissociation constants of Levene and Simms[10], assuming that the mobilities were proportional to the net charge on the molecule, and inversely proportional to the cube root of the molecular volumes, a relationship which should hold to a close approximation in the case of such asymmetrical molecules, and which has been found to hold with some minor deviations in practice. The

CALCULATED ELECTROPHORETIC MOBILITIES TOWARDS THE POSITIVE ELECTRODE OF ALL THE MONO- AND DI-NUCLEOTIDES AND SOME OF THE TRI-NUCLEOTIDES AT pH 8·5, RELATIVE TO THAT OF URIDYLIC ACID
The symbols *A*, *G*, *C* and *U* signify the presence in the compound of one residue of adenylic, guanylic, cytidylic and uridylic acid respectively. The order in which they appear is not significant.

Mononucleotides		Dinucleotides		Trinucleotides	
C	0·16	*CC*	0·25	*ACC*	0·54
A	0·46	*AC*	0·48	*AAC*	0·75
G	0·95	*AA*	0·71	*GCC*	0·88
U	1·00	*GC*	0·85	*ACG*	1·09
		CU	0·89	*ACU*	1·13
		AG	1·08	*AAG*	1·30
		AU	1·18	*AAU*	1·33
		GG	1·46	*AGG*	1·64
		GU	1·50	*GCU*	1·67
		UU	1·54	*AUU*	1·71

order of movement that we calculated for pH 3·5 (M/20 ammonium formate buffer)—the value which we selected as optimum for our purposes—is shown in the accompanying table. At this pH the mobility is decided entirely by the primary phosphoric acid —OH⁻ groups and the —NH₃⁺ groups of the bases, and therefore anhydrides of the type of *C* and *U* and their derivatives will move at approximately the same speed as the corresponding nucleotides and their derivatives.

On electrophoresis, bands 1, 2, 3 and 5 are each found to contain at least three or four major constituents, most of which have been identified provisionally, while several of these substances have been submitted to analysis and have been found to have simple compositions. Among the latter are the dinucleotides of adenine and guanine, adenine and cytosine, guanine and uracil, and guanine and cytosine. These substances are found in bands 1 and 2 and are not attacked by ribonuclease; but there are also substances having the same composition with regard to the bases as the last three of these dinucleotides, but occurring in bands 3 and 5. The latter are digested by ribonuclease to give the dinucleotides only. As an example of this we can take the guanine–uracil dinucleotide of band 1. This substance can be isolated in a pure state from band 1 by electrophoresis, and is the fastest moving component of this band, having a *gross* mobility of 1·1 × 10^{-4} cm.^{2} sec.$^{-1}$ volt^{-1}. In band 3 there is a substance which also has one equivalent of guanine to one of uracil and has a mobility of 1·3 × 10^{-4} cm.^{2} sec.$^{-1}$ volt^{-1} (this difference is not significant). The substance from band 3 is converted into the dinucleotide of band 1 slowly by ribonuclease digestion. This digestion is not splitting a tetranucleotide, as such a compound would have a mobility of about 2 × 10^{-4} cm.^{2} sec.$^{-1}$ volt^{-1}, nor, of course, is any phosphorus liberated. Similarly, the adenine–cytosine dinucleotide of band 5 is converted by ribonuclease to that in band 2, as is the adenine–uracil dinucleotide of band 5; and all these digestions also cause the resulting dinucleotides to have higher R_F values in solvent *b*.

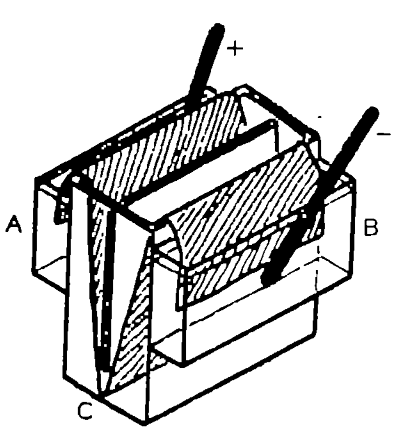

Fig. 1. Electrophoresis apparatus. Vessels *A* and *B* contain the buffer solution. Vessel *C* contains carbon tetrachloride, and in use is covered with a piece of plate glass. The wet paper is spaced in vessel *C* by a piece of celluloid. The electrodes are arc carbons

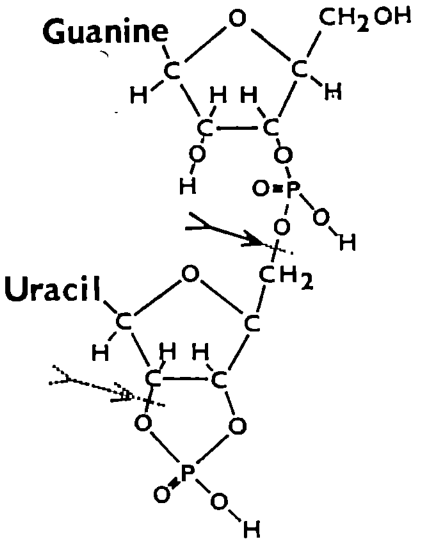

Fig. 2. Probable structure of the guanine–uracil dinucleotide anhydride. The arrows show the alkali labile bonds, while the dotted arrow indicates the bond which is also broken by ribonuclease

Now these properties parallel exactly the behaviour of the pyrimidine nucleotide 2′, 3′ anhydrides, so it would seem that the dinucleotides of bands 3 and 5 contain the latter joined at position 5′ as one half of the molecule.

The purine nucleotides derived from these dinucleotides by alkaline hydrolysis are of the 2′ and 3′ types and the dinucleotides do not react with periodate, so that the internucleotide link must be of the 3′ (or 2′), 5′ type. The only likely formula for the guanine–uracil dinucleotide anhydride is given in Fig. 2 (it being understood that at the moment it is not possible to distinguish between a 2′ and a 3′ nucleotide residue in such a compound, as hydrolysis invariably results in the formation of roughly equal amounts of the 2′ and 3′ nucleotides).

Discussion

It will be seen from these results that a large number of the internucleotide linkages in yeast ribonucleic acid are of the 3′ (or 2′), 5′ type and also that some at least of the alkali labile bonds of ribonucleic acid are situated at the 5′ sugar carbon atoms. From this it would appear that the linkages broken by ribonuclease are similar to those broken by alkali, with the important exception that ribonuclease distinguishes between purine and pyrimidine nucleotides. We have found that, by cautious alkaline hydrolysis of ribonucleic acids, using barium carbonate at 100°, corresponding to a pH of just over 9, the anhydrides of the pyrimidine nucleotides are released, showing the analogy of the action of alkali and ribonuclease.

The general nature of the products of ribonuclease digestion suggests that, as in alkaline hydrolysis, it is necessary for a cyclic intermediate to exist, and that this intermediate must also be a pyrimidine nucleotide derivative. This would explain the rapid formation of the large amounts of the anhydrides *C* and *U*, as they would be chopped out of the ribonucleic acid wherever two or more adjacent pyrimidine nucleotides having either a free 2′ or 3′ —OH group were to be found in the molecule. The existence in the digests of the free 2′- and 3′-guanylic and adenylic acids is difficult to account for by this theory, unless they were joined to pyrimidine nucleotides by a 2′, 3′ link (or the equivalent), as this link would allow the formation of the intermediate anhydride.

A study of the trinucleotides of band 1 and the larger products of ribonuclease digestion is now being made in an attempt to confirm this theory, and we are also hoping to be able to make quantitative estimates of the amount of the various constituents on the well-characterized and undegraded turnip yellow mosaic virus nucleic acid[4].

It is a pleasure to thank Prof. D. Keilin and Dr. K. M. Smith for their interest in this work. We are also greatly indebted to Prof. A. R. Todd and his colleagues, notably Drs. Brown and Dekker, for discussing problems of mutual interest.

[August 7.

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OBITUARIES

Prof. A. J. Allmand, F.R.S.

Prof. A. J. Allmand, emeritus professor of chemistry in the University of London, died in hospital in London on August 11 after an operation.

He was the son of Frank Allmand and was born at Wrexham in 1885. He was educated at Alleyn's School, Dulwich, at Grove Park School, Wrexham, and at the University of Liverpool. He also studied at the technical high schools of Karlsruhe and Dresden. He took his D.Sc. in Liverpool in 1910 and then returned to study in Germany as a Science Research Scholar of the Exhibition of 1851. At Karlsruhe he worked under Prof. F. Haber on the measurement of radiation from flames, and at Dresden he worked under Prof. Luther on the primary products of photochemical change. He then took the post of assistant lecturer and demonstrator at Liverpool, where he was one of the group of chemists inspired by Donnan, whom he always regarded with gratitude and affection. At this period his work was naturally concerned with electrochemistry, and in 1912 he published his well-known text-book on the "Principles of Applied Electrochemistry", of which a revised edition was published in 1925.

During the First World War, Allmand was called upon to bring his knowledge and experience to bear upon the new problems of chemical warfare. He became chemical adviser to the Fourth, and later to the Second, Army H.Q., with the rank of major, and during this period he was awarded the Military Cross. His Army service left him with an enduring enthusiasm for military life and history which is somewhat unusual among men of science, and in his library the official history of the war jostled with the *Proceedings* (*A*) *of the Royal Society*, and was studied with equal diligence and zest.

In 1919 Allmand was appointed professor of chemistry at King's College, London, where he spent the remainder of his academic life until his retirement in 1950. While maintaining his interest in electrochemistry and developing the Drumm transport battery, he worked mainly in two other fields, namely, in the adsorption of gases and vapours by charcoal, and in photochemistry. In the latter field he was specially interested in photolysis and the photochemical reaction between hydrogen and chlorine. In both these fields he carried out a large amount of accurate experimental work which played an important part in future developments.

In 1938 he succeeded Prof. S. Smiles as Daniell professor and head of the Department of Chemistry at King's College. He was a member of the Senate of the University of London from 1929 until 1932, and he acted as assistant principal of King's College during 1937–43. He was elected a Fellow of the Royal Society in 1929 and made a Fellow of King's College in 1932.

During the Second World War, Allmand was again called to serve his country, this time as superintendent of the Explosives Research Department in the Ministry of Supply—an exacting task which he combined with almost nightly fire-watching duties at King's College. After the War his research interests returned again to electrochemistry, and his most recent publication dealt with the simultaneous electrodeposition of zinc and copper from solution. It was fitting that his last official position was that of president of the Faraday Society, a post which he held during 1947–48.

Although Allmand was a great teacher and a very distinguished physical chemist, it is more by his extraordinary personal influence that he will be remembered rather than by his purely scientific contributions. He was one of the most loved and revered members of the Common Room at King's College. His Department was singularly happy and harmonious. He was always greatly interested in the work and welfare of all his students, both while they were at College and afterwards when they occupied posts in universities or industry. They in turn regarded him with warm affection, and, at his farewell dinner, every year since his appointment was represented by a group of former students.

He was a man of complete moral integrity, whose whole life was inspired by spiritual purposes. His advice and judgment were always sound, selfless and rigidly based on principle. He was severe and ascetic with himself, although never censorious of others. On the rare occasions when he expressed disapproval, he was decisive and final; but he will be remembered more readily for the warm encouragement of his approval and the frequent generosity of his help. He was one of the most modest and self-effacing men in the College; but he has left a deep and enduring influence and a noble example.

He leaves a wife, a son and a daughter. His elder son, Michael, was wounded in the Burma campaign and was posthumously awarded the Victoria Cross for great gallantry in action. G. Temple

Prof. Hantaro Nagaoka

Prof. Nagaoka was born on August 18, 1865, when Japan was in the midst of turmoil centring on the problem of the re-opening of trade and diplomatic relations with European countries and the United States after two hundred years of isolation from the rest of the world. He graduated from the College of Science of Tokyo Imperial University (now the University of Tokyo) in 1887, not long after it had been established by the new government. He obtained his doctorate in 1893 and, after having studied further in Germany for three years, he was appointed professor of physics at Tokyo Imperial University and held that position from 1896 until 1926. From 1926, he continued to carry out research at the Institute of Physical and Chemical Research (now Scientific Research Institute) in Tokyo until 1945. Even after he left the Institute, he was actively engaged in research work up to the very end of his life, which came on December 10, 1950, at the age of eighty-five.

Prof. Nagaoka published more than three hundred scientific papers covering a wide range of pure and applied physics, extending from hyperfine structure of atomic spectra to the theory of earthquakes. His earliest work on geophysics was followed by the investigation of magnetism, which was further extended by K. Honda. Then his interest turned to spectroscopy. In his latest years, he returned to various subjects on geophysics. Among numerous papers, however, he is best known by his pioneering work on the atom model, which appeared in the *Philosophical Magazine* in 1904. His Saturn model of the atom could be regarded, in a sense, as the forerunner of the Rutherford–Bohr theory. It is also worth while mentioning that he predicted the existence of the ionosphere quite independently of Kennelly and Heaviside.

Prof. Nagaoka was elected a member of the Imperial Academy of Japan (now the Japan Academy) in 1905 and was president of the Academy during 1939–48. He was the first president of Osaka (Imperial) University, which was established in 1931. He was elected an honorary member of the Physical Society of Japan in 1950 and was among the first who received in 1937 the Order of Cultural Merit, a medal of high distinction. Honours came also from abroad. He was elected an honorary fellow of the Physical Society of London in 1912, and received in 1925 the honorary degree of doctor of philosophy from the University of Cambridge.

His influence, both direct and indirect, was great on a large number of younger Japanese, who looked up to him as an outstanding native scientist, as they were eager to catch up with Western science and technology. He was a born scientist with a genuine love of Nature. His tireless endeavour for nearly sixty years in search of truth justly earned his reputation.

Hideki Yukawa

Dr. C. D. Perrine

We record with regret the death, which occurred on June 21, 1951, at the age of eighty-three years, of Dr. Charles D. Perrine, former director of the Cordoba Observatory, Argentine. Dr. Perrine began his astronomical career at the Lick Observatory in 1893. He made many observations of comets, and was active in discovering them, his discoveries including comets 1895 IV, 1896 I, 1896 VII (periodic), 1897 I, 1897 III, 1898 I, 1898 VI, 1898 IX, 1902 III. He was also the first to observe the periodic comets, D'Arrest at its return in 1897, Pons-Winnecke at its return in 1898, and Temple (2) at its return in 1899. In 1904 he discovered, on photographs with the Crossley reflector, the sixth satellite of Jupiter, and the following year the fainter seventh satellite; these two satellites form a pair with nearly the same mean distances (about seven times greater than that of the most distant of the previously known satellites) and have interlocking orbits. Their motions are subject to large perturbations. From observations with the Crossley reflector of Nova Persei 1901, Perrine discovered the expanding nebulosity around the nova, caused by the light from the outburst as it travelled outwards, illuminating the interstellar cloud in which the nova happened to be. From his observations of faint spiral nebulæ he was able to conclude that the number of such systems discoverable with this telescope was about half a million, providing the first evidence of the vast number of these objects, which has been fully confirmed by later observations. In 1903 he succeeded in obtaining the spectrum of Nova Aurigæ (1891) which was then of the 14th magnitude, and showed that it consisted of bright lines superposed on a continuous spectrum.

In 1909 Perrine left the Lick Observatory to take up the appointment of director of the Cordoba Observatory, a position which he held until his retirement in 1936. A fine series of photographs of Halley's Comet at its return in 1910, together with measurements of position and of brightness, were obtained, which formed the basis of a large volume, published in 1934, which contained excellent reproductions of many of the photographs, together with the observations and their discussion. Sixteen volumes of the "Resultados del Observatorio Nacional Argentino" were published under his direction. By his energy and enterprise, Perrine was responsible for the creation of the Astrophysical Station at Bosque Alegre, with its 60-in. reflector.

Perrine was interested in eclipse observations. He led the Lick expedition to Sumatra in 1901 to observe the total eclipse of May 18 that year, which secured successful observations. In 1914 he joined with Dr. W. W. Campbell, director of the Lick Observatory, in an expedition to the Crimea to observe the eclipse of August 21. Observations were hindered by clouds and the return journey was complicated by the outbreak of the First World War.

Perrine was awarded the Lalande prize of the Paris Academy of Sciences in 1897. In 1902 he was president of the Astronomical Society of the Pacific. He was elected an Associate of the Royal Astronomical Society in 1904, and at the time of his death was the senior, by nine years, of the Associates of the Society.

H. Spencer Jones

We regret to announce the following deaths:

Prof. Gilbert Cook, F.R.S., emeritus professor of civil engineering and mechanics in the University of Glasgow, on August 28.

Prof. T. H. Johnston, professor of zoology in the University of Adelaide, known for his work on the control of prickly pear in Australia, on August 30, aged sixty-nine.

Prof. G. Steindorf, formerly professor of Egyptology in the University of Leipzig, on August 28, aged eighty-nine.

NEWS and VIEWS

Sir Arthur Schuster (1851–1934)

SIR ARTHUR SCHUSTER, who was born in Frankfurt-on-Main a century ago, on September 12, entered his father's business at Manchester in 1870. After studying physics and mathematics at Owens College, he took up spectrum analysis and went to work with Kirchhoff at Heidelberg, where he obtained his Ph.D. degree in 1873. Further study at Göttingen and Berlin was followed by his leadership, when only twenty-four, of the Royal Society's solar eclipse expedition to Siam. Subsequent expeditions took him to Colorado, Egypt and the West Indies. He became a naturalized British subject in 1875. After five years under Clerk Maxwell and Lord Rayleigh at the Cavendish Laboratory, Cambridge, he was appointed professor of applied mathematics at Owens College in 1881, succeeding his former teacher, Balfour Stewart, as Langworthy professor of physics in 1888. He was elected a Fellow of the Royal Society at the age of twenty-eight. He was secretary of the Royal Society during 1912–19, foreign secretary during 1920–24, and vice-president 1919–24; he received a Royal and the Rumford and Copley Medals. Schuster carried out important work on the discharge of electricity through gases, in meteorology, in terrestrial magnetism, and on the mathematical theory of periodicity; he was the first to photograph the spectrum of the solar corona. His classic "An Introduction to the Theory of Optics" was published in 1904. He was president of the British Association for the Manchester meeting in 1915, and was knighted in 1920. After his retirement from the chair at Manchester, he took an active part in fostering international collaboration in science, and was the first secretary of the International Research Council, which in 1931 became the International Council of Scientific Unions. Reserved and difficult to know, Schuster was always the friend of his students. He died on October 14, 1934.

National Physical Laboratory: Fifty Years of Progress

ON January 1, 1900, Sir (then Mr.) Richard Glazebrook was appointed the first director of the National Physical Laboratory at Teddington; and although Bushy House, once a Royal residence, was not formally opened as the Laboratory proper until March 19, 1902, the Laboratory can be said to date from Glazebrook's appointment. Thus to celebrate the jubilee, an exhibition of the work of the Laboratory was held in the Royal Society's rooms on January 30, 1950 (see *Nature*, 165, 257; 1950), and during May 23–29 this year the 'open days' of the Laboratory were intended partly as a jubilee celebration (see *Nature*, June 23, p. 1006). Bushy House with its gardens is still part, but now only a corner, of the fifty-acre estate on which sixteen major and minor buildings have been constructed to house the ever-growing needs of the Laboratory. The history of the growth and development of the Laboratory and the story of its many activities is of interest, not only to men of science all over the world, but also makes fascinating reading for the less technically minded public. The publication, therefore, of the Jubilee Book of the National Physical Laboratory (pp. 104+32 plates; London: H.M. Stationery Office, 1951; 4*s*. net) in time for the many visitors both from home and overseas in London for the Festival was greatly to be welcomed. Written by John Langdon-Davies and profusely and beautifully illustrated, it gives an accurate, interesting and easily read description of the way in which, in spite of difficulties and the increasing number of new branches of applied science, the Laboratory still gives pride of place to the science and art of measurement. The book consists of seven chapters, beginning with a discussion of the importance of accuracy in all the work at Teddington. Chapter 2 describes the origin of the Laboratory and chapter 3 its organization and relation to other bodies. The two succeeding chapters outline the maintenance of standards and the type of research that is undertaken, and the final two discuss some recent investigations and special types of research. There can be no doubt that the Laboratory will continue, as in the past, to be the champion of accuracy in measurement; an invaluable storehouse of equipment, techniques and personnel which could not be spared without serious loss to the nation's scientific capital; and an effective instrument for making existing scientific knowledge known as rapidly as possible to industry and others who are in a position to use it.

Research Council of Alberta

THE thirty-first annual report of the Research Council of Alberta covering the year 1950, like earlier reports, stresses the importance of the investigations of the Athabasca bituminous sands, both as road material and as a source of liquid fuel. Co-operative experiments in the National Research Laboratories have demonstrated the feasibility of combining the hot-water separation process with the fluidized-bed cracking and distillation process, using the wet crude oil from the former as feed stock for the latter process; and by use of this combination the economic development of the bituminous sand is reported as immediately practicable. Besides further work on the cleaning, briquetting and balling of coal, studies on the constitution of coal have been made, including an investigation of the oxidation of low-rank Alberta coals. A preliminary survey was made of the Pleistocene deposits of the Edmonton area and a survey of automobile lubricating oils for sale within the Province was continued, as well as various other investigations of petroleum and associated products, including a study of anti-freeze solutions. Work continued on compaction studies on new road construction, and as a result of preliminary investigations on the causes of cracks in asphalt paving that do not appear to be associated with overloading of the road structure, consisting of pavement-supporting base and sub-soil, a detailed programme has been planned for the winter period. Two locations of unstable hillsides have been studied in detail to assess the soil conditions accompanying such instability.

The natural gas research programme comprises three current projects: the catalytic pyrolysis of natural gas in a fluidized bed; the kinetics and yields of the partial oxidation of butane in the gas phase; and an evaluation on the pilot plant of the National Research Council's process for carbon black from natural gas. An irrigation survey of the Bow River was completed as well as one of the Carmangay, and a preliminary survey of the William Pearce project for diverting some of the water of the Red Deer River. Some 400,000 acres were mapped in the Brazeau–Rocky Mountains House area, and about 1,750,000 acres in the McLennan and High Prairie area. Exploratory surveys were made of an area north and west of Blueberry Mountain and of an area north of Hotchkiss. Accumulation of records of ultra-violet solar radiation with the thorium photocell continued, and a study is being made of the relative response at different wave-lengths of the three photo-cells used in the investigation. Problems of biological cycles, particularly the alternate prevalence and scarcity of forms of wild life, are being examined, including both the rabbit cycle and the collection of grouse material. A list of publications of the Research Council is appended.

National Foundation for Scientific Research, Brussels : Annual Report for 1949–50

The twenty-third annual report of the National Foundation for Scientific Research, Brussels (pp. 196 ; 1950), covers the year 1949–50, and, besides lists of publications and of members of the scientific commissions, includes notes on the work in progress at Brussels, Ghent, Liège, Louvain, Mons and the Royal Military School. This has included studies on the following topics : the separation of isotopes by thermodiffusion in the liquid phase, the properties of uranium salts, the metallurgy of nuclear pure uranium, the preparation of pure graphite, heavy water, geological applications of radioactivity, neutrons, thick photographic emulsions, the preparation of uranium fluoride and hexafluoride, the variation of intensity of a pencil of neutrons with distance in terms of the medium interposed, the absorption of neutrons and the technique of the photographic plate. In addition, there have been some biochemical investigations, and studies in mass spectrography, the separation of isotopes, slow neutrons and nuclear isomerism, and the construction of a high-tension cathodic oscillograph and a linear accelerator of protons. In the financial statement, besides research grants totalling 3,125,000 francs for the year, the National Foundation has approved a supplementary grant of 2,000,000 francs for a Franco-Belgian expedition for submarine exploration, and 'extraordinary grants' of 212,971 francs to the University of Liège for the acquisition of a camera for cinematographic registration of rapid physical phenomena. Other grants are : 250,000 francs for the construction of an apparatus for X-ray emission and absorption spectra ; 100,000 francs to the University of Liège for transporting and installing at the scientific station of the Jungfraujoch the cœlostat and large infra-red spectrometer from Cointe Observatory ; 175,000 francs for sociographical research at the University of Brussels ; 250,000 francs to the University of Louvain for a campaign of excavation at Alba Fucens ; and 250,000 francs for equipping the four universities for biological research with radioisotopes. Besides a full list of publications by recipients of grants during the year 1949–50, there is appended a list of recipients of grants for 1950–51 and of their research objectives.

American Institute of Physics : Twentieth Anniversary

The twentieth anniversary of the American Institute of Physics will be celebrated in Chicago during October 23–27 by a joint meeting of the founding societies of the Institute. Member societies which will hold their regular autumn technical meetings during the five-day anniversary celebration are the American Physical Society (October 25–27), Optical Society of America (October 23–25), Acoustical Society of America (October 23–25), Society of Rheology (October 24–26), and the American Association of Physics Teachers (October 25–27). The American Crystallographic Association, an affiliated society of the American Institute of Physics, will also participate in the anniversary meeting. An all-day symposium on October 25, on the theme "Physics To-day", will include papers by Dr. Enrico Fermi, University of Chicago ; Dr. E. U. Condon, retiring director of the Bureau of Standards ; Prof. J. C. Slater, Massachusetts Institute of Technology ; Dr. Harvey Fletcher, Columbia University ; and Dr. Edwin H. Land, president and director of research of the Polaroid Corporation. The symposium will be concluded with a more general talk entitled "Physics as Science and as Art" by Dr. K. K. Darrow, of the Bell Telephone Laboratories. Senator Brien McMahon, chairman of the Joint Congressional Committee on Atomic Energy, and Dr. K. T. Compton, chairman of the Corporation of the Massachusetts Institute of Technology, will be guest speakers at a joint banquet on October 25. Included in the programme will be an industrial exhibit of scientific instruments and apparatus arranged by the leading manufacturers of scientific equipment in the United States. Further information can be obtained from the Secretary, American Institute of Physics, 57 East 55th Street, New York City.

New Indian Institute of Technology

A new Institute of Technology, the first of four such institutes which it is hoped to build in India, is in the course of being constructed at Kharagpur, seventy-two miles from Calcutta, and already more than two hundred students are attending courses in buildings already in existence on the site. It is expected that the Institute will be finally completed and equipped in about four years time, and then it will be able to take about two thousand students. Mr. Jerzy Malanowski, a mechanical engineer, has recently gone to the Institute as the first member of a team from the United Nations Educational, Scientific and Cultural Organization under the United Nations Technical Assistance plan. Mr. Malanowski's work, besides organizing the four-year course in mechanical engineering and lecturing to students, will be to help plan and construct laboratories and workshops and their equipment for the Institute. Courses will be run on similar lines to those at the Massachusetts Institute of Technology. Departments of civil and sanitary engineering, electrical engineering, mechanical engineering, building construction and architecture, metallurgy, naval architecture and marine engineering, and geology and geophysics are being set up, and students will follow a four-year course leading to the degree of B.Sc. Eventually postgraduate courses, lasting a year, will be organized.

Measurement of Low Temperatures

Since the end of the Second World War interest in the field of low-temperature physics has expanded considerably, and there are now many more physical laboratories either engaged on, or about to embark on, low-temperature research work. Though the methods of measurement of temperatures below 90° K. are well established and are fully described in the literature, it would be difficult to find, if such exists, a comprehensive statement of them in any one book or periodical. The handy reference monograph on "The Measurement of Low Temperatures" (Research Report R-94433-2-A ; Physics Department, Westinghouse Research Laboratories, East Pittsburgh, Penn. ;

free) which C. T. Linder has compiled is therefore timely and should prove most useful. The contents of the monograph consist of details of the different methods of temperature determination, together with tables and graphs of data useful in the practical application of those methods. First, the low-temperature scale is briefly outlined, and then in more detail the gas and vapour thermometers, the thermocouple and the resistance thermometer are discussed. Finally, the measurement of temperatures below 1° K. is briefly considered, and the suggestion of Lawson and Long to use the Brownian motion, though not yet experimentally verified, is mentioned. The tables and graphs constitute nearly two-thirds of the monograph, and although the complete monograph is a photographic reproduction of typescript, the tables and graphs are exceptionally clear and easy to read. Every effort has been taken to make the material presented as up-to-date as possible. Table 2, consisting of seven pages, deals with the variation with temperature of the vapour pressure of helium and has been copied directly from material, dated June 1949, made available by the Royal Society Mond Laboratory, Cambridge.

Astronomical Photographs from the Yerkes Observatory

SINCE 1903 the Yerkes Observatory of the University of Chicago has been reproducing, in lantern slides, transparencies and prints, the original astronomical photographs made at Williams Bay. Within recent years, copies of photographs made at other observatories have been added to the collection, and these reproductions are sold by the University of Chicago Press. In "Astronomical Photographs", an illustrated catalogue edited by Thornton Page (pp. 36; Williams Bay, Wis.: Yerkes Observatory, 1951), the reproductions are listed and can be ordered by catalogue number from the Photographic Service Department, Yerkes Observatory, Williams Bay, Wisconsin. One hundred 3¼ in. × 4 in. slides for the use of teachers and lecturers are available, and at greatly reduced cost sixty selected slides are now offered in the 2 in. × 2 in. size, and on 35 mm. film strip, the former at 25 dollars for the sixty and the latter at 10 cents each. In addition to the set of selected slides for general use, the catalogue lists and describes slides and photographs illustrating specific research problems of modern astronomy and astrophysics—problems of the solar chromosphere and corona, of planetary atmospheres, of the origin of the solar system, of the aurora borealis, of lunar craters, of meteor and comet spectra, of interstellar clouds, of novæ and supernovæ, of the spectra of all types of nebulæ, and of galactic structure. The list finishes off with maps of neon and iron spectra, views of modern and historical instruments, and portraits of ninety famous astronomers.

Petroleum Consumption and Production in Great Britain

THE Petroleum Information Bureau has recently issued a pamphlet (pp. 8; London: 29 New Bond Street, W.1; 1951), at the behest of the U.K. Petroleum Industry Advisory Committee, setting forth statistics on consumption of petroleum products; deliveries of motor spirit to dealers and commercial consumers; analysis of deliveries into consumption of gas, diesel and fuel oils; production of petroleum products from imported and indigenous crude and process oils; and indigenous materials made available for distribution by the petroleum industry. From the statistics given it appears that, during 1950, 5,195,173 tons of motor spirit, including motor benzole, were consumed in Great Britain. Considering that petrol rationing was not lifted until May 1950, this is a high figure, one, however, certain to be greatly exceeded for the current year. Total deliveries of gas, diesel and fuel oils for burning and power in the same year amounted to 5,337,791 tons. During the year Great Britain produced 949 tons of indigenous petrol by low-temperature carbonization, 130,177 tons of petrol and aviation spirit by hydrogenation and 188,842 tons of refined benzole—not an unworthy record.

Cambial Injuries in a Pruned Stand of Norway Spruce

A FORESTRY Commission publication, Forest Record No. 4 (pp. 12; London: H.M. Stationery Office, 1950; 9*d*. net), by W. R. Day, is devoted to "Cambial Injuries in a Pruned Stand of Norway Spruce" and is based on an experiment made of pruning the side branches of Norway spruce with the object of raising the quality of timber and so the economic value of the crop. One of the pruning experiments was carried out in Drummond Hill Forest on Loch Tay-side, Perthshire, at four different times of the year—May, July, October and January. Unpruned control plots were maintained, and all the plots had been brashed up to a height of about 6 ft. The trees in the forest were planted in 1912 and were thirty-five years old when examined in 1947. In a summary of the research work undertaken, the author says that a severe case of bark necrosis occurred, owing to frost damage, usually after the pruning had taken place and either at the beginning or end of the growing season. The damage to the unpruned trees was much less severe. The wood made by the spruce is abnormal in that its cell walls are of a weak structure and tend to be insufficiently lignified, especially the late wood. A typical feature of these trees is that the annual ring ends abnormally, indicating that their growing season is unduly long considering the type of climate in which they grow. The experimental demonstration of the diagnosis put forward in this paper is under consideration. The technical difficulties are involved, and research will be required into the relationship between provenance of spruce seed, that is, of the variability of a species and the relative usefulness of its variations in any particular region. Research is also required in the type of wood developed in Great Britain and susceptibility to the type of injury here described—a matter of some importance, for the results might seriously affect the productive efficiency of future plantations.

Chestnut Blight

THE symptoms of chestnut blight, caused by the fungus *Endothia parasitica*, are described and illustrated in colour in Booklet No. 3 of the Forestry Commission (pp. 4+4 pl.; London: H.M. Stationery Office; 1950; 2*s*. 6*d*. net). This is a disease of the sweet chestnut, *Castanea sativa*, which has not yet been found in Great Britain; it has, however, caused very serious damage in the United States and is established in Italy and Spain. There is sufficient sweet chestnut in France to form a potential infection-bridge to the fairly extensive coppices of this tree in the south of England, and it is therefore highly desirable to recognize any possible occurrence in

Britain and to limit its spread, if discovered. The fungus attacks the bark, girdles the tree with a typical canker and kills the part beyond the canker. Orange-yellow spore tendrils are produced in moist weather, and the fungus also produces mycelial fans under the bark. Chestnut blight can be distinguished from ink disease of the same tree in that the latter kills the tree completely, whereas the former often allows normal growth in the part below the canker. The Forestry Commission invites reports of suspected cases of the disease to its Research Station, Alice Holt Lodge, Farnham, Surrey. It is pointed out that material should be packed in a tin to avoid spreading fungus spores during transit.

Animals of Scotland

To accompany a new section devoted to animals of Scotland in the "Habitat Court" of the Glasgow Art Gallery and Museum, a suitable booklet has been prepared by the curator of the natural history department. This describes the appearance and habits of the twenty-eight mammals and birds included in the exhibit as well as their general taxonomic characters. Other exhibits are concerned with the animals of Africa, India and Australia, and the number of visitors they are attracting indicate their popularity. A fifth exhibit, featuring animals of arctic and antarctic regions, is under construction.

Fear and Social Structure

According to Dr. Grantly Dick Read, the influence of fear on social structure is not well understood or appreciated (*South Afr. J. Sci.*, 47, No. 8; March 1951). Practically the whole basis of human communal existence to-day, he suggests, is influenced by fear; man's mental and physical health vary as to his ability to remain balanced in face of fear. Dr. Dick Read also suggests that children are not only emotionally influenced from the moment of their birth but even from the moment of conception. At fifteen weeks the reflexes of the fœtus indicate individuality of behaviour. From birth the child is regularly subjected to stimuli which induce fear and lead to insecurity. According to its nature the child risks rebellion in violence or excessively anti-social behaviour, or resolves into that submissive state when even attempted activity of any sort, or any expression of its individuality, is paralysed by the deeply implanted fear of consequences. Dr. Dick Read believes that much of this unnecessary fear with its harmful effects on the individual and society would be eliminated if the fear of child-birth in women were eliminated.

Montefiore Prizes for Electrical Development

Montefiore Prizes, awarded by the George Montefiore Foundation of Liège, have been awarded to Dr. U. Krabbe (Fruens-Bøge, Denmark), for an essay on "The Transductor Amplifier"; Dr. M. Hoyaux (Charleroi), for an essay on "Théorie de la chute dans l'arc des redresseurs à vapeur de mercure"; E. H. Hubert (Liège), for an essay on "Contribution théorique et expérimentale aux possibilités d'application du réenclenchement automatique des disjoncteurs"; and R. Pellisier (Paris), for an essay on "La propagation des ondes transitoires et périodiques le long des lignes électriques". These Prizes are usually given every five years; but the present awards are for the period 1939–50. They were established by a bequest of M. Montefiore, who founded the Electro-Technical Institute of the University of Liège, and are given for original contributions of scientific or technical significance for electrical progress. The committee of award consists of five Belgian and five non-Belgian engineers. Seventeen essays were submitted on this occasion. Particulars relating to the awards can be obtained from the Fondation George Montefiore, Université, Liège; the next awards will be made in 1955.

Unification of the "Air Almanac" and the "American Air Almanac"

As from 1953, the "Air Almanac" and the "American Air Almanac" will become a single publication, under the title of the "Air Almanac". It will be produced jointly by H.M. Nautical Almanac Office of the Royal Greenwich Observatory, Herstmonceux, and the Nautical Almanac Office of the U.S. Naval Observatory in Washington, to meet the general requirements for air navigation in the United Kingdom, the United States and Canada. The "Air Almanac" will be printed and published separately in England and the United States, but will otherwise be identical. A number of changes have been necessary in both the former publications. None of these has any effect on the principles of tabulation or on the use of the "Almanac" in navigation.

British Institution of Radio Engineers: Premiums for 1950

The British Institution of Radio Engineers has awarded the following Premiums for 1950, the awards being based on papers (titles as indicated) published during the year in the *Journal* of the Institution: *Clerk Maxwell Premium* (for the most outstanding paper of the year), to D. W. Heightman, English Electric Co., Ltd. (propagation of metric waves beyond the optical range); *Heinrich Hertz Premium*, R. Kompfner, Clarendon Laboratory, Oxford (operation of the travelling-wave tube at low level); *Louis Sterling Premium*, J. E. B. Jacob, Cinema Television, Ltd. (high-performance television monitors); *Dr. Norman Partridge Memorial Award*, S. W. Punnett, University College, Southampton (audio frequency selective amplifiers).

Announcements

Prof. Emile Guyénot, *correspondant* for the Section of Anatomy and Zoology of the Paris Academy of Sciences and professor of zoology and comparative anatomy in the University of Geneva, has been elected a non-resident member of the Academy in succession to the late Prof. L. Cuénot, formerly professor of zoology in the University of Nancy.

Prof. G. L. Brown, Jodrell professor of physiology in the University of London, and Sir James Learmonth, regius professor of clinical surgery and professor of surgery in the University of Edinburgh and surgeon to H.M. The King, have been appointed members of the Medical Research Council as from October 1.

The annual 'open day' at the Chemical Research Laboratory (Department of Scientific and Industrial Research), Teddington, will be on September 19.

The Medical Research Council announces that travelling awards in ophthalmology and otology under the Alexander Pigott Wernher Memorial Trust, tenable during the academic year 1951–52, have been made to Dr. Patricia R. Davey (Sydney) and Dr. R. N. Misra (Medical College, Lucknow).

ÇHEMISTRY AND TECHNOLOGY OF METALS AND ALLOYS

THE joint meeting of the Sections B (Chemistry) and G (Engineering) of the British Association, held on August 14 at Edinburgh to discuss "Metals and Alloys", was noteworthy because it was the first time in the history of the Association that a meeting had been devoted exclusively to subjects of metallurgical interest. This was pointed out in his opening remarks by the chairman, Sir Andrew McCance, who went on to remind his listeners that announcements of historic metallurgical importance have nevertheless been made at earlier meetings; for example, at the Cheltenham meeting in 1856 Bessemer made the first public announcement of his revolutionary process for making steel from pig iron without fuel by blowing air through it. Sir Andrew aptly summed up the course of metallurgy during the past hundred years by saying that the latter half of the nineteenth century was devoted to developing the art of manufacture on an ever-increasing scale, whereas the first half of this century has been characterized by an equally intense endeavour to understand the scientific principles of the processes in use.

This was well illustrated by the paper on "Chemistry in Metal Extraction" given by Dr. F. D. Richardson. The study of the physical chemistry of metals and slags is a development of the past twenty-five years; and so far as the older metal industries are concerned, research has been aimed at establishing the physico-chemical background of existing processes, and no startling discoveries have been made. On the other hand, chemical research has been directly responsible for the methods of extracting such new and costly metals as titanium, zirconium and uranium. Concerning metal extraction at high temperatures, least is known about molten slags and mattes, and research is therefore required on the chemistry of molten silicates, oxides and sulphides and their mixtures. According to the picture so far developed, molten silicates consist of disordered three-dimensional networks of tetrahedral silicate groups (SiO_4). These groups share corners with one another via Si—O—Si 'bridges' which can be broken by the addition of metal oxides, with a corresponding decrease in viscosity. When all the bridges have been broken, addition of further metal oxide gives rise to oxygen and metal ions dispersed between silicate tetrahedra. Much confusion has arisen from theories of the formation of various kinds of molecular compounds in liquid slags; but Dr. Richardson stressed that the only entities that can be recognized as having a distinctive existence are the metal ions, the silicate tetrahedra (which carry a net negative charge and may be bridged together in varying degrees) and the excess oxygen ions.

The rates of reactions between slags and metals are not controlled by the chemistry of the processes which take place at the interface between them but by the diffusion of reactants and resultants to and from the interface, particularly in the slag, since diffusion in the slag is generally much slower than in the metal. The rates of refining processes with slags can also be increased by efficient mixing of the slag and metal. The partition of sulphur between slag and metal obtained in the blast furnace is much less favourable than can be obtained under equilibrium conditions in the laboratory, and Dr. Richardson suggested that pig iron of lower sulphur content might be made by mixing slag and metal in the ladle after tapping. This would be an additional operation; but the slag and metal would be readily available at the desired temperature. It might also be practicable to recover the sulphur from the enriched slag by blowing air or oxygen through it, and to use the sulphur dioxide evolved for manufacturing sulphuric acid. If so, the seven million tons of blast-furnace slag made annually in Britain would be a potential source of a hundred thousand tons of sulphur.

The second paper, by Prof. A. H. Cottrell, was concerned with "The Strength of Metals". The atoms in a slip plane cannot all slip simultaneously over their neighbours in the next plane; slip must begin at certain places and then spread. The term 'slip dislocation' is applied to the line boundary separating the region in which slip has occurred from the rest of the slip plane. Three important properties of a slip dislocation are: when a slip dislocation is moved in a slip plane the amount of plastic deformation in the crystal is altered; the stress needed to move a dislocation through a slip plane of an otherwise perfect crystal is smaller than the smallest observed yield-strength; and third, the stress needed to create a dislocation in a perfect lattice is larger than the highest observed strength. This last property implies that slip dislocations must be present in crystals before they are plastically deformed. Support for this idea has been provided by Frank's theory of crystal growth, according to which growth occurs by deposition along spiral terraces on crystal faces, the centre of each spiral being the point where a dislocation line emerges from the interior of the crystal. On this theory the imperfect crystals, that is, the ones containing dislocations, are those most likely to grow. Growth spirals have been observed on both inorganic and organic crystals.

Prof. Cottrell then showed how dislocation theory explains the effect on the yield-strength exerted by foreign atoms, precipitates, crystal boundaries and other irregularities which are obstacles to the propagation of dislocations. Strain-hardening—one of the first problems to be studied from the point of view of dislocations—is the outstanding unsolved problem facing the theory. According to recent work the initial dislocations tend to assemble in sheet-like arrays that are very stable and act as barriers to the propagation of later dislocations; these special arrays of dislocations appear to be the main cause of strain-hardening; but it is not yet known why they are formed in the first place and why they are so stable.

A survey of alloy development during the past ten years or so was given by Prof. A. G. Quarrell. To a large extent new alloys are developed to meet the needs of the engineer, and the gas turbine has provided an incentive for the development of alloys with improved high-temperature properties in much the same way that the needs of the aircraft industry led to the introduction of alloys of better strength-to-weight ratio. For the most part the improvement of alloys is still empirical, depending upon the 'metal sense' of the metallurgist, and most of the alloys now technically important are complex, containing from six to ten alloying elements. It is to be hoped that, as the theory of alloy formation becomes more complete, it will be possible to design alloys on a more rational basis and possibly with greater economy of alloys.

After reviewing some of the characteristics of "Brittle Fracture in Mild Steel", which has become so important since the introduction of welding on a large scale into shipbuilding, Mr. T. S. Robertson went on to describe a new form of test for the assessment of brittleness. In this test a shock crack propagated at low temperature passes through material stressed to a value comparable with that carried by the structure in practice. A temperature gradient is maintained along the direction followed by the crack, and this enables the temperature at which the material arrests propagation of the crack to be determined. As the transverse stress is reduced there is a sudden drop in the temperature at which the propagating crack is arrested, and Mr. Robertson suggested that this stress could be regarded as a safe design stress below which there is no chance of brittle fracture at ordinary working temperatures. Mr. Robertson illustrated his remarks with an excellent colour film of a test in progress. This showed that the speed of crack propagation is such that for the usual travel of about six inches, photography at 4,000 frames per second is too slow to record it, since no film so far taken has shown the crack in process of development. The speed of propagation must therefore exceed 2,000 feet per second.

In discussion Prof. J. A. Pope reminded the meeting that engineers are specially interested in the dynamic properties of metals. Under fatigue conditions the nature of the surface is most important: for example, light alloys tested with the as-extruded surface show much poorer properties than when the surface is carefully polished. Again, engineers are interested in machinability. If easily machined alloys are used, it might be possible to use water-cooled gas-turbine blades and to maintain a lower metal temperature by taking advantage of the stationary 'air' layer adjacent to the blade surface.

GENETICS AND EMBRYOLOGY

A DISCUSSION on the relations between genetics and embryology was held by Section D (Zoology) of the British Association on August 9. In introducing the topic, Prof. C. H. Waddington pointed out that when Bateson invented the word 'genetics' he defined it as the science which dealt with the physiology of descent, a phrase which could be held also to cover the subject which is usually known as experimental embryology. In spite of this, these two branches of biology, both of which have grown extremely rapidly in the past few decades, have developed almost in isolation from one another. After the disproof of at least the simple forms of the theory that differentiation is due to differential nuclear divisions, the concepts commonly used in them gradually diverged. Genetics came to envisage development in terms of the control of single chemical substances or enzymes by nuclear genes; while experimental embryology operated with the notions of gradients, on one hand, and active substances or regions, such as specific plasms or organizers on the other, neither of these types of agent being essentially connected with the nuclei. In quite recent years, these two categories of thought have begun to come together again. Thus, experimental embryology has been driven to recognize the fundamental importance of developmental competence, and to realize that this property is controlled, at least in the main, by genetical factors; while genetics has discovered that the connexion between gene and final product is not simple, but involves a balance between interacting forces which issues in a condition similar to the competence postulated by the embryologists. It may be hoped therefore that the natural unity between genetics and embryology will come to full expression in the near future.

Dr. R. A. Beatty then discussed some aspects of the importance of chromosomes in development, particularly in mammals. He described the occurrence of polyploids in mice. Triploid embryos are found to occur naturally in certain strains, and both triploids and tetraploids can be induced by hot shocks applied to the early stages of the eggs in the Fallopian tubes. So far no polyploids have been observed after birth; but the embryos appear to develop normally to mid-term, and it is hoped that polyploid young will shortly be identified. Turning to a rather different subject, he pointed out that evidence has been gradually accumulating that the cells of differentiated mammalian tissues may contain very different numbers of chromosomes. It does not seem plausible to attribute this to the technical difficulties of counting the chromosomes. There is no evidence that the type of differentiation is correlated with chromosome number; it seems more probable that neighbouring cells can co-operate, so that the important matter is the chromosome balance in the whole tissue rather than in the individual cells composing it.

Dr. D. S. Falconer pointed out that one approach to developmental genetics is to regard a mutation as causing a 'natural experiment'. It may be possible to show that the mutant gene produces some rather simple effect early in development and to trace a whole series of later modifications back to this original cause. As an example of such an approach, he described the analysis of a recent mutation in the mouse known as 'Crinkled'. The main initial effect seems to be the prevention of the formation of hair follicles except during a short period just before birth. This has a direct effect on the coat as a whole, which lacks the long guard hairs, normally initiated at an early period, as well as the short 'zig-zags', which are normally initiated after birth. It also explains the existence of certain localized bald patches, the absence of certain vibrissae, and, by its effect on the growth of the skin, the distortion of the vertebrae of the tail from which the gene gets its name, as well as a number of other minor effects.

After the discussion, a series of cinema films were shown, one of which demonstrated the technique used for inducing polyploidy in mouse eggs.

SHIPBUILDING

AN international conference of naval architects and marine engineers was held during June 25–30, with proceedings in London, Glasgow and Newcastle upon Tyne.

The first paper read in London, "Ships Structures —A Century of Progress", by Mr. R. B. Shepheard, of Lloyd's Register of Shipping, traced the development of ships' structures from the wooden ships in general use one hundred years ago, through the stages of iron and riveted mild steel to the modern welded steel ship. With certain noteworthy exceptions, progress following the introduction of new methods of shipbuilding has been delayed by persistent attempts to reproduce the traditions of the earlier methods in the new material.

The application of scientific principles to the structural design of ships developed from the earlier work of Grantham and Fairbairn about ninety years ago, until some forty years later rational methods of obtaining the distribution of material in the section of a ship were developed, largely due to the work of Foster-King, Bruhn and Isherwood. Since that time, research on the behaviour of ships' structures and component structural members has continued in order that further economies might be effected in the light of increased knowledge. The recent introduction of welding on a large scale has presented the designer with many new problems.

Developments of shipbuilding during the Second World War, particularly in the United States, brought to light the importance of notch toughness in mild steel, several major failures occurring due to lack of this quality. This problem of notch toughness which, so far as it relates to ship structures, was isolated in Great Britain in the Engineering Laboratory, Cambridge, as long ago as 1944, is being attacked by metallurgists and engineers in many countries.

Changes in the design and arrangement of dry cargo ships over the past fifty years have tended to increase the bending moments for the loaded condition at sea. In the case of the larger tankers, where there is considerable flexibility of loading in the ballast condition, a stage has been reached where the design must be developed with defined limitations on service schemes of loading.

Another paper, "Proposed Design for a Combined Research, Training and Cargo Ship", by Prof. H. E. Jaeger and J. C. Arkenbout Schokker, must have been of particular interest to shipbuilders in Great Britain owing to the very extensive work in the same field which is being carried out for the Admiralty Ship Welding Committee. It developed the interesting idea of building a dry cargo ship of about 9,500 tons deadweight which would serve the triple purpose of: (*a*) a training ship for officers and engineers for the merchant marine; (*b*) a research ship in which problems on ships' structures and performance could be investigated; and (*c*) a cargo ship engaged in normal trade partly to give realistic conditions for both training and research and partly to offset the cost of the project. This use of the ship for trading purposes would be subordinated to the needs of training and research.

The authors suggested that the most suitable size for such a vessel would be about 472 ft. length (B.P.) and 68 ft. breadth. The displacement would be 15,000 tons and the desirable speed 17 knots, requiring engines of about 8,700 S.H.P. The initial installation should be a diesel electric set installed aft with provision for the substitution of a gas-turbine motor at a later date. Suitable accommodation is planned for the large number of officer cadets and research workers, in addition to the normal complement.

The structure of the ship would include examples of several different types of construction. For example, the fore part would be longitudinally framed, whereas the after part would be transversely framed. Several different types of bulkhead stiffening would be fitted, including some corrugated bulkheads. All bulkheads would be designed to allow the holds to be filled with water up to the level of the shelter deck. This would enable large bending moments and other actions to be applied to the ship during structural tests. Various types of roll-stabilizing equipment would be installed for testing the relative merits of different systems.

No details were given by the authors of the equipment for measuring and recording the forces acting on the ship at sea and the strains induced in the structure. There would, of course, be the great advantage over the recent British experiments on the S.S. *Ocean Vulcan* that the installation of instruments could be made while the ship was under construction.

More rational methods of designing ship structures can only be developed with confidence when more is known of the actual forces to which the structure is likely to be subjected, so that the authors' proposal that several research ships should be built and operated in all parts of the world is attractive. Unfortunately, such experiments are costly, not only in the initial outlay on the ships and in their running, but also in the reduction to useful form of the vast amount of records collected on each voyage.

The cost of such full-scale experiments compels naval architects, as it does engineers in so many fields, to attempt to collect information from model tests such as those described by J. C. Niedermair, of the Bureau of Ships, in his paper "Ship Motions". The paper describes a series of experiments on the behaviour of five ship models of widely differing forms under steady wave conditions. In most of the tests a constant propelling force was applied to each ship in turn, and the amplitudes and periods of the resulting motions were measured together with the mean speed of advance through the waves. In the testing tank used, it was only possible to propagate waves the direction of advance of which was parallel to the ship's course. The full-scale dimensions of the waves used ranged from 300 ft. to 900 ft., and the full-scale heights lay between 19 ft. and 33 ft., while the lengths of the ships were from 380 to 550 ft.

Remarkable changes in the mean speed of advance were shown with changes in wave length. Despite a great difference in form of the ships, the five models showed like characteristics. Each model exhibited a minimum speed for constant propelling force when the wave-length was about equal to the ship's length.

Curves giving the pitch amplitude as a function of wave-length show that the ratio of maximum pitch to maximum wave slope continues to increase with increasing wave-length at least until the wave-length equals twice the length of the ship. It is significant that no irregularities occur in these curves around the value of wave-length which should theoretically cause resonant pitching. The experimental records have been related to the theoretical analysis recently published by Weinblum and St. Denis, and found to be in general agreement. The pitching periods during these tests were those of the period of encounter, although it is generally accepted that a ship in a seaway pitches usually to its own natural period. It appears that the severity of the forcing motion used has masked the natural oscillations of the ship.

Not unnaturally, the authors feel the need for the verification of the similarity of ship and model motions, and they point out that this would involve instrumenting a ship fully, both to record ship motions and to record simultaneously the surface of the sea. All ways, therefore, seem to point to the need for more research ships.

CANCER RESEARCH IN GREAT BRITAIN

TWO annual reports which have recently been published, those of the Imperial Cancer Research Fund* and of the British Empire Cancer Campaign†, record the slow but steady progress that has been made in cancer research during the past year. The report for 1948 of the Imperial Cancer Research Fund gave first place to an account of certain investigations which lent weighty support to the virus theory of cancer, in that it was thought that what had been done since the classical work of Peyton Rous in 1911 on the chicken tumour could be reproduced on a mammalian tumour. It had been shown in the Fund's laboratories that mouse tumours could be frozen and dried, yet could still be successfully transplanted into mice. Freeze-drying kills cells but not viruses, and so it is considered that mouse tumour is transmitted by a virus liberated from the killed tumour cells.

The assumption of this essential condition did not survive tests at some other centres of cancer research. It was soon shown that freeze-drying, if carried to a more-or-less advanced stage, still leaves some viable cells which can be demonstrated by their growth in tissue culture. The positive results on inoculation can therefore be explained without invoking a virus as the agent for transmitting the tumour.

In the present report, the director of the Fund, Dr. James Craigie, frankly states that the mammalian virus hypothesis of tumour transplantation can no longer be considered. He has found, however, that the cells of a mouse tumour contain, in addition to the usual neoplastic cells, another type of cell characterized by being highly resistant to freeze-drying and by its high refractility. It can only be recognized by phase-contrast microscopy. He suggests that the cells of some tumours can assume the refractile state and that these cells can also change back into "normal tumour cells". The analogy with spore formation of micro-organisms is obvious.

The refractile cells are very potent tumour-carriers; only seventy-five cells are required to produce a tumour on inoculation into mice. "It has been found possible to obtain them (refractile cells) in considerable quantity for study, either by fractionating suitable suspensions prepared from subcutaneous tumours or by collecting them from the fluid which accumulates when tumour growth is produced by intraperitoneal inoculation . . . it was found that the refractile bodies were not stable in vitro but might change into recognizable tumour cells. . . . The discovery that the cells of some tumours assume this resistant state raises a number of questions. . . .". Clearly, these observations are of great importance and their development should do much to stimulate the biology of cancer.

Other studies at the Fund's laboratories at Mill Hill include those of L. Foulds on the responsiveness of some mouse mammary tumours to the hormonal influences which operate during parturition and lactation. An attempt is being made by P. C. Williams to induce similar effects by supplying hormones artificially to female mice bearing this type of tumour.

H. G. Crabtree has as yet found no straightforward relationship between the liver cancer inducing potency and the chemical structure of a series of azo-carcinogens. Reduction fission of the azo-compound yields a diamine moiety which selectively inhibits enzymes the activity of which is dependent upon intact sulphydryl groups; however, the correlation between carcinogenicity and potential inhibition shows some discrepancies.

E. Vazquez-Lopez finds that administration of thiourea to virgin mice of cancer-liable strains causes a significant decrease in the incidence of mammary cancer. After treatment by thiourea the œstrogenic secretion is re-established and mammary tumours begin to appear. These experiments suggest that "oestrogens are active carcinogenic agents independently of their primary morphogenetic functions".

Of the scores of researches described in the report for 1950 of the British Empire Cancer Campaign, the most attractive is by Sir Ernest Kennaway. Sir Ernest, who has recently celebrated his seventieth birthday, is too well known for his achievements in cancer research to need reiteration; the enigma of neoplasia has been compared to an uncharted ocean, and on this basis he could be called its Columbus. One of the reasons for the extraordinary interest of his essay is that it does squarely face the problem of the cause of cancer.

Cancer of the lung has undergone an immense increase of incidence in recent years—four times as high in an interval of fifteen years. Is this multiplication due to an increase in the inhalation of carcinogens, benzpyrene in town smoke or of arsenic in tobacco smoke? The analysis of twenty-seven brands of cigarettes shows that British, Canadian, American and Norwegian cigarettes contain the largest amount of arsenic (24–106 μgm./gm.), and Bulgarian the least, 0–1·2; Turkish tobacco contains little arsenic, 0–4·3. Nevertheless, the incidence of lung cancer is very high in Istanbul, for in 1946–48 the percentage of cancer of lung was thirty per cent of all cancer autopsies in males. In autopsies at St. Bartholomew's Hospital, London, the comparable figure was 41·17 per cent. Although no simple relation can be thus shown between lung cancer and arsenic in tobacco, the possible synergistic effect of this carcinogen cannot be ignored; a smoker can volatilize half a milligram of arsenic a day. Certain occupations have a low lung-cancer incidence, namely, agriculture, coal mining and mule spinning. The workers in the two last-named cannot smoke for a third of the day, and, in the first, atmospheric benzpyrene from town smoke is at a minimum. The aeration and temperature of the glowing tip of a cigarette is such as to render the production of benzpyrene negligible. In town smoke this carcinogen is due to the agglomeration of active domestic chimneys, for it is not emitted by properly working industrial furnaces or generating stations. The part played by other associated factors has still to be investigated—for example, the size of the particles in smoke containing the benzpyrene and the chances of these being retained in the bronchi and lungs, and secondly, the carcinogenic effect, if any, of components in the exhaust gases of motor vehicles.

"The finely divided carbon (in human lungs) . . . represents the intake of a lifetime. . . . The carbon itself may be innocuous, but from the study of atmospheric pollution . . . one can form some idea of the amount of benzpyrene which would accompany it. The small amounts of radioactive material, and of arsenic, which have been found in the dust of towns incline one to attach more importance to benzpyrene in this respect, but one must remember that: (*a*) we have no data upon the minimum effective dose of any carcinogen in man; and (*b*) we do not know whether the effects of different carcinogens upon the same tissue can summate."

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* Forty-Eighth Annual Report of the Imperial Cancer Research Fund, 1950–1951. (Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2.)

† British Empire Cancer Campaign. Report for 1950. Edited by Sir Heneage Ogilvie. (11 Grosvenor Crescent, London, S.W.1.)

Cancer of the larynx has increased of late years but not so rapidly as lung cancer, and this disease also shows a sex difference. Sir Ernest, in explanation, advances the stimulating idea that: "The differences in the anatomical, social and geographical distribution of cancer of the larynx in men, and in women, show that these two must be regarded as, to a large extent, different diseases; any statistics in which they are pooled are of no value. The larynx is a secondary sexual organ, hence such differences are not surprising. The adoption of smoking by women, and the increased consumption of tobacco and especially of cigarettes, by both sexes, has not affected the absolute numbers of cancers of the larynx in recent years; there has been no uniform change in either sex since 1930. As recently as 1929 the numbers of cancers of the larynx, and of the lungs, in males was about equal . . . since then, the deaths attributed to the latter have increased enormously".

After these examples of scientific thought and language, the approach to the rest of the report requires some little mental readjustment; most of the material presented is very technical and will be of great interest, and of course is mainly intended, for research workers engaged on closely allied branches of work.

Specialization is inevitable; but it carries with it a danger for cancer research, for each step in development implies more refined technique and more recondite treatment, and consequently there sometimes arises a tendency to encourage the pursuit of the means rather than the end.

A long report from the Clinical Cancer Research Committee on cancer of the lip, mouth and tongue is concerned chiefly with the compilation of abundant data rather than the extraction of generalizations.

Apart from the investigations mentioned so far, the principal themes of research have been threefold: physics and radiology (developments in radio-therapy, and changes in tissue brought about by X-rays); 'model experiments', that is, the study of changes induced in genic material and structures; and carcinogens and carcinogenesis.

The attention devoted to chemotherapy is rather less than in previous years; much more emphasis is being laid on the lines of the 'model experiments'. The agents used for investigation have been radiations, mitotic poisons, nucleotoxins, carcinogens and mutagens; the test objects have been cells in tissue culture, chromosomes, genes and nucleoproteins. The precise relation of this voluminous work to cancer is perhaps not obvious to the uninitiated. It depends upon the thesis that cancer is an aberration of growth, development, repair and differentiation, that these four features of cells and tissues depend in turn on the nucleus of the cell, that the dynamics of the cell are an expression of the structure, metabolism and influence of the nucleoproteins, and, finally, that genes and viruses have largely the same type of chemical nature.

J. F. Danielli and collaborators have succeeded, using microdissection, in transplanting the nuclei of two amœbæ giving an *Amœba proteus* nucleus living in an *Amœba discoides* cytoplasm. The next step is plain: these investigators should now try to transplant the nucleus of a tumour cell into the enucleated cytoplasm of a normal cell.

The histological alterations in the epidermal tissue of the mouse after X-radiation has been examined by A. Glucksmann, who found that destruction of the epidermis, hair follicles and superficial parts of the derma is followed by regeneration, scarring, a breakdown of the scar tissue and a repetition of the whole process, without further radiation, which finally gives rise to squamous cell cancer.

J. W. Orr and co-workers have transplanted mouse skin, which had previously been painted with methylcholanthrene, on to some other part of the mouse; the striking fact has been revealed that the decisive pre-cancerous change has been effected in the sub-epithelial tissues although the methylcholanthrene-induced cancer arises in the epithelial cells: ". . . when the stroma has been adequately prepared by carcinogenic treatment it is not necessary that the epithelium growing on it should have been itself exposed to a carcinogen before carcinoma can occur. It also appears that carcinogen-treated epithelium may not become neoplastic when transferred to a healthy bed."

Two items dealing with cancer of the liver are also included: the report from the South African Cancer Association refers to the extreme susceptibility of the Bantu to liver cancer (forty times as high as in Europeans); C. Berman has now published his admirable studies in this field of cancer research in the form of a monograph, "Primary Carcinoma of the Liver" (H. K. Lewis, London).

ROYAL GREENWICH OBSERVATORY

ANNUAL REPORT

THE report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory*, presented at the annual visitation held on June 2, covers the period May 1, 1950–April 30, 1951, and exhibits the state of the Observatory on the last date. Only some of the more outstanding matters of general interest can be mentioned here.

Many will regret the fact that Flamsteed House, including the Octagon Room, is no longer under the jurisdiction of the Royal Observatory, as it has been converted into two flats for naval officers of the Royal Naval College. The Wren Building, taken over by the Ministry of Works, will be treated as an ancient monument, and repair work is now in progress. At Herstmonceux no work has yet started on the sites of either the meridian group or the equatorial groups, but the exact locations for the individual meridian instruments have been selected. Work has not proceeded as anticipated in the previous year's report, which stated that the building for the Cooke reversible transit circle was not expected to be completed before the spring of 1951; that the building for the photographic zenith tube was planned to be completed in the summer of 1951, and the pavilion for the Melbourne reversible transit circle by the middle of 1952. In addition, it was hoped that the buildings for the 26-in. and 28-in. refractors would be completed during 1952; but unfortunately no further building has been started, and it seems improbable that the target date of the end of 1953 for the completion of the removal of the Observatory to Herstmonceux will be attained.

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* Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory read at the Annual Visitation of the Royal Observatory, 1951 June 2. Pp. ii+20. (Greenwich: Royal Observatory, 1951.)

The report follows the usual lines of those of previous years; but one matter is worth special attention as it contains great possibilities for the future. On the suggestion of Prof. R. O. Redman, long exposures were made on regions containing the most intense discrete sources of galactic radio noises, and it is intended to repeat the plates after a year to discover whether any very faint object shown has a large proper motion. Three first-epoch plates have already been secured in the direction of the source in Cassiopeia, three towards that in Coma Berenices, and one towards that in Cygnus. One second-epoch exposure on the Coma source has shown that the method used is unsuitable for the detection of a small displacement in one object among scores to be examined. A different procedure will be adopted in the future; second-epoch plates will be taken direct, and glass positives, prepared from the second-epoch plates or from the earlier plates, whichever happen to be the more exposed, will be used for detecting any proper motion that may be large enough to be seen.

As a result of the work on the solar eclipse of November 1, 1948, it seems possible that improvements could be made in the method by which the limb-contours were being reduced in Washington. The observers at Washington have sent an improved contour for librations corresponding approximately with the librations at the time of the eclipse, and plans have been developed for a more extensive application of the method at the total eclipse of February, 1952. It is proposed to make observations at two places near Khartoum which just lie outside the region of totality on both sides of the central line, and also at two places near Basra, similarly placed with respect to the central line. Long-focus cameras will be used at the Khartoum sites to photograph the eclipse with the object of obtaining the precise contour of the moon's limb during the eclipse.

About four pages are devoted to the work of the Nautical Almanac Office, and one rather disconcerting matter is mentioned at the beginning of this report. Although the junior staff has been up to its complement for the greater part of the year, it has not been possible to fill the vacant post of 'scientific officer', which has been unfilled since 1945. In the *Almanac* for 1952 three major changes which were announced in 1951 have been made; eighteen pages have been devoted to ephemerides of Ceres, Pallas, Juno and Vesta. The list of apparent places of stars has been replaced by an extended list of mean places of stars; elements of occultations have been omitted, but apparent places of occulted stars (pp. 321–329 in the *Almanac* for 1952) have been retained. The occultation machine, designed by Mr. J. D. McNeile and built by Mr. A. C. S. Westcott, has undergone a number of improvements, among which may be noticed that to the 'moon' system. The work was carried out at the National Physical Laboratory to a design by Dr. D. S. Perfect, to allow greater accuracy in setting the limb of the moon on a station and in other ways to provide more satisfactory results. Preliminary tests have shown a great improvement in accuracy; but at present it is impossible to say whether the times as determined by the machine will dispense with the necessity for prediction computations. The new form of *Abridged Nautical Almanac* for 1952, a preliminary notice of which has aroused considerable interest, was not published at the time of the compilation of the report, but has since appeared.

It is very satisfactory to know that so far the experience of observational conditions at Herstmonceux shows they are up to expectations. Over a period of nearly a year the amount of sunshine at Herstmonceux has been nearly fifty per cent higher than at Greenwich, the greatest excess of sunshine at Herstmonceux occurring in the afternoon; the greater amount of cumulus cloud at Greenwich is responsible for the difference. Although the night sky records at Herstmonceux show only a moderate excess of clear sky, the transparency there is much better than that at Greenwich, and the average definition is also superior. It is anticipated that the freedom from the glare of artificial lights at Herstmonceux will be of great benefit in all types of observations, and the staff is eagerly looking forward to the commencement of night observations free from the difficulties under which they were carried on at Greenwich for many years.

DEPARTMENT OF SCIENTIFIC RESEARCH, INDIA

THE report of the Department of Scientific Research, India, for 1950–51* states that investigations on atomic energy continued in research institutes and university laboratories all over India, and that important results have been obtained in the study of cosmic rays. A factory capable of processing annually 1,500 tons of monazite to give 207 tons of thorium nitrate, 1,500 tons of rare earth chlorides and 1,800 tons of trisodium phosphate will be completed during the present year. Valuable deposits of uranium and beryl have been discovered. An International Conference on Elementary Particles was organized at the Tata Institute of Fundamental Research, Bombay, during December 14–24, 1950. The Advisory Committee for Co-ordinating Scientific Work, presided over by the Prime Minister, reviewed the work and functions of the various departmental scientific committees and has established a scientific advisory committee to study and advise on methods of broadcasting, as well as a committee to consider the establishment of national parks and Nature reserves for the preservation of flora and fauna.

A directory of type cultures maintained at various places in India is being prepared, and attention has also been given to the improvement of the cultivation of pyrethrum plants and of the extraction, stabilization and formulation of pyrethrin. With assistance from the United Nations Educational, Scientific and Cultural Organization, an Indian National Bibliographical Centre is being established and this may also be developed into a national library. Sir C. V. Raman has continued his work on the diffusion of light in transparent media. Besides encouraging the study of geophysics in the universities, the Central Board of Geophysics is seeking to set up a central geophysical institute.

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* Report of the Department of Scientific Research for 1950–51. Pp. 22. (New Delhi: Department of Scientific Research, 1951.)

The Council of Scientific and Industrial Research records the opening during the period of seven national research laboratories: the National Chemical Laboratory, Poona, on January 3, 1950; the National Physical Laboratory, New Delhi, on January 21, 1950; the Fuel Research Institute, Dhanbad, on April 22; the Central Glass and Ceramic Research Institute, Jadavpur, on August 26; the Central Food Technological Research Institute, Mysore, on October 21, 1950; the National Metallurgical Laboratory, Jamshedpur, on November 26; and the Central Drug Research Institute, Lucknow, on February 17, 1951. The programme of work to be undertaken by these laboratories is indicated in the report. In addition, six regional coal survey stations are being set up to survey the coal resources of India.

The Central Road Research Institute, New Delhi, is studying the vitrification of bricks for road use, the improvement of bullock cart wheels and jointing compositions for aerodrome runways. The Central Building Research Institute, Roorkee, is investigating the use of indigenous building materials for houses, water-proofing agents to supplement the stabilizing action of lime sludge from sugar factories and problems in the manufacture of bricks. The use of myrobolan extract in the South India tannage and the manufacture of synthetic tannins from cashew shell and Bhilawan nuts are being examined at the Central Leather Research Institute, Madras.

Research schemes sanctioned by the Council during the year included the following topics: development of heavy-duty parts of internal combustion engines, hot-air engines and gas turbines and jet propulsion units; investigations of Indian medicinal plants, proteins from green leaves, gases in steel, and radio valves; and the manufacture of alcohol from bagasse and other agricultural wastes, of aluminium metal by electrolysis, of anhydrous aluminium chloride and of synthetic sapphires.

A Board of Engineering Research, with five expert committees, has been established.

The report also outlines the broad policy to be followed by the national laboratories in giving technical assistance to industry.

SCIENTIFIC RESEARCH IN INDUSTRY IN BELGIUM

THE annual report, for 1950, of the Institute for the Encouragement of Scientific Research in Industry and Agriculture, Belgium*, records a distribution during the year of grants totalling 69,202,500 francs. Of this total, 16,715,000 francs went to the committee on mapping the soil and vegetation of Belgium for making a systematic survey of the pedological characteristics of Belgian soils and completing a pedological map of the kingdom, and 6,438,000 francs to the committee for the study of the diseases and nutrition of livestock, and particularly trichosomiasis and brucellosis. A subsidy of 5,607,000 francs was allotted for the construction of an electronic calculating machine, and one of 5,281,000 francs for investigations, during two years, on the improvement of the quality of milk and problems of interest to the butter and cheese industry. A grant of 5,120,000 francs was made for research on rational and intensive exploitation of grasslands in Belgium, and another of 4,300,000 francs for investigations for improving the development of orchards, including soil investigations, studies on fruit trees and their culture and the diseases of fruit and their prevention. The Institute granted 2,800,000 francs for the investigations on industrial and potable water and the treatment of effluents, and 1,950,000 francs for scientific and technical investigations on the culture of vegetables for preservation, the selection of varieties and on the biological, chemical and physical conditions for preservation.

Grants were also made of 1,492,000 francs for chemical and physico-chemical researches on high polymers, including the study of dielectric constants, and of thermodynamic properties, the fractionation of polymers and investigations on the co-polymerization of styrene with drying oils, the dissolution of acrylonitrile and the thermal stability of polyvinyl acetate; 1,230,000 francs for investigations on soilless culture directed to the determination of practical conditions and to the study of physiological aspects of mineral nutrition of general interest in agriculture; and 890,000 francs for investigations on the improvement of the cultivation, conservation and utilization of medicinal and aromatic plants. The Union for Electrical Development in Belgium received 850,000 francs for continuing its researches on furnace refractories. Grants totalling 820,000 francs were given for researches on medicinal plants collected during 1947–48 in the Belgian Congo, and 779,500 francs for genetic, entomological and technological investigations on both Belgian and Congo timber. The Belgian Institute for High Pressure received a further 771,000 francs for continuing its piezometric studies, its studies on manometric balances, and on the biological effects of high pressures, while 762,500 francs was given for research on the proteins of barley and malt, and 700,000 francs for the continuation of work on the effect of oxygen excess in the blast vent of the Thomas steel plant.

Smaller grants were made for the following purposes: road research (514,000 francs); mushroom cultivation (485,000 francs); improvement and cultivation of the strawberry plant (400,000 francs); manufacture of calcium cyanide (480,000 francs); behaviour of asphalt mastics (380,000 francs); plasticity of ceramic doughs (277,500 francs); organic matter in Belgian soils (228,000 francs); Belgian Institute of Welding for research on the use of ultrasonics for the auscultation of welds (227,500 francs); preliminary investigations on the utilization of metals (222,500 francs); use of explosives in mining demolition and in quarrying (168,500 francs); preservation of perishable produce by rapid freezing (121,000 francs); and for investigations on air liquefiers (85,000 francs).

A list of publications relating to researches subsidized between October 1, 1949, and December 31, 1950, is appended, and the Institute has also issued a pamphlet summarizing briefly its activities since it began to operate in 1945, showing the results achieved by the expenditure of some 240 million francs distributed over 173 subsidies.

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* Institut pour l'Encouragement de la Recherche scientifique dans l'Industrie et l'Agriculture. Rapport Annuel 1950. Pp. 164. Cinq années d'activité: un Bilan, 1945–1950. Pp. 24. (Bruxelles, 1951.)

LETTERS TO THE EDITORS

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o notice is taken of anonymous communications

Terminology for Use in Lactational Physiology

Recent advances in the elucidation of the physiological mechanisms of lactation, particularly those mechanisms concerned in the transfer of milk from the mammary glands to the young, have revealed inadequacies and ambiguities in the terminology in common use in relation to lactational physiology. An example of such an ambiguity is the term 'to suckle', which is at present being used to denote the activity of the lactating mammal or the young or both. In 1947, one of us[1] proposed a scheme, now generally adopted, which classified and defined the major physiological components of the total phenomenon which is called 'lactation', and which has done much to clarify terminology in this field. We should now like to put forward additional terms which, if generally accepted, we believe will render the above-mentioned scheme more comprehensive and will largely resolve the ambiguities still in existence.

The terminology we propose is as follows:

Nursing. The behaviour of the lactating mammal in promoting access of the young to the nipples or teats.

Suckling (milking). The activity of the young (or operation of the milking device) with the aim of obtaining milk from the mammary glands.

Suckling (milking) stimulus. The sum of stimuli applied to the lactating mammal by suckling (or milking).

Alveolar milk. The milk stored in the lumina of the alveoli and ducts of fine calibre.

Sinus milk. The milk stored in the ducts of large calibre and lactiferous sinuses or cisterns.

Passive withdrawal. The removal of sinus (or cistern) milk which at low intramammary pressure can be brought about by the action of suckling or milking or by cannulation without the intervention of the special contractile tissue of the mammary glands.

Milk ejection. The effect of alveolar contraction elicited reflexly by the suckling or milking stimulus in mammary glands distended with secretion. It involves the movement of some alveolar secretion into the sinus or cistern (that is, alveolar discharge) thereby producing a rise in intramammary pressure (hitherto called 'let-down' or 'draught'). Milk ejection may or may not involve passage of milk to the exterior.

The scheme of Folley[1], illustrating the phases of lactation may thus be extended as follows:

- Lactation
  - *A.* Milk secretion
    - (*a*) Synthesis of milk by the cells of the alveolar epithelium
    - (*b*) Passage of milk from the cytoplasm of the alveolar epithelial cells into the alveolar lumen
  - *B.* Milk removal
    - (*a*) Passive withdrawal
    - (*b*) Milk ejection

It is hoped that the terminology proposed will cover the phenomena formerly described by 'let-down', 'hold-up', and 'draught' in agricultural and medical circles, and that these latter terms will no longer be used, at least in scientific literature.

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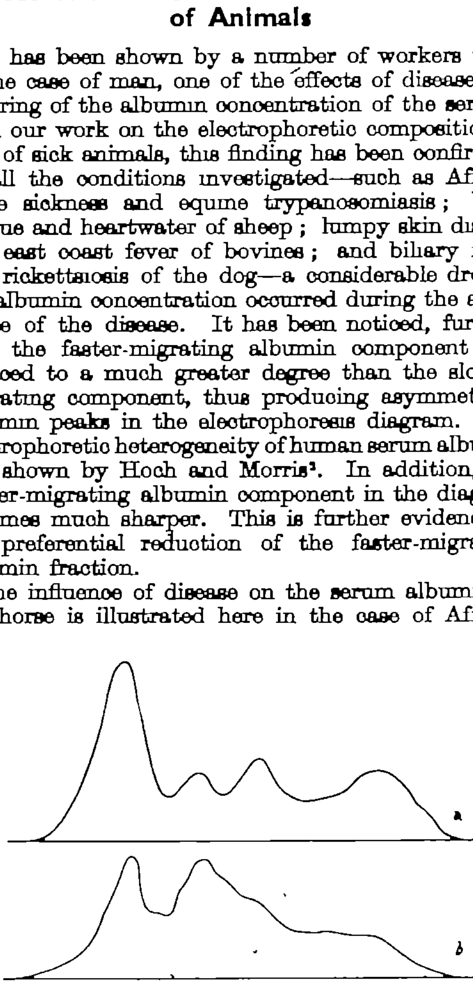
Effect of Diseases on the Serum Albumin of Animals

It has been shown by a number of workers that, in the case of man, one of the effects of disease is a lowering of the albumin concentration of the serum[1].

In our work on the electrophoretic composition of sera of sick animals, this finding has been confirmed. In all the conditions investigated—such as African horse sickness and equine trypanosomiasis; bluetongue and heartwater of sheep; lumpy skin disease and east coast fever of bovines; and biliary fever and rickettsiosis of the dog—a considerable drop in the albumin concentration occurred during the acute phase of the disease. It has been noticed, further, that the faster-migrating albumin component was reduced to a much greater degree than the slower-migrating component, thus producing asymmetrical albumin peaks in the electrophoresis diagram. The electrophoretic heterogeneity of human serum albumin was shown by Hoch and Morris[2]. In addition, the slower-migrating albumin component in the diagram becomes much sharper. This is further evidence of the preferential reduction of the faster-migrating albumin fraction.

The influence of disease on the serum albumin in the horse is illustrated here in the case of African



Electrophoresis diagrams of the serum of the susceptible horse (*a*) before inoculation with horse sickness; (*b*) at the peak of the reaction to African horse sickness horse sickness. Fig. *a* shows the electrophoresis diagram of the serum of a susceptible horse; Fig. *b* is the diagram of the serum taken at the peak of the reaction to African horse sickness in the same horse after experimental infection. The dissimilarity between the two diagrams is obvious. In this communication attention will be paid only to the albumin component.

In the serum of the horse taken at the peak of the reaction the albumin component is reduced considerably and becomes quite sharp and asymmetrical. There is a distinct bulge on its side which indicates that the faster-moving albumin constituent is reduced in concentration. In normal serum at *p*H 8·6 at which these measurements were made, the two components migrate with velocities which differ only by a few per cent. It is only when the concentration of one component is reduced that the heterogeneous nature of the albumin is noticed.

So far as I am aware, the selective reduction of the albumin through the influence of a disease has not been reported by other workers in this field. This is due to the relative insensitivity of the usual optical methods employed in electrophoretic studies, as compared with the very sensitive Lamm-scale method used in this work.

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Cocarboxylase in Experimental Diabetes

In previous experiments we have found that the injection of cocarboxylase causes, in the alloxan-diabetic rat, a diminution of the blood sugar and an increase of the respiratory quotient and of tissue glycogen. Thiamine produces similar effects; however, with severely affected animals it fails to act[1,2]. The hypothesis was then advanced that, in severe alloxan diabetes, thiamine does not produce any effect because its conversion to cocarboxylase is prevented. We have now obtained some evidence in support of this hypothesis.

According to Ochoa[3], the phosphorylation of thiamine occurs mainly in the liver; we have therefore estimated the cocarboxylase in this organ of the alloxan-diabetic rat after injection of thiamine.

Table 1. Stock rats of both sexes of 200 gm. approximately were used. Thiamine hydrochloride 20 mgm./kgm. body-weight by intramuscular injection; animals killed by decapitation 30 min. after the injection. Cocarboxylase was determined by the method of Ochoa and Peters (ref. 4) with minor adaptations (ref. 5)

Rats	No. of animals tested	Liver cocarboxylase (μgm./gm. wet tissue)	
		Range	Average
Normal	22	7·70–12·91	9·62 ± 0·28
Diabetic	25	3·24–6·39	4·57 ± 0·16
Normal + thiamine	15	16·40–24·45	20·49 ± 0·67
Diabetic + thiamine	15	3·60–11·10	6·69 ± 0·61

It will be seen from Table 1 that in alloxan-diabetes a significant decrease of the cocarboxylase content of the liver occurs. This reduction was usually higher in those animals more severely affected. In the normal animals the injection of thiamine was followed by an increase of the liver cocarboxylase; this increase occurred in all the animals tested and exceeded 110 per cent.

In the diabetic rats the injection of thiamine was also followed by an increase of the liver cocarboxylase; however, this increase was much less than in the normal animals.

To see whether a relation existed between the respiratory quotient of the diabetic rat after injection of thiamine and the concentration of liver cocarboxylase, we have measured the respiratory quotient just before the injection of thiamine (20 mgm./kgm.) and glucose (5 gm./kgm.), and 60 min. later; after a few hours, another dose (20 mgm./kgm.) of thiamine was injected and the liver cocarboxylase determined.

The animals more severely affected by diabetes failed to show an appreciable increase of respiratory quotient; in these animals the cocarboxylase content of the liver remained very low, of the same order of that found in the untreated diabetic rats. On the other hand, in animals which showed an increase of the respiratory quotient after injection of thiamine, the liver cocarboxylase was considerably increased. Two typical results are given in Table 2.

Table 2. Respiratory quotient (R.Q.) measured by the method of Haldane-Margaria (ref. 6). Cocarboxylase determined a few hours after the R.Q. and 30 min. after an additional dose (20 mgm./kgm.) of thiamine

R.Q. of diabetic rats		Liver cocarboxylase (μgm./gm. wet tissue)
Before	60 min. after thiamine + glucose	
0·65	0·67	3·80
0·74	0·95	13·74

These results indicate that in alloxan-diabetes the phosphorylation of thiamine is partially or completely inhibited; by analogy, they could also offer an explanation for the high levels of blood keto-acids found in severe pancreatic diabetes.

We think that the lack of available insulin which characterizes the diabetic condition is the primary cause of the phenomena described.

A full report of this work will appear elsewhere.

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The Gelatinous Mass in Rabbit Semen

Rabbit semen consists of two main parts, gelatinous and fluid. After ejaculation, the gelatinous part fills the lumen of the vagina as a copulation plug (*bouchon vaginal*). The existence of a copulation plug, which prevents the semen running out of the vagina after ejaculation, has been observed[1] in a number of mammals besides rodents. Its importance in rats for fertile mating has been shown by Blandu[2]. That the production and maintenance of the gelatinous mass which mainly constitutes the copulation plug in the rabbit depends on testosterone has been shown by Parsons[3]. She found that castration in rabbits leads to complete absence of the gelatinous mass in ejaculates. When testosterone propionate was injected into such castrated rabbits, the gelatinous mass reappeared. She further found that implantation of stilbœstrol tablets into a buck previously castrated and implanted with testosterone brought about an inhibition of sex drive as well as a sharp decrease in seminal fructose, but an increase in the gelatinous part. This increase in the gelatinous part, however, remained unexplained.

With the view of finding out the significance of the gelatinous mass in rabbit semen in normal mating, semen samples from six bucks were obtained in an artificial vagina. It has been found that the gelatinous mass per ejaculate varied from 0·34 to 4·19 gm., the average being 1·67 ± 0·36 gm. Fructose, the seminal nutrient for spermatozoa[4], is present in the fluid portion. The thoroughly washed gelatinous portion, when examined for fructose by the technique described by Mann[5], was found to have an almost negligible quantity. Incubation of semen samples with and without the gelatinous mass at the vaginal temperature of rabbit (namely, 40° C.) has shown that the rate of utilization of fructose in semen is positively correlated with sperm concentration of the sample. The rate, however, is uninfluenced by the presence or absence of the gelatinous mass.

Examination of the thoroughly washed gelatinous mass under the microscope revealed a large number of inactive spermatozoa encased in it. On incubating the mass at 37° C. in normal saline, it dissolved and the spermatozoa thus released were found to be highly active. The encasement of spermatozoa by the gelatinous mass is perhaps due to the fact that at the time of ejaculation both parts of the semen are in a fluid state. Subsequent gel formation of one part encases some of the seminal fluid containing spermatozoa in contact with it.

It has also been found that 800 mgm. of the gelatinous mass dissolved in 8 ml. of water at approximately 80° C., when injected subcutaneously after cooling in four equal doses with two injections a day at an interval of 8 hr. between the two injections into ovariectomized immature rats, produced keratinization of the vaginal cells after 96–120 hr. from the first injection. Similar results have been obtained by injecting 400 mgm. of the mass dissolved in 4 ml. of hot water into ovariectomized mice of approximately one month old. Subcutaneous injections were also given to eight adult male rats each of which received, in six equal doses with two injections a day, altogether 1·2 gm. of the mass in 12 ml. of water. The rats were killed on the ninth day from the first injection, and the histological examination of their testes revealed degeneration of the seminiferous tubules. There was also significant decrease in the weight of the seminal vesicles and a highly significant decrease in their fructose content compared with those of the control rats of the same age and body-weight. These findings, therefore, indicate that the gelatinous mass appears to contain œstrogenic substance in appreciable quantity.

We are indebted to Dr. S. N. Ray, of the Animal Nutrition Section of the Indian Veterinary Research Institute, for helpful suggestions.

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Light-scattering Studies on Penicillin G Solutions

Literature concerning the physical-chemical state of aqueous systems of penicillin reveals a controversial issue. Claims that micelles, between 200 A. and 5000 A. in length, are formed above a critical concentration of 10,000 units/c.c. (0·6 per cent)[1-4] contrast with evidence which indicates that penicillins behave as simple electrolytes[5-8]. One paper[8] reports that colloidal electrolyte behaviour is not reached until 8·26 per cent, a concentration so high as to be of little biological importance.

In view of this controversy, a light-scattering technique, as used by Debye[10], which permits precise measurements of scattering over a wide angular range and which is admirably suited for studies of micelle systems, has been applied. From determinations of the dependence of turbidity and of the refractive index on concentration, molecular weights can be found by use of the well-known equation[11]:

$$\frac{1}{M} = \frac{32\pi^3}{3}\,\frac{\mu_0^2}{\Lambda\,\lambda^4}\left(\frac{\mu-\mu_0}{c}\right)^2 C/\tau$$

Furthermore, by analysis of the angular dependence of the scattered light, information about the size and shape of micelles is possible.

Studies have been made using Wyeth crystalline potassium penicillin *G* (Lot *EKD* 500804 containing 1,650 units/mgm.) in the concentration-range 3,000–30,000 units/c.c. A solution in water, at a concentration of 10,000 units/c.c., exhibits much less scattering than that of systems containing micelles as large as those previously reported for penicillin at that concentration[3]. For this reason, further studies have been made in solutions containing electrolytes, a condition which enhances micelle formation. Also, in the presence of electrolytes, aqueous solutions can be readily freed from dust particles by filtration through very fine sintered glass, and thus a danger which may lead to spurious observation of micelles is removed. In potassium bromide solutions of ionic strength 0·2 and 0·5 respectively, the angular scattering, about 90° over the whole concentration-range, exhibits perfect symmetry (Fig. 1).

Unless a scattering particle has some dimension greater than about one-tenth of the wave-length of the exciting radiation, no dissymmetry in the scattered light can be detected. In this case the symmetrical scattering reveals that, apart from the possible existence of a minute fraction of large particles, any particles present have a maximum dimension not greater than 300 A. For the same systems the value obtained by extrapolation of the linear graph of concentration divided by turbidity (C/τ in the equation) is 35 at zero concentration (Fig. 2). The refractive increment $(\mu - \mu_0)/c$ can be

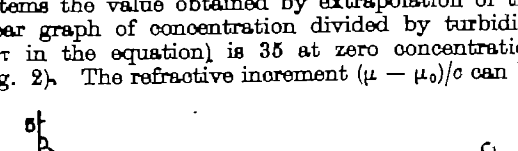

Fig. 1. Relative scattering intensity (I) of unpolarized light (λ = 4358 A.) by potassium penicillin *G* (13·9 mgm./c.c.) in 0·5 *M* potassium bromide

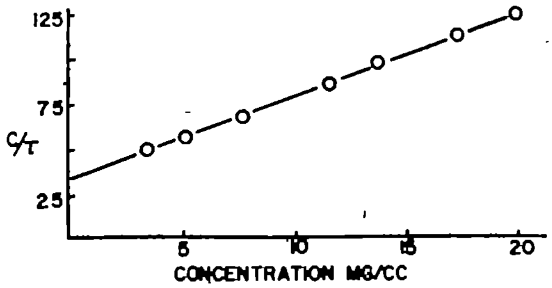

Fig. 2. Concentration-turbidity dependence for potassium penicillin *G* in 0·5 *M* potassium bromide

expediently determined with a differential refractometer and has a value of 0·185. Since these figures indicate a very low scattering system, in contrast to that expected from other work[3], we can ascribe a value of 3,000 as an upper limit to the molecular weight of any particles present.

The angular scattering data, Fig. 1, which indicate no dissymmetry, at once place an upper limit of 300 A. on any particles which may be present. In addition, the molecular weight maximum also dismisses the existence of large micelles of potassium penicillin *G* in the above concentration-range. Thus, although potassium penicillin *G* is slightly capillary-active, as evidenced by a small degree of frothing on shaking its solutions, the bulk phase contains associations of relatively few molecules even under conditions which enhance micelle formation and which also resemble more closely those encountered in biological systems.

I am indebted to Dr. F. Bueche for his interest and helpful discussions.

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So-called Non-adaptive or Neutral Characters in Evolution

The reaction that set in some thirty years ago against the facile assumption that all interspecific differences are adaptive was good but went too far. Several authors insisted that most specific and subspecific differences were non-adaptive. More recently, Mayr[1], while emphasizing the great importance of selection in speciation, considered that not all geographical variation is adaptive and, in particular, that most of the characters involved in polymorphism are completely neutral so far as survival value is concerned. Later[2], he reversed this judgment on polymorphism.

Carter[3] places considerable emphasis on neutral characters, quoting as evidence banding in the polymorphic snail *Cepaea nemoralis*, Mayr's demonstration of apparently irregular variation in populations of *Cacatua galerita triton* in New Guinea, and the distribution of certain third chromosome inversions in *Drosophila pseudo-obscura*. But Mayr himself points out (ref. 1, p. 89) that size variation in *Cacatua* is not random except perhaps for the population on Biak (and Mayr and de Schauensee[4] have shown that the birds of Biak, which may be in part a very old island, are often different from those of nearby territories). Dobzhansky and others[5] have shown that the inversions are definitely subject to selection; and Cain and Sheppard[6] have demonstrated that variation in *Cepaea*, so often quoted as random, is, in fact, selectively controlled. Other examples quoted by Carter show an apparent randomness of variation, and he considers that it is difficult to see how the characters concerned could have any concomitant effects which might themselves be subject to selection. This is the real basis for every postulate of random variation or (more recently) genetical drift. The investigator finds that he, personally, cannot see any correlations in a given example of variation, and concludes that, therefore, there is none.

In view of the complexity of living things and their environment, a more cautious approach should be used. So far, every supposed example of random variation that has been properly studied has been shown to be non-random. One must agree that some characters have no value in themselves. But when it is found that their variation is stably clinal or otherwise correlated with their environment and history, then selection acting on their concomitant effects must be admitted as the governing factor. Mayr[1] gives many examples. He contends that some clines are non-adaptive because apparently independent of environmental gradients. Here again we just do not know, and he admits that probably some selective factors are involved.

It seems only reasonable, therefore, to suggest that those characters or variation patterns that have been described as non-adaptive or random should properly be described as uninvestigated. One must not assume randomness (or selection) without proof.

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Growth Inhibition in Amphibian Larvæ by 4-Amino Pteroyl Glutamic Acid (Aminopterin)

A number of workers have demonstrated the inhibition of growth in the rat and mouse[1,2], bacteria[3-5], and in the chick[6-8] by means of folic acid antagonists. Seeger *et al.*[9] have shown that 4-amino pteroyl glutamic acid is a powerful antagonist of folic acid by the *Streptococcus faecalis* R. test, and its toxicity in mammals has been well established.

Karnofsky *et al.*[7] demonstrated quite conclusively that 4-amino pteroyl glutamic acid, as an analogue of folic acid, has the ability to inhibit growth in the chick, and the question arose as to whether this reaction could be found in a cold-blooded vertebrate as well. In this preliminary report, the growth inhibition of amphibian larvæ by 4-amino pteroyl glutamic acid is indicated, particularly in the growth phases in the middle and late larvæ. Studies on inhibition in early development, effects on embryogenesis, and possible reversal effects are to be presented elsewhere at a later date.

Adult *Rana pipiens* were ovulated by pituitary induction and the eggs stripped and fertilized. At the two-cell stage, the eggs were divided into two groups: group *B*, in which the tertiary membranes were left intact, and group *C*, in which the tertiary membranes were removed. Group *A*, serving as controls, consisted of two further series, one with membranes intact, the other with membranes removed from the eggs. The eggs were allowed to develop in pond water at a temperature of 18° ± 0·5° C. Groups *B* and *C* received daily doses of 4-amino pteroyl glutamic acid (aminopterin) (Lab. No. 7-9332 furnished through the courtesy of Dr. E. L. R. Stokstad, Lederle Laboratories Division, American Cyanamid Corp., Pearl River, N.Y.) as follows: 1,000, 500, 100 and 10 µgm. per 100 c.c. of pond water in a single bowl. Because the antagonist forms degradation products after twenty-four hours, daily changes were made of the liquid contents of the bowls in which the animals were kept.

Table 1. EFFECT OF AMINOPTERIN ON THE DEVELOPMENT OF LATE ANURAN LARVÆ WITH MEMBRANES INTACT.

Each observation is the mean for 3–5 larvæ; temperature of habitat bowls containing larvæ, 18° ± 0·5° C.

Stage (Shumway)	Micrograms of aminopterin 1,000	500	100	10	0 (Controls)
	(All measurements expressed in mm.)				
19	6·0	5·9	5 9	5·3	6·0
22	9·9	8·8	8·2	7·8	8 6
24	11·4	10 8	10·8	10·3	10 6
24–25	11·0	10·8	12·0	11·1	12 0
25	11·6	10·6	12·3	11·9	13·1
25+	12·3	10·4	13 4	12·0	14 7

In series *B* (Table 1), the most marked inhibition appears to occur immediately following stages 21–22[9], at which time the mouth is open and the larvæ begin actual feeding. A dosage of 1,000 µgm. is not a lethal dose for anuran embryos and, further, it does not appear to produce such marked inhibition as, for example, 500 µgm. does for this series.

Table 2. EFFECT OF AMINOPTERIN ON THE DEVELOPMENT OF LATE ANURAN LARVÆ WITH MEMBRANES REMOVED.

Each observation is the mean for 3–5 larvæ; temperature of habitat bowls containing larvæ, 18° ± 0·5° C.

Stage (Shumway)	Micrograms of aminopterin 1,000	500	100	10	0 (Controls)
	(All measurements expressed in mm.)				
19	5·5	5·6	5 1	6·1	5·3
22	8·8	8·5	7·5	7 2	8·1
24	10 2	10·5	9·1	10 4	11·4
24–25	10·2	10·5	10·5	11·9	13·3
25	10·2	11·6	10·5	12·4	14·8
25+	dead	dead	9 6	12·0	15·3

Results for series *C* are presented in Table 2. It is presumed that larvæ in this group were in more direct contact with the actions of the antagonist, as the highly selective factors effective within the outer membranes are discounted, since the greater portion of the tertiary membranes were removed. Here both 1,000 µgm. and 500 µgm. represent a lethal dosage for the larvæ. Prior to death, the greatest inhibition of growth occurred in animals given 1,000 µgm.

From these results it appears that 4-amino pteroyl glutamic acid has an inhibiting effect upon the growth of middle and late *R. pipiens* larvæ. The mode of action of this inhibition is not yet known. In the higher vertebrates, 4-amino pteroyl glutamic acid is not an ideal metabolic inhibitor, as a reversal effect cannot always be obtained by administration of folic acid[8,10]. Also, it is difficult to say whether the inhibition of growth observed in experiments employing folic acid antagonists is due to a general interference with the growth of the larvæ or injury to a specific tissue leading to retardation as a whole. The work now in progress is designed to investigate this matter. There are indications that the antagonist interferes with the more actively growing areas, those tissues which grow more rapidly being most affected. The abnormalities produced by graded concentrations of 4-amino pteroyl glutamic acid in the early frog embryo are rather non-specific and have been produced by a variety of experimental procedures. All are believed to interfere with the energy expenditure of the embryo, causing failures in gastrulation, neuralation, as well as in other phases of growth. It is quite likely that the action of the antagonist in this case is of a similar nature. Experiments are now in progress which consider this premise.

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A Micro-method for the Examination of the Biochemical Activities of Micro-organisms

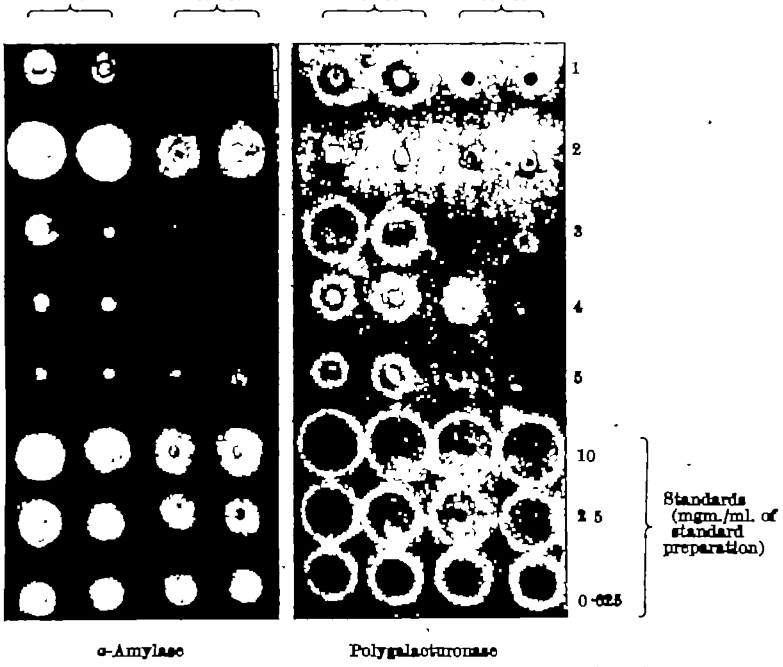
THE large-scale screening of cultures of micro-organisms for biochemical activities is nowadays frequently designed to select organisms which are effective in submerged culture[1]. We have recently developed a technique for the examination of hundreds of cultures for their suitability for surface culture, with particular reference to enzyme formation.

The method consists in growing the organism in a small cylinder containing 0·1 ml. of an agar medium, which is added aseptically from a hot-water jacketed micro-burette. The cylinders rest on a thin polyvinyl chloride sheet in a Petri dish, containing up to 40 cylinders. The latter, usually porcelain or glass, are conveniently sterilized in glass columns prior to filling. With two operators, 500 cylinders can be filled in an hour. Using spore suspensions, five fungi have been inoculated in one dish, with no cross-infection. Incubation in a humidity chamber is necessary, to prevent drying out of the medium. When the mycelial mat is formed, little drying is observed after ten days incubation, and the growth of twenty different fungi was quite typical and sporulation was not retarded.

For estimating the metabolic products formed, a modification of the agar-plate diffusion technique has been used[1,2]. The plugs of agar inside the cylinders are transferred to a glass sheet by extrusion with a glass rod. For estimating enzyme activity, a suitably buffered 1·5 per cent agar solution containing the substrate is poured on to the plate at 48–50° C. This ensures that a perfect seal is formed around each plug. It is necessary to include salicylanilide in the assay medium, to prevent further growth during the assay. The glass sheet is incubated for twenty-four hours and developed with a suitable reagent. In a typical experiment, five fungi were examined for α-amylase and polygalacturonase, sample plugs being removed and assayed each day for ten days. In the accompanying photograph, two typical plates, for polygalacturonase and α-amylase, are shown with zones, representing a day's samples, and dilutions of a standard enzyme preparation to allow calculation of the enzyme concentrations in the unknowns. This photograph shows that in the case of *Aspergillus flavus oryzae* (sp.) large amounts of α-amylase are produced, but no polygalacturonase; with *Penicillium chrysogenum* the reverse is apparent.

Other products can be estimated using plain agar plates, and after diffusion development with a suitable reagent, for example, kojic acid, developed with ferric chloride to give red zones around the plug; antibiotics can be assayed by the usual methods. The technique is being used successfully for the screening of cultures of micro-fungi, and by using purified agar and nutrients, the effect of nitrogen source, growth factors, etc., on the biochemical activities of a culture can be readily studied. Full experimental details will be published elsewhere.

ASSAY OF DUPLICATE THREE-DAY OLD CULTURES OF MICRO-FUNGI, GROWN AT 25° AND 37° C., FOR α-AMYLASE AND POLYGALACTURONASE



Organisms: (1) *Aspergillus foetidus* (n.sp.); (2) *Aspergillus flavus-oryzae*; (3) *Botrytis cinerea*; (4) *Penicillium chrysogenum*, Q.176; (5) *Syncephalastrum cinereum*.

We wish to thank W. W. Reid for his help in this work, and the directors of H. W. Carter and Co. for permission to publish these results.

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April 26.

---

[1] Baker, P. B., *Nature*, 163, 732 (1949).

[2] Reid, W. W., *Nature*, 166, 569 (1950).

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Unicellular Algæ as a Source of Food

SUPPLIES of food are not enough to give the present world population an adequate diet, and population is increasing more rapidly than the output of agriculture. In 1948, Dr. F. N. Woodward (then at the British Commonwealth Scientific Office, Washington) reported that some American scientific workers thought the problem could only be solved by devising non-agricultural methods for producing proteins, fats, carbohydrates, etc. One of the American suggestions was that unicellular green algæ, suitably cultured, might give much higher yields per acre than conventional agricultural crops. Among the algæ suggested were species of *Chlorella* and *Scenedesmus*.

Calculations based on available data, from researches into photosynthesis in which *Chlorella* is widely used as the experimental subject, suggested that it was theoretically feasible to obtain much higher yields per acre from *Chlorella* than from agricultural crops. (One of the assumptions made was that the alga could be grown in shallow ponds.) Experimental work was therefore started at Jealott's Hill to obtain more information. Much remains to be done before the economic possibilities can be accurately assessed; but it is hoped that the present account of the position we have now reached may be of help to others engaged in similar research.

The growth and composition of unicellular algæ are influenced by many factors, most of which are interrelated. Hence, determination of the optimum conditions for the mass culture of these organisms would involve considerable time and effort. Our approach has therefore been somewhat arbitrary, the aim being to devise a technique which would give reasonably high yields of a product with a tolerably constant composition.

This work has been conducted with *Chlorella vulgaris* var. *viridis*; but it is recognized that this may not be the most suitable alga. The diameters of the cells of the strain used in these experiments ranged from 3 to 10 microns. *Chlorella* multiplies by binary fission, and there are four distinct stages in the growth-cycle: a lag phase, an exponential phase, an approximately linear phase, when growth is somewhat less than in the exponential phase, and finally a stationary phase.

The size of the inoculum used in all the cultures described here was equivalent to 5 mgm. of dry matter per litre. The yield of dry matter was considerably increased by eliminating the initial lag phase in growth. This was done by inoculating with cells that were in the exponential growth phase.

At the beginning of these investigations, a nutrient medium recommended by Winokur[1] was used; but it was found that when nitrate nitrogen was replaced by ammoniacal nitrogen, higher yields of dry matter were obtained, and that when ammonium nitrate was used the organism preferentially absorbed the ammonium ion. Accordingly, in all subsequent experiments ammoniacal nitrogen was used. The *p*H of the medium was initially adjusted to 6·0, and throughout the incubation period it was readjusted twice daily. The optimum temperature is about 25° C., growth being much poorer at 20° C. and 30° C. In all experiments carbon dioxide has been supplied, chiefly for convenience, as a 5 per cent carbon dioxide – 95 per cent air mixture. Only 15 per cent of the carbon dioxide supplied escaped to the atmosphere, that is, about 85 per cent was used by the organism.

The cultures were illuminated by 'daylight' fluorescent tubes. Very good growth was obtained at 1,300 foot-candles. It was appreciated that artificial illumination might be quite uneconomic, but it was essential to have a constant light source when other factors were being studied. Tests showed that if the cultures were illuminated for 8 hr. and kept in the dark for 16 hr. each day, yield per unit of light supplied was as high as with continuous illumination; that is, the cells did not appear to go off exponential growth in the dark period. It is therefore theoretically possible to use daylight and get high yields. In southern England, illumination (not direct sunlight) averages about 1,250 foot-candles for 8 hr. a day for six months of the year and about 750 foot-candles for another two months. In lower latitudes, conditions might be more favourable.

Agitation was found necessary for maximum yields. In our experiments in tubes, an intermittent air 'blast' was used.

In the earlier experiments, the organism was cultured in flasks and in narrow cylinders. In a later experiment it was cultured in a battery of tubes 4½ ft. long × 2½ in. diameter with continuous lighting (1,300 foot-candles). When harvesting every sixth day over a period of months, the average yield was 1·9 gm. dry matter/litre/6 days. Later, a batch process was run in these tubes, the idea being to maintain a fairly dense population growing exponentially. Each day, three-quarters of the liquid in each tube was run off, the cells removed and the liquor, suitably adjusted with nutrient and water, returned. The average yield per litre harvested was 0·7 gm./day.

Harvesting by ordinary filtration proved difficult, as the cells bed down tightly; but centrifuging is quite satisfactory. The product was freeze-dried and its composition has been fairly constant; namely, 8 per cent nitrogen (47 per cent 'true' protein), 1–5 per cent ether extract and 7·5 per cent ash. It is deep green in colour and contains more than 1,200 p.p.m. of β-carotene.

The amount of 'fat' extracted by ether alone was between 1 and 5 per cent; but ether extraction after dilute acid hydrolysis or straight methanol extraction removed about 20–25 per cent of the material. The nature of this is being investigated, as are the amino-acid content of the protein and the constituents of the 'carbohydrate' fraction.

The product might be used as food for animals or even humans, or as a substrate for growing other organisms. Through the kind co-operation of Dr. Kathleen M. Henry, feeding tests on rats were conducted at the National Institute for Research in Dairying. The diet contained 17 per cent freeze-dried *Chlorella* cells, and the 'protein efficiency ratio', though less than that of skimmed milk, was significantly higher than that of dried brewers' yeast or groundnut meal.

Our work is being continued and will be reported in detail elsewhere at a later date.

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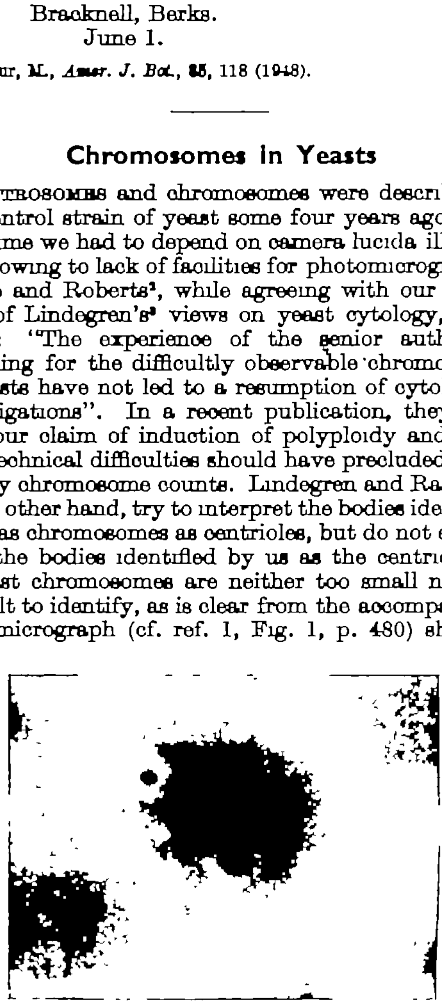
[1] Winokur, M., *Amer. J. Bot.*, **35**, 118 (1948).

Chromosomes in Yeasts

CENTROSOMES and chromosomes were described in our control strain of yeast some four years ago[1]. At that time we had to depend on camera lucida illustrations, owing to lack of facilities for photomicrography. Winge and Roberts[2], while agreeing with our criticisms of Lindegren's[3] views on yeast cytology, comment: "The experience of the senior author in searching for the difficultly observable chromosomes in yeasts have not led to a resumption of cytological investigations". In a recent publication, they[4] dispute our claim of induction of polyploidy and state that technical difficulties should have precluded satisfactory chromosome counts. Lindegren and Rafalko[5], on the other hand, try to interpret the bodies identified by us as chromosomes as centrioles, but do not extend it to the bodies identified by us as the centrioles.

Yeast chromosomes are neither too small nor too difficult to identify, as is clear from the accompanying photomicrograph (cf. ref. 1, Fig. 1, p. 480) showing



Photograph from a smear of an aerobic liquid culture fixed in Carnoy and stained with iron hæmatoxylin. × c. 5,750 an early metaphase condition. The two chromosomes are orientated on a spindle at the poles of which can be seen the centrioles with the centrospheres.

Photomicrographs illustrating induction of polyploidy and the cytological behaviour of such induced autotetraploids are awaiting publication elsewhere[6].

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Bangalore. Feb. 2.

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Recent Climatic Variations in Indonesia

IN the past few years, interest in recent climatic changes has been growing. Especially in moderate and high latitudes of the northern hemisphere, climatic variations for several decades have been studied. The most striking phenomenon is the rise in temperature, especially that of winter temperatures, up to about 1940[1]. Petterssen[1] showed that this climatic change in moderate and high northern latitudes is connected with a variation of circulation. A similar rise in temperature, although much less marked, has occurred in certain equatorial regions[2]; further, it was found that about the year 1921, or at any rate between 1920 and 1939, the rate of rise of temperature increased rather suddenly.

To show a change in circulation with the aid of pressure and wind observations is much more difficult for equatorial regions than elsewhere, due to the smaller differences in pressure and wind. It seems to be possible, however, to draw certain conclusions on the climatic variation in equatorial regions by considering the precipitation records of Indonesia, where regular measurements of this climatological element have been taken from 1879 onward. In order to omit, so far as possible, the influence of the normal variation in sunspot numbers, we took overlapping eleven-year totals of the amounts of precipitation for West Java, Central Java, East Java (each being a mean of twenty representative stations), and for about thirty stations in the other islands of Indonesia.

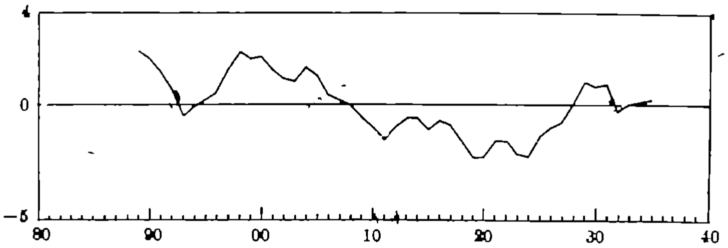

Fig. 2. Overlapping 11-year totals for the air pressure in Hongkong

Considering these eleven-year totals, it appeared possible to distinguish two groups, each of about ten stations (including the three provinces of Java), the groups showing an anti-parallel course. In the first group, the eleven-year totals for rainfall show a maximum between 1920 and 1930, whereas the stations of the second group show a minimum during this period, which is the very period during which the rate of temperature rise increased. The stations of the first group are crowded along the equator, whereas those of the second group consist of stations situated in the southern hemisphere between, say, lat. 2° and 10° S.

The difference between the maximum and the minimum eleven-year totals for precipitation may in each group amount to as much as 20 per cent of the mean eleven-year total itself. This suggests that we have to deal with an important climatic fluctuation. In Fig. 1, Pontianak, situated on the equator, is an example of the first group, whereas West Java belongs to the second group. The correlation coefficient calculated from the 11-year totals of the precipitation at Pontianak and in West Java over the period 1879–1940 is -0.75. It appears from Fig. 1, however, that during the first ten years of this period the relation existing between the two precipitations is different from that during the remainder of that period.

If we confine ourselves to the eleven-year totals from 1889 onward, we find r to be -0.89, with a standard error of 0·03. It seems clear from these figures, and also from their graphical representation, that we are dealing here with a strong interdependence between the climatic variations in Pontianak and those in West Java. This interdependence may be the outcome of the southward displacement of the 'intertropic zone of convergence' in the autumn and winter of the northern hemisphere, and of its northward displacement in the spring; for these displacements manifest themselves in the amounts of

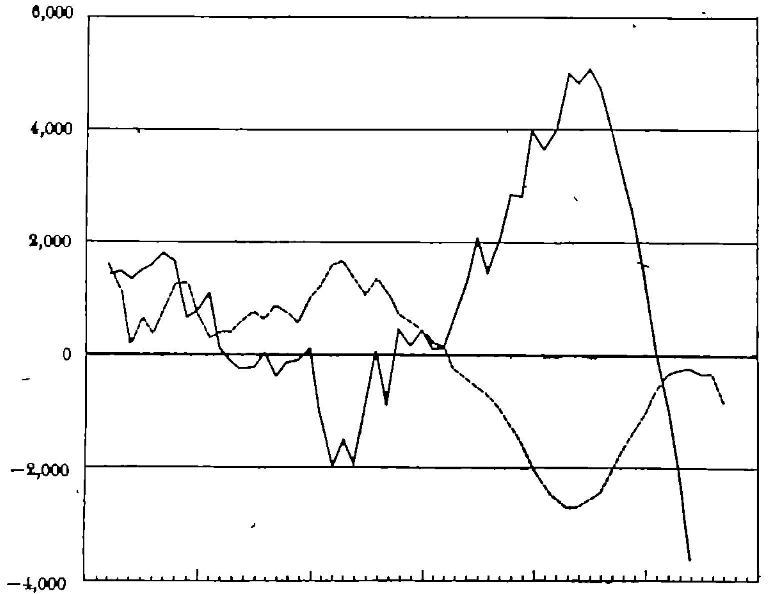

Fig. 1. Overlapping 11-year total for the precipitation in Pontianak (full line) and West Java (broken line)

precipitation, the rainfall being especially abundant during the passing of the convergence.

To show further proof of this influence of the intertropic zone of convergence, the 11-year totals for the pressure at Hongkong are given in Fig. 2. This quantity may be regarded as being representative of the intensity of the Siberian pressure maximum, and therefore to be determining very largely the convergence displacements over Indonesia. The connexion already follows from the figures. High pressure at Hongkong is accompanied by a maximum of precipitation in West Java, and a minimum at Pontianak. The correlation coefficient between the 11-year totals for the pressure at Hongkong and the 11-year totals for the precipitation in West Java is + 0·55 with a standard error of 0·10.

These results show clearly that variations of circulation occur not only in moderate latitudes, but also in the tropics.

We intend to discuss elsewhere in some detail the problem of recent climatic variations in Indonesia.

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[1] Various authors in *Geografiska Annaler*, 31 (1949).

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The Lithium-7 Nucleus

OBSERVATIONS by Rose and Wilson[1] in the reaction $^{10}\mathrm{B}(n,\alpha')^{7*}\mathrm{Li}(\gamma)^{7}\mathrm{Li}$ and by Littauer[2] in $^{7}\mathrm{Li}(p,p')^{7*}\mathrm{Li}(\gamma)^{7}\mathrm{Li}$ have shown that the 480-keV. gamma ray is emitted isotropically in these reactions. In the former experiment the yield of radiation was measured relative to the direction of emission of the short-range alpha particle. In the latter case it was determined with respect to the incident proton. These observations constitute strong evidence that the spin of the 480-keV. state is $\frac{1}{2}$, although in both cases the lack of a correlation could arise from other special circumstances. Accordingly, we have looked for a correlation between the short-range proton and the gamma-ray in the $^{6}\mathrm{Li}(d,p')^{7*}\mathrm{Li}(\gamma)^{7}\mathrm{Li}$ reaction.

A thin target of lithium-6, prepared in a mass spectrograph[3] and maintained constantly under vacuum, was bombarded with 0·80 MeV. deuterons from an electrostatic generator. The protons and the gamma rays from the reaction were detected with suitable scintillation counters, and successive proton-gamma emissions were observed by operating the counters in coincidence. The particle detector was placed so as to observe protons emitted in the direction of the incident beam. The gamma-ray counter was operated at angles varying between 35° and 145°. Despite the relatively pure lithium-6 target and considerable shielding, the accidental coincidence-rate was high, with resolving times of somewhat more than 10^{-8} sec., when beam currents were used large enough to make the rate of detection of real coincidences reasonable. Provision was made therefore for constantly monitoring the accidental coincidence-rate. This was desirable also because of fluctuations in the counting-rate arising from the unsteady source[4].

The reaction itself was monitored by observing the single-channel counting-rate of the fixed proton counter, and also by means of a beam current integrator. The single-channel counting-rate from the gamma-ray counter was observed but was not a true measure of the yield of radiation of the reaction under study, because of the presence of other gamma-rays resulting from the deuteron bombardment of lithium-6 and target impurities.

The proton-gamma coincidence-rate was measured at nine settings of the gamma counter. Upward of 2,000 coincidences were obtained at each angle. The coincidence-rate per proton, corrected for small variations in the distance of the gamma counter, varied in a random fashion within the statistical limits of the measurements, which were between 5 and 10 per cent. A least-square analysis of these data into a cosine series gives a coefficient of $\cos^2\theta$ which is less than 3 per cent of the isotropic term. Because of the low recoil velocity of the lithium-7 nucleus in this experimental arrangement ($9\times10^{-3}\,c$), the Doppler effect produces a negligible correction. A check was made on the amount of gamma-ray scattering present and the reality of the observed coincidences by placing lead absorbers in front of the gamma-ray detector at several gamma-angles. The results verified the nature of the coincidences, and indicated that the effects of scattering were small and not noticeably dependent on the angle.

This lithium-6 reaction differs from the boron-10 reaction investigated by Rose and Wilson[1], in that the compound nucleus beryllium-8 is not formed entirely by *s*-wave capture[5]. In the present experimental arrangement, however, the complexity of the correlation will be determined primarily by the properties of the excited state in lithium-7 and the subsequent radiation. The failure to detect a correlation in this experiment, therefore, is consistent with the assignment of $I = \frac{1}{2}$ to the 480-keV. state. Additional experimental details and a theoretical discussion will appear elsewhere.

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April 21.

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[2] Littauer, R. M., *Proc. Phys. Soc.*, A, 63, 294 (1950).

[3] This instrument, built specifically for separating the lithium isotopes, follows the design of Smythe, Rumbaugh and West, *Phys. Rev.*, 45, 724 (1934).

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31-keV. Excited State of Aluminium-28

A RECENT accurate magnetic analysis of the proton groups from the reaction $^{27}\mathrm{Al}(d,p)^{28}\mathrm{Al}$ by Strait and his collaborators[1] showed the presence of an excited state in the residual nucleus of aluminium-28 at 31 ± 2 keV.

The existence of such a low-lying level in a light nucleus is of considerable interest. Predictions of the positions of the lowest nuclear levels have been made by considering the rotation of the nucleus as a whole[2,3], and the excitation energies thus calculated show reasonable agreement with the levels previously experimentally determined. However, the lowest rotational level for the aluminium-28 nucleus would be expected to have an excitation energy above 100 keV., and a level at 31 keV. could not be a simple rotational level. It is also unlikely that such a level could be explained on the basis of the nuclear shell model recently discussed by Mayer[4] as a splitting of the ground state due to spin-orbit interaction. In this connexion a knowledge of the multipole order of any gamma-ray transition between this level and the ground state would be of value.

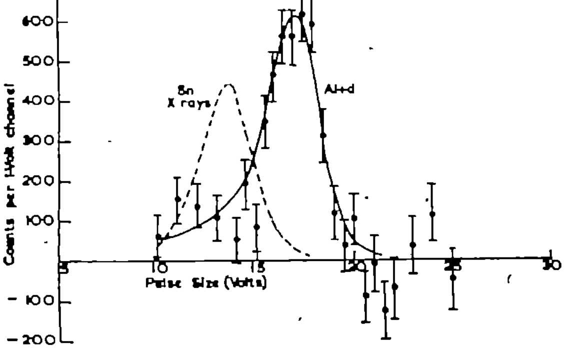
In view of the particular interest of this level, a search has been made for gamma-radiation resulting from its de-excitation. An aluminium target was bombarded with deuterons with an energy of 700 keV. The radiation was detected at 90° to the deuteron beam with a proportional counter. The counter, 4 in. in diameter, was fitted with 'field tubes'[5] to eliminate end effects, and filled with argon and methane to partial pressures of 3 atmospheres and 15 cm. respectively. The counter was screened with 3 in. of lead, and the β-particles from the decay of aluminium-28 and nitrogen-13 (produced from carbon contamination of the target) were prevented from reaching the counter by polythene absorbers and the field of a strong permanent magnet.

Radiation of an energy of 31·4 ± 1·0 keV. was detected and presumed to be due to the de-excitation of the 31-keV. level in aluminium-28. The peak counting-rate was about one quarter the background rate. This background was due to gamma-radiation and neutrons both from the target and from reactions produced by that part of the beam which struck the walls of the resolving chamber. The background not originating at the target was variable, and to minimize this variation it was necessary to keep the beam current and focus particularly steady during counts. Successive counts were made with aluminium and lead absorbers of equal surface density at each setting of the pulse analyser. The difference between these pairs of counts is plotted in the accompanying graph as a function of pulse amplitude. The spectrum of the K X-rays of tin is also shown. The energy of the gamma-ray was determined by comparison with these X-rays and those of barium, produced by proton bombardment of targets of metallic tin and barium chloride. Absorption measurements of the gamma-radiation were also made and were consistent with the energy thus determined.

The radiation was also detected by a scintillation method. A thallium-activated sodium iodide crystal 1 cm. square and 1 mm. thick was mounted on an *E.M.I.* type 5311 photomultiplier and screened with 3 in. of lead. The β-particles were absorbed with polythene. Although the background was less than that experienced with the counter, the resolution of the crystal was inferior and the counter was, therefore, used for determining the energy of the gamma-ray.

From the calculated efficiency of the counter and on the assumption that the radiation is isotropic, the yield from a thick aluminium target at a bombarding energy of 700 keV. was estimated to be 1·1 ± 0·5 × 10^8 γ per microcoulomb.

The low-energy electrons from this reaction have been examined with a 180° magnetic spectrometer. No internal conversion electrons corresponding to the 31-keV. gamma-ray have been detected: from the efficiency of the spectrometer it is estimated that the internal conversion coefficient α_K is less than 2. Such a value suggests that the transition to the ground state is electric dipole. A more precise measurement is to be made.



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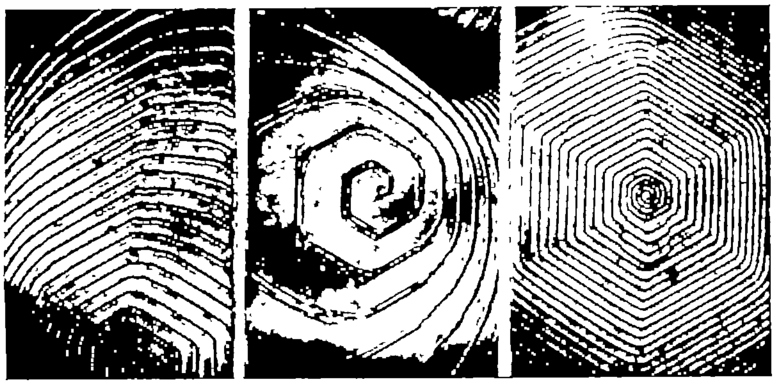
Growth Spirals on Carborundum Crystals

The observation of growth spirals on carborundum crystals has been reported earlier[1]. These growth spirals can be divided into two classes: (1) those in which the step-height between the successive edges of the spiral is equal to the height of a unit cell; and (2) those in which the step-height is a multiple of it. The latter type of multi-stepped spiral will result from a dislocation the strength of which is a multiple of the repetition period, the Burger's vector being a multiple of the height of the unit cell. Such spirals have been found to originate at a large hole (see Fig. 2); they have a much higher optical visibility because of the relatively large step-height, being therefore easily observed with a microscope using bright-field illumination. Of the numerous spirals of this kind seen, two typical examples are shown here. The steps of these spirals can break up into their component steps under certain conditions. In Fig. 1, showing only one half of the spiral, the various components advance together in different directions for some twelve turns, after which they break up into five or six close branches. In Fig. 2 is illustrated a case where the dissociation takes place quite near the centre and growth can be regarded as taking place from the multiple dislocations.

Carborundum[2] is a polytypic crystal. In the hexagonal types or the rhombohedral types referred to the hexagonal axes, the number of layers necessary for the arrangement to repeat itself is also the number of 'formula weights' in the unit cell. However, in the actual rhombohedral unit cell, the number of formula weights is one-third of the total number of layers included within the c-axis. The measurement of the step-height of the growth-spirals on the different types should be able to show this point.

On the hexagonal type II crystal (6H in Ramsdell's notation) the step-height measurements have already been given[1] and shown to be equal to the height of the unit cell (c = 15 A.). Further measurements of the step-height, by the application of multiple-beam interferometry on the growth spirals on the different rhombohedral types, are now reported here.

On a type I crystal (15R in Ramsdell's notation) the measured step-height is 12 ± 2 A. This is equal to one-third of the lattice parameter c of the unit cell referred to the hexagonal axes, and is in agreement within experimental error with the predicted X-ray value of a_{rh} = 13 A. of the rhombohedral cell. The visibility of this growth spiral is consistent with this measurement of step-height.



(1) (2) (3)

On a type VI crystal ($33R$ in Ramsdell's notation), the measured step-height is 28 ± 2 A., which again is very close to a_{rh} of the rhombohedral cell, and within experimental error is identical with it.

Fig. 3 shows a hexagonal spiral with step-height nearly 130 A., and it may be concluded that it is one of the types with giant unit cells. If a_{rh} is indeed equal to the step-height of 130 A., then the classification is probably $159R$.

Thus, it seems established that the step-height is equal to the height of the actual unit cell. This gives another physical confirmation of the existence of the X-ray unit cell.

I wish to express my thanks to Prof. S. Tolansky for his interest in the work, and to the British Council for the award of a scholarship.

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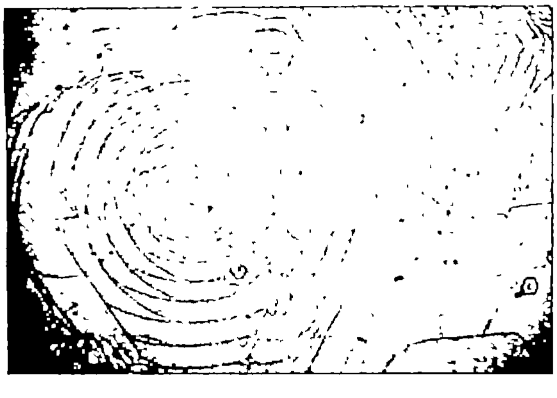
[1] Verma, A. R., *Nature*, 167, 939 (1951).

[2] Ramsdell, L. S., *Amer. Min.*, 32, 64 (1947).

Growth Mechanism of Carborundum Crystals

GROWTH spirals, as predicted by F. C. Frank's theory[1] on crystal growth, have been observed on the c(0001) faces of carborundum by Ajit Ram Verma[2] and by S. Amelinckx[3]. The steps between successive turns, as stated by Frank, are exactly one unit cell high. This seems, in fact, to be true in many cases, although steps of several unit cells high are not exceptions.



We now have evidence that layers thinner than one unit cell are formed in certain circumstances.

The photograph reproduced herewith shows a growth pattern on a c(0001) face of a carborundum crystal. The technique of observation was the same as the one used previously. By means of Weissenberg photographs about an α-axis, we found the crystal to be of the type $6H$ (formerly type II)[4]. The structure of this type of carborundum can be considered as being made up of superimposed three-layered lamellæ, each lamella rotated 180° to that immediately below it[5]. The unit cell contains two such lamellæ, and each of them has trigonal symmetry about the c-axis.

The accompanying photograph shows a double growth-spiral. The two components are generated by the same dislocation end; both have trigonal symmetry as shown by their radial growth-velocity, but their orientation differs by 180°. This shows that two successive sheets are not equivalent.

The average height of a step between successive loops of the spiral was measured by means of multiple beam interferometry[6] and found to be 7 ± 2 A., that is, the height of one three-layered lamella (or half a unit cell).

The most logical interpretation of this pattern would appear to be that these two spirals are due to the growth of each lamella separately. Consequently carborundum crystals (of type $6H$) seem to grow, at least in certain circumstances, not by unit cells but by three-layered lamellæ. Probably similar conclusions will hold for the growth of the other types of silicon carbide; they could provide a basis for the explanation of the existence of the numerous types of carborundum which are known.

A more detailed account of this work is being published elsewhere.

I am grateful to Prof. W. Dekeyser for continuous interest and encouragement. This work is part of a research scheme supported by the Centre National, Belge de Chimie Physique Moléculaire, to which I am indebted for a research fellowship. The carborundum samples were kindly provided by S.E.C.E.M.A.E.U. (Usine de la Bathie, France).

S. AMELINCKX

Crystallographic Laboratory,
Geological Institute,
University of Ghent. July 15.

[1] Frank, F. C., Farad. Soc. Discuss. Crystal Growth, No. 5 (1949).

[2] Ajit Ram Verma, *Nature*, 167, 939 (1951).

[3] Amelinckx, S., *Nature*, 167, 940 (1951).

[4] Ramsdell, L. S., *Amer. Min.*, 32, 64 (1947).

[5] Lundquist, D., *Acta Chem. Scand.*, 2, 177 (1948).

[6] Tolansky, S., "Multiple Beam Interferometry of Surfaces and Films" (Oxford Univ. Press, 1948).

Crystal Structure of Ergine

ERGINE, $C_{16}H_{17}ON_3$, the amide of lysergic acid, is the simplest of the ergot alkaloids. It forms salts with hydrochloric and hydrobromic acids, and crystals of these were kindly put at our disposal by Prof. A. Stoll, of Basle. Both salts crystallize in elongated colourless plates, which are optically biaxial positive with the plane of the optic axes perpendicular to the *b*-axis.

Exposures were made of the (*h*0*l*), (*h*1*l*), (0*kl*) and (1*kl*) zones of both compounds with a Weissenberg camera, using copper $K\alpha$ radiation.

Oscillation photographs around the three axes were also taken. The following results were obtained from these photographs :

$B\cdot$HCl · $a = 9\cdot44° \pm 0\cdot02$ A.
$b = 5\cdot74 \pm 0\cdot01$ A.
$c = 18\cdot60 \pm 0\cdot05$ A.
$\beta = 91\cdot2°$

B HBr : $a = 9\cdot60° \pm 0\cdot02$ A.
$b = 5\cdot74 \pm 0\cdot01$ A.
$c = 13\cdot79 \pm 0\cdot05$ A.
$\beta = 91\cdot2°$

The compounds proved to be isomorphous, space group $P2_1$. The measured densities of 1·40 and 1·56 for hydrochloride and hydrobromide respectively indicated two molecules in the unit cell. The intensities of the (*h*0*l*) and (0*kl*) reflexions of both compounds were estimated visually, and corrected for the Lorentz polarization factor. The F^2-values were brought on to an absolute scale, using Wilson's method[1]. Patterson maps were prepared for both compounds along [100] and [010], using *X-RAC* (calculation on *X-RAC* under contract No. N6onr-26916, T.O. 16 with the Office of Naval Research). The co-ordinates of the halogen atoms were found from these maps.

In addition, a Patterson map was prepared, using as coefficients ($F^2{}_{B\cdot\mathrm{HBr}} - F^2{}_{B\cdot\mathrm{HCl}}$). These maps show only the vectors between atoms of weight (Br—Cl), and between these atoms and the lighter atoms. Vectors between the lighter atoms only do not appear. This Patterson map was drawn twice with its origin at each of the two halogen positions. These two drawings were superimposed and points were marked where regions of high vector density coincided[2], as is shown in Fig. 1.

Signs of the (*h*0*l*) coefficients were calculated from the halogen contributions using the isomorphous rule. Electron density maps on (010) prepared on *X-RAC* for both compounds showed the molecule clearly resolved. By successive Fourier approximations, and using the criterion of non-negativity of the background on *X-RAC*[3], the (010) projection was refined to give Fig. 2, which is essentially the same as Fig. 1.

The chemical formula proposed by Jacobs, Craig and collaborators[4], with an indole group coupled with two non-aromatic rings, is confirmed. Interpretation and refinement of an electron density map on (100) is now in progress.

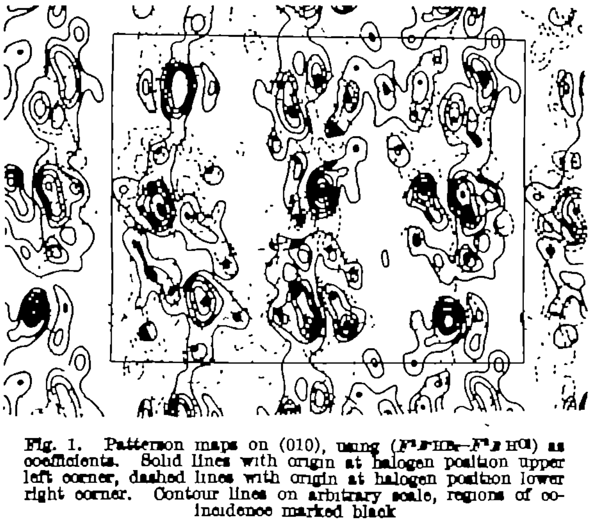


Fig. 1. Patterson maps on (010), using ($F^2{}_{B\cdot\mathrm{HBr}} - F^2{}_{B\cdot\mathrm{HCl}}$) as coefficients. Solid lines with origin at halogen position upper left corner, dashed lines with origin at halogen position lower right corner. Contour lines on arbitrary scale, regions of coincidence marked black

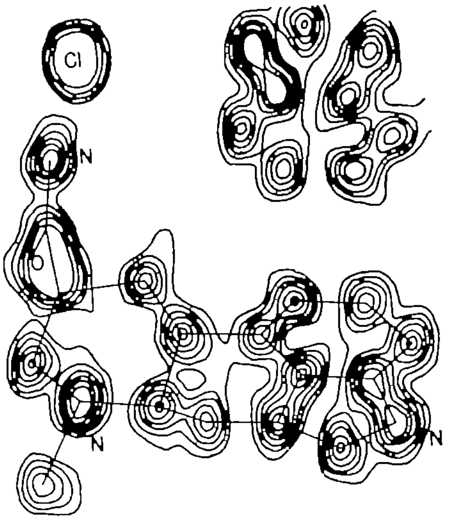


Fig. 2. Part of final electron density projected on (010) of *B* HCl, showing the molecule. Contour lines on arbitrary scale

We wish to express our gratitude to the Research Corporation, Lilly Research Laboratories, and the Office of Naval Research, for support on the programme of which this investigation is a part.

J. L. DEVRIES*
R. PEPINSKY

Pennsylvania State College.
April 20.

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* Eli Lilly Research Fellow.

[1] Wilson, A. J., *Nature*, 150, 152 (1942).

[2] Beevers, C., and Robertson, J. H., *Acta Cryst.*, 3, 164 (1950).

[3] Eiland, P. F., and Pepinsky, R., *Acta Cryst.*, 3, 160 (1950).

[4] Craig, Gould and Jacobs, *J. Biol. Chem.*, 125, 289 (1938). Jacobs and Craig, *J. Amer. Chem. Soc.*, 60, 1101 (1938). See also Henry, T., "Plant Alkaloids", p. 528 (Blakiston Co., Philadelphia, 1949).

Age of Tektites

AN investigation has been made of the argon content of tektites utilizing the mass-spectrometric isotopic-dilution technique in an attempt to find a clue to the origin of these supposedly meteoric glasses[1]. Previous investigations have shown that the bubbles frequently present in tektites have a gas pressure of less than 10^{-4} atmosphere[2], and that the total argon content of the tektites is below the limits of detection of the ordinary methods of gas analysis[3]. These results show that, from the point of view of age determination of these materials by the argon method, diffusion is negligible.

Tektite samples weighing about 10 gm. each were broken into fragments having dimensions of about 3 mm. These fragments, together with a known quantity of 97·5 per cent argon-38, prepared by neutron irradiation of sodium chloride, were introduced in a vacuum into a stainless-steel system containing about 30 gm. of outgassed sodium hydroxide flux at 400° C. The gases obtained were purified by passage through cupric oxide, a liquid-air trap and a calcium furnace. Finally, the remaining gases were adsorbed on activated charcoal, transferred to a mass spectrometer and their argon isotopic composition determined.

Two experiments were made with the so-called 'gas-rich' tektites from the Philippines and one with an australite. The Philippine tektites came from a Mid-Pleistocene deposit and the australites from a 'practically recent' deposit. The K_2O content given in the literature for these types of tektites ranges between 2 and 2·8 per cent. Dr. O. Joensuu, of the Department of Geology in the University of Chicago, has kindly made a spectroscopic determination of the potassium content of our samples. We have used his results in our calculations.

The results are shown in the accompanying table. The ages obtained are based on a value of $1·33 \times 10^9$ years for the half-life of krypton-40, a value of 7·92 for the ratio of decay to calcium as compared to the decay to argon, and a value of 0·0119 per cent for the abundance of potassium-40. The amounts of argon obtained were so small as to preclude measurement of the argon-36 peak to determine whether the argon-40 was of radiogenic or atmospheric origin. Thus, to set upper limits to the ages of the tektites, we have assumed that all the argon-40 measured was radiogenic. Since experiments run without tektites present give amounts of argon-40 comparable to that obtained from the tektites, it seems probable that the actual age of the tektites is less than the ages quoted.

ARGON CONTENT AND THE AGE OF TEKTITES

	Philippinite		Australite
	1	2	3
Wt. of sample	5·66 gm.	8·80 gm.	12·27 gm.
Potassium (per cent)	1·70 ± 0·2	2·16 ± 0·2	1 99 ± 0·2
Argon-40 per gm. potassium	$0·282 \times 10^{-8}$ c.c.	$0·0403 \times 10^{-8}$ c.c.	$0·104 \times 10^{-8}$ c.c.
Argon-40 per gm. potassium expected for 2×10^9 year age	$13·7 \times 10^{-8}$ c.c.	$13·7 \times 10^{-8}$ c.c.	$13·7 \times 10^{-8}$ c.c.
Max. age (yr.)	$< 73 \times 10^6$	$< 10 \times 10^6$	$< 32 \times 10^6$

The results show that the tektites are definitely much younger than the solar system, and also that they are much younger than the ordinary meteorites which have been dated by Paneth by means of their helium content[5].

We wish to express our thanks to Dr. Otley Beyer, Manila, Philippines, for supplying philippinites from Santa Mesa Site, Rizal Province, and to Sir Kerr Grant, University of Adelaide, and to the Museum of South Australia for supplying the australites used in this investigation.

HANS E. SUESS
RICHARD J. HAYDEN
MARK G. INGHRAM

Institute for Nuclear Studies,
University of Chicago,
and
Argonne National Laboratory,
Chicago, Illinois.
April 25.

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[1] See, for example, Paneth, F. A., Halley Lecture (1940).

[2] Suess, H. E., paper at the Washington Meeting, American Geol. Soc., Nov. 1950.

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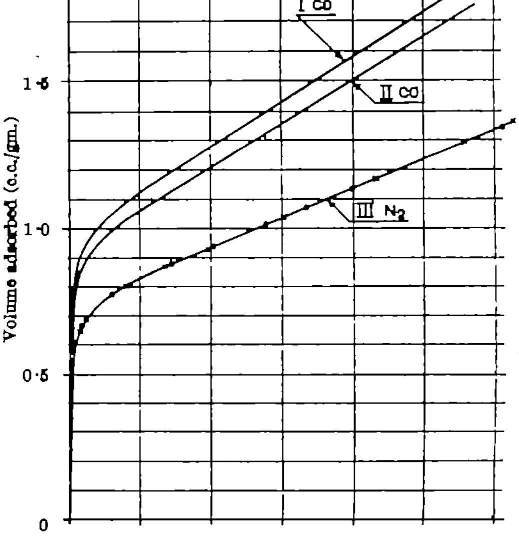
Influence of a Chemisorbed Film on Subsequent Physical Adsorption Processes

Stone and Tiley[1] have reported that the presence of a chemisorbed film of carbon monoxide reduces the low-temperature physical adsorption of krypton on a copper oxide catalyst. This observation is of particular interest, because the accepted method[2] of estimating the area of free metal in a mixed surface involves the assumptions that, at low temperatures, carbon monoxide is initially chemisorbed only on the metal surface, and afterwards physically adsorbed over the whole surface; and that the chemisorbed layer and the bare non-metallic surface have the same adsorption characteristics.

The experimental results shown in the accompanying graph were obtained with an alkali-promoted iron catalyst (as used for the Fischer–Tropsch synthesis), reduced at 450° C. in hydrogen, and degassed at 450° C. for two hours. Similar curves were obtained for two other preparations of the same type of catalyst. The sequence of operations was: (*a*) adsorption of nitrogen at – 195° C. (curve III, ⊙); (*b*) evacuation at 450° C. for half an hour, the evacuation proceeding as the temperature was increased; (*c*) adsorption of carbon monoxide at – 195° C. (curve I); (*d*) desorption of carbon monoxide at – 78° C. for half an hour, at a pressure of 10^{-4} mm. of mercury; (*e*) adsorption of carbon monoxide at – 195° C. (curve II); (*f*) desorption of carbon monoxide exactly as in (*d*); (*g*) adsorption of nitrogen at – 195° C. (curve III, ×).

The presence on the catalyst surface of an amount of strongly chemisorbed carbon monoxide corresponding to the difference between curves I and II is therefore without effect on the subsequent physical adsorption of nitrogen. For the three samples of catalyst tested, the fractions of the surface covered by chemisorbed carbon monoxide were 6·5, 11·6 and 21·5 per cent; in each case the presence of the chemisorbed layer had no effect on the subsequent adsorption of nitrogen.

A possible explanation of the curves in the graph, and of the difference between these observations and



those of Stone and Tiley, is that two different 'chemisorbed' states are involved. In one case the adsorbed molecule may be completely incorporated in the surface with loss of its individual characteristics, so that the perturbation of the original averaged surface field may not be sufficient to have any appreciable influence at the distances of purely physical attraction. It is this type of chemisorption which may be expected in the case of carbon monoxide to occur on clean metallic areas at fairly low coverages, and is represented by the difference between curves I and II. In the second case, the adsorbed molecule may remain distinct from the surface, to which it may be attached by a weak semi-polar bond, and so retain its individual character. In this case the adsorbed molecule behaves as a fresh adsorption centre, the potential at which will certainly differ from the original. This type of carbon monoxide adsorption will probably take place at high coverages on metallic surfaces, and at all coverages on oxides, carbides[3] and nitrides; it approximates to the difference between curves II and III.

A detailed experimental and theoretical investigation is in progress.

This work forms part of the programme of the Fuel Research Board and is published by permission of the director of fuel research, Dr. A. Parker.

A. S. Joy
T. A. Dorling

Fuel Research Station,
Greenwich,
London, S.E.10.
July 3.

[1] Stone and Tiley, *Nature*, 167, 654 (1951).

[2] Emmett and Brunauer, *J. Amer. Chem. Soc.*, 59, 1553 (1937).

[3] Podgurski, Kummer, De Witt and Emmett, *J. Amer. Chem. Soc.*, 72, 5382 (1950).

The results of Joy and Dorling are not altogether surprising, and their suggested explanation is generally in agreement with our views. There are, however, two points of interest.

First, it does not seem in accord with the reported heats of adsorption to refer to carbon monoxide on an iron catalyst as being "strongly chemisorbed" in contrast to the "weak" chemisorption on cuprous oxide. The initial heat of carbon monoxide on iron is approximately 25 k.cal./mole[1], whereas on cuprous oxide it is 21 k.cal./mole[2]. Moreover, after carbon monoxide adsorption at 20° C., prior to the krypton adsorption, we evacuated at a pressure of less than 10^{-4} mm. of mercury for 1 hour at room temperature, thus removing all gas adsorbed with a heat less than 18 k.cal., whereas Joy and Dorling pump off at − 78° C., removing only the gas with a heat less than 12 k.cal. (These are only approximate heat values.) The question of strength of the chemisorbed bond is therefore not immediately significant.

The difference between these two cases surely lies in the nature of the chemisorbed state and its relationship to the nature of the substrate. In so far as carbon monoxide is held on a metallic surface by a form of bonding which is essentially metallic, then the chemisorbed film may be considered as extending the surface of the metal, and no profound modification of the van der Waals adsorption potential occurs. With carbon monoxide on cuprous oxide, the adsorbate molecule is held by a covalent bond to a (largely) ionic surface, with a consequent increase in adsorption potential. It should be noted, however, that on certain metallic oxides carbon monoxide is adsorbed irreversibly, and Garner[3] has suggested that it is then incorporated into the surface as a carbonate ion ($CO_3^=$). In such cases, it seems probable that the physical adsorption characteristics are not so markedly changed, and experimental investigation is proceeding on these lines.

Since our last communication, Mr. Reeves, in this laboratory, has repeated the work, using nitrogen instead of krypton, and a similar modification of the isotherm has been observed. It is felt that in our initial discussion we tended to over-emphasize the significance of E_L, the heat of liquefaction. In order to cause a drop in the apparent value of V_m, it is not theoretically necessary that $E_1' < E_L$ but only that E_1' (heat of adsorption on the chemisorbed film) should differ considerably from E_l (heat of adsorption on the bare surface). The 'dual surface' adsorption theory of Walker and Zettlemoyer[4], in which they discuss hypothetical composite isotherms obtained from two surfaces with differing values of the Brunauer–Emmett–Teller parameter *c*, is of considerable interest in this connexion.

P. F. Tiley

Department of Physical and Inorganic Chemistry,
University of Bristol.

[1] Beebe, R. A., and Stevens, N. P., *J. Amer. Chem. Soc.*, 62, 2134 (1940),

[2] Stone, F. S., and Tiley, P. F., Faraday Soc. Discussion on Heterogeneous Catalysis, 252 (1950).

[3] Garner, W. E., *J. Chem. Soc.*, 1239 (1947).

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Application of an Incomplete Block Design to the Assessment of Quality in Cacao

During the course of recent work at the West African Cacao Research Institute, it became necessary to evaluate the products of small-scale fermentations of different types of cacao. Hitherto, samples have been judged for degree of fermentation on the appearance in longitudinal section and condition of testa. These criteria have not been sufficiently discriminating, especially in laboratory fermentation work[1], where in some instances different cacao types have given similar percentages to fully fermented beans.

An attempt has therefore been made to form a local 'taste panel' for assessment of the chocolate flavour of liquors prepared by a standard procedure recommended by the British Food Manufacturing Industries Research Association (Cocoa Panel)[2]. This consists essentially of pre-heating fermented beans at 95–100° C. for one hour before roasting them in a glass-jacketed tube placed in a glycerine bath at 148° C. for 55–60 min., depending on the state of division of the beans. The only difference from the method as recommended is that no sugar has been added to the liquors.

Preliminary work showed that with randomized blocks and 'taster Latin square' designs, panel members had to taste several samples per session, with consequent deterioration in taste perception. A method was sought which would be statistically sound and which required the tasting of only two samples on any one occasion. A given set of samples was arranged in pairs, each sample being matched against every other sample by each taster. Scoring was by pair differences, each taster being asked to distribute ten points between the two samples under test; for example, if the samples were of equal value five points were allotted to each, the pair difference here being zero. The order of tasting was at random, as was the distribution of the pairs to each taster. The subsequent statistical analysis follows the model laid down by Yates[3].

During the first series, six samples were examined by a panel of six tasters, and the analysis of variance takes the following form, in terms of pair difference throughout:

Table 1

Factor	Degrees of freedom	Sums of squares	Mean square	Variance ratio (F)
Samples	5	88·03	17·61	2·652*
Error	85	563·97	6·64	
Total	90	652·00		

* Significant effect $P < 0\cdot05$

If the samples are A, B, C, etc., the 'sample' sum of squares is derived from the expression $\frac{1}{st}(T'^{2}_{A} + T'^{2}_{B} + T'^{2}_{C} \ldots + T'^{2}_{F})$. Each of the totals T'_A, T'_B, is the sum of pair differences, no correction for the mean being required, where s is the number of samples, t is the number of tasters and the totals T'_A, etc., are derived from a table of the form shown as Table 2.

Table 2

	—	$S(B–A)$	$S(C–A)$	……	……	……
	$S(A–B)$	—	$S(C–B$	……	……	……
	$S(A–C)$	$S(B–C)$	—	……	……	……
	$S(A–D)$	$S(B–D)$	$S(C–D)$	—	……	……
	$S(A–E)$	……	……	……	—	……
	$S(A–F)$	……	……	……	……	—
Totals	T'_A	T'_B	T'_C	T'_D	T'_E	T'_F

Mean sample effects are given by $\frac{1}{st}T'_A$, $\frac{1}{st}T'_B$, etc., and these may be presented as mean scores by the addition of the general mean, that is, 5. The standard error of the difference between these values is:

$$\sqrt{\frac{2 \times \text{error mean square}}{st}}.$$

In the first series, bean samples from West African Amelonado, Gold Coast selection $E1$ and Upper Amazon selection $T60$ (Parinari × Nanay) were sorted into fully fermented and insufficiently fermented lots, the lack of 'nibbing' and presence of purple pigments being the criteria of insufficient fermentation. The bulk samples from which these were drawn were obtained from basket fermentations containing 40 lb. wet beans[4]. In the second series, unsorted beans of West African Amelonado and $T60$ were each roasted for 50, 60 and 70 min., and the results are summarized in Table 3 as mean scores.

From these results, it appeared to the local panel that the quality was not affected by the degree of fermentation. With the standard roast (series 1), $T60$ is markedly inferior to the other types. With an increase in roasting time no significant differences could be detected.

It would therefore appear feasible to apply the incomplete block lay-out to the design of a laboratory assessment panel where a large number of samples have to be submitted to subjective tests.

We wish to acknowledge the help given by the Director of Cacao Research and other members of the staff of this Institute who constituted the assessment panels; and also the British Food Manufacturing Industries Research Association Cocoa Panel for supplying details of a method of preparation of liquors.

Table 3

	Series 1 Standard roast (55 min.)		Series 2 Length of roast		
	Under fermented	Fully fermented	50 min.	60 min.	70 min.
W.A.A.	5·56	5·22	5·20	5·27	5·13
$T.60$	4·11	3·00	4·33	5·27	4·80
$E1$	5·61	5·50	—	—	—
S.E. of a difference	±0·607		±0·445		
Significant difference ($P = 0\cdot05$)	±1·20		±0·880		

J. A. R. MacLean
Robert Wickens

West African Cacao Research Institute,
Tafo, Gold Coast.
July 14.

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[1] MacLean, J. A. R., *Nature*, 166, 910 (1950).

[2] B.F.M.I.R.A. (private communication).

[3] Yates, F., *Ann. Eug.*, 7, 121 (1936).

[4] Anon., Pamphlet No. W11758/31 Dept. Agric., Nigeria (June 1947).

Distribution of British Freshwater Amphipoda

Contributions by Hynes[1], Spooner[2] and Reid[3] have recently appeared in *Nature* on this subject. In referring to the spread of *Eucrangonyx gracilis* (S. I. Smith) Spooner states: "It is clear that the canal system has provided this species with an easy means of dispersal. It would be interesting, by a systematic examination of canals, to ascertain the northward limits of its range". It is therefore worthy of placing on record that I found *E. gracilis* in the Huddersfield–Ashton canal at Golcar near Huddersfield (Yorkshire) in July of the present year, this being apparently the most northerly record of this species in Britain to date. In one stretch of the canal it was the only amphipod found after considerable search and was present in some numbers. In an adjoining stretch it was found in company with *Gammarus pulex* (L.) and was considerably outnumbered by this species. Preliminary search of the canal at Marsden, some three miles to the south-west, revealed its presence there, so it is probably distributed throughout that section of the canal which lies to the east of the Pennines.

In an earlier series of communications, Cain and Cushing[4], and Reid[5] directed attention to the apparent increase in range of the semi-terrestrial amphipod *Orchestia bottae* (M. Edws.). Since that time I have established the existence of a more northerly station for this species, namely, at Huddersfield, and have placed this on record elsewhere[6]. Whether, as Reid suggests, these organisms have been present for some time but have remained undiscovered, or are indeed rapidly spreading northwards, is as yet undecided. Mr. D. M. Reid kindly checked the identity of both the above-mentioned amphipods.

G. Fryer

Department of Biology,
Technical College,
Huddersfield.

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[1] Hynes, H. B. N., *Nature*, 167, 152 (1951).

[2] Spooner, G. M., *Nature*, 167, 580 (1951).

[3] Reid, D. M., *Nature*, 168, 126 (1951).

[4] Cain, A. J., and Cushing, D. H., *Nature*, 161, 483 (1948).

[5] Reid, D. M., *Nature*, 161, 609 (1948).

[6] Fryer, G., *Naturalist*, No. 835, 148 (1950).

FORTHCOMING EVENTS

Tuesday, September 11—Thursday, September 13

INSTITUTION OF MECHANICAL ENGINEERS and the AMERICAN SOCIETY OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1).—Conference on "Heat Transfer".

Tuesday, September 11—Thursday, September 20

BUILDING RESEARCH CONGRESS

(at the Institution of Civil Engineers, Great George Street, London, S.W.1).—Division 1: "The Influence of Mechanization and Prefabrication on Techniques and Cost of Building".

(at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2).—Division 2: "Building Materials".

(in Room 140, County Hall, Westminster Bridge, London, S.E.1).—Division 3, Part 1: "The Acoustics of Auditoria and Studios".

(at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1).—Division 3, Part 2: "The Heating and Ventilating of Buildings in relation to Summer and Winter Conditions".

(at the Royal Institution of Chartered Surveyors, 12 Great George Street, London, S.W.1).—Division 3, Part 3: "The Lighting of Buildings".

(at the Royal Institute of British Architects, 66 Portland Place, London, W.1).—Division 3, Part 4: Symposia on "The Problems of Three Specific Types of Buildings".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (with an honours degree in science and/or agriculture, an interest in grassland husbandry and an aptitude for investigational and research work) TO THE ADVISORY OFFICER IN GRASSLAND HUSBANDRY, and ASSISTANTS (one honours graduate and one non-graduate) IN THE CHEMISTRY DEPARTMENT, for duties in connexion with soils and land fertility investigations—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (September 14).

ASSISTANT (Grade A) IN PHYSICAL CHEMISTRY, at Constantine Technical College—The Director of Education, Education Offices, Woodlands Road, Middlesbrough (September 15).

ASSISTANT CHEMIST (good experience in general analytical work essential, and knowledge and experience of sewage purification or bacteriology and bacteriological and enzyme chemistry an advantage)—The Chief Engineer, Middlesex County Council, Main Drainage Department, Mogden Works, Isleworth, Middx., quoting J.795.T (September 15).

CHEMIST (Assistant Experimental Officer grade) interested in agricultural research, to do routine sampling and analysis of grass and grassland products—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (September 15).

ELECTRON MICROSCOPIST for work on viruses at the Plant Virus Research Unit, Cambridge—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (September 15).

LECTURER IN AGRICULTURAL BOTANY—The Registrar, King's College, Newcastle-upon-Tyne (September 15).

LECTURER IN AGRICULTURAL SCIENCES, and a LECTURER IN AGRICULTURE (farm implements, building construction, etc.), at the Cheshire School of Agriculture, Reaseheath—The Director of Education, County Education Offices, City Road, Chester (September 15).

LECTURER IN INORGANIC CHEMISTRY in the Department of Chemistry, Colour Chemistry and Dyeing, and a TEACHER (with honours degree in mathematics) OF MATHEMATICS—The Principal, Technical College, Queen Street South, Huddersfield (September 15).

LECTURER IN THE DEPARTMENT OF NATURAL PHILOSOPHY—The Secretary, The University, Edinburgh (September 15).

SCIENTISTS (Grade II) (with good honours degree, or equivalent qualifications, in science or engineering, and some previous research experience) at London headquarters—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/366 (September 15)

PRINCIPAL SCIENTIFIC OFFICER IN THE DEPARTMENT OF SUPPLY, Long Range Weapons Establishment, Adelaide, for the organization and direction of research and development work in the fields of ballistic calculations and mathematical aspects of aerodynamics—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (September 18).

ASSISTANT LECTURER (graduate in physics, chemistry or metallurgy) IN DENTAL MATERIALS—The Registrar, The University, Manchester 13 (September 20).

ASSISTANT (with honours degree in biochemistry, or its equivalent) IN BIOCHEMISTRY—The Secretary, The University, Aberdeen (September 21).

ENGINEER I at the Ministry of Supply in London, to be responsible for ordering and inspection of plant, planning and production of gauges and cutting tools for all types of ammunition manufacture—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.517/51A (September 24).

LECTURER IN MECHANICAL ENGINEERING, and an ASSISTANT FOR THE TEACHING OF CHEMISTRY and either Physics or Mathematics to a standard approximately that of the Ordinary Level of the General Certificate of Education—The Principal, Wigan and District Mining and Technical College, Wigan (September 25).

ELECTRICAL and MECHANICAL ENGINEERS (Experimental Officer grade) at a Ministry of Supply research and development establishment near London: (Ref. C.514/51A) MECHANICAL or ELECTRICAL ENGINEER with thorough experience in the design and use of small electromechanical devices; (Ref C.515/51A) MECHANICAL ENGINEER for tests and trials of small mechanical devices—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 29).

SENIOR SCIENTIFIC OFFICERS or SCIENTIFIC OFFICERS (ENGINEERS with a knowledge of assembling jig designs and able to appreciate the engineering principles of continuous production machinery) for micro-wave valve development and experimental production at an Admiralty establishment in Essex—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D 232/51A (September 29).

KEEPER OF THE DEPARTMENT OF BIOLOGY—The Director, Museum and Art Gallery, New Walk, Leicester, endorsed 'Keeper of Biology' (September 30).

MECHANICAL ENGINEER (with headquarters in London) to test and report upon various items of mechanical equipment—The Secretary, Forestry Commission, 25 Savile Row, London, W.1 (October 1).

PHYSICAL CHEMIST for investigations of high molecular weight substances by ultracentrifugation—The House Governor, Royal Cancer Hospital, Fulham Road, London, S.W.3 (October 1).

SENIOR EXPERIMENTAL OFFICERS (with H.S. Certificate with Mathematics or a science subject as a principal subject, or an equivalent qualification, and considerable technical experience of the raw material resources of the Colonial territories which are of plant or animal origin) in the Colonial Products Advisory Bureau (Plant and Animal)—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4067/51 (October 4).

CHAIR OF MINING—The Registrar, The University, Sheffield (October 6).

DIRECTOR OF THE AUCKLAND ART GALLERY, New Zealand—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (Auckland, October 31).

ELECTRICAL ENGINEER AND MANAGER to the Antigua Electricity Board—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M 28838.B.

GRADUATE SCIENTISTS to take part in research and for training in the scientific control of brewery operations in the Foundation's physical, chemical, analytical, biological or brewing laboratories—The Director, Brewing Industry Research Foundation, Nutfield, Surrey.

GRADUATES IN FUEL, CHEMISTRY, PHYSICS or CHEMICAL ENGINEERING, for laboratory and/or plant work: PRINCIPAL or SENIOR SCIENTIFIC OFFICERS (with good honours degree) as research section leaders, and SCIENTIFIC and EXPERIMENTAL OFFICERS for work in laboratory or on coke ovens and iron and steel plants—The Director, British Coke Research Association, 74 Grosvenor Street, London, W.1.

JUNIOR ASSISTANT PHYSICIST—The Secretary, South Manchester Hospital Management Committee, Christie Hospital and Holt Radium Institute, Manchester 20.

MATHEMATICIAN (M. or F., with honours degree, and knowledge of engineering, physics or chemistry an advantage)—The Secretary (Ref. A.28), British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey.

PHYSICAL or INORGANIC CHEMIST (preferably with one or two years research experience) to work on the surface structure of inorganic pigments, and a PHYSICAL CHEMIST (with a good knowledge of surface chemistry) for work on the physico-chemical relationships between pigments and organic media in surface coating materials—The Director, Paint Research Station, Waldegrave Road, Teddington, Middx.

PROFESSORS OF MATHEMATICS, PHYSICS, CHEMISTRY, ZOOLOGY, BOTANY, GEOGRAPHY, PSYCHOLOGY, PHILOSOPHY, ECONOMICS, ENGLISH, POLITICAL SCIENCE AND INTERNATIONAL RELATIONS, and HISTORY, at the University of Karachi, Pakistan—The Educational Attache to the High Commissioner for Pakistan, 39 Lowndes Square, London, S.W.1.

REGIONAL TRIALS OFFICER (with a university degree or diploma in agriculture and/or biology, and experience of conducting field trials)—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

SENIOR PLANT PATHOLOGIST (Senior Principal Scientific Officer grade) at the West African Cocoa Research Institute, Gold Coast—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

SENIOR PHYSICIST, and an ASSISTANT PHYSICIST, to the Radiotherapy Department—The Group Secretary, Wolverhampton Hospital Management Committee, Royal Hospital, Wolverhampton.

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS at Admiralty experimental establishments in the vicinity of London, Baldock, Greenock, Haslemere, Portsmouth, Rosyth and Weymouth: PHYSICISTS (Ref. A.336/50A) capable of undertaking research or development in general physical problems, electronics, acoustics or thermodynamics, ELECTRICAL ENGINEERS (Ref. D.367/50A) qualified to undertake research, development or design in telecommunications, radar, electronics, instrumentation or light electrical mechanisms, MECHANICAL ENGINEERS (Ref. C.631/50A) capable of design, development or research work in light mechanisms, structures or hydrodynamics—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

STRUCTURAL ENGINEER (Public Works), Northern Rhodesia (Ref. 27322/222), and a SANITARY ENGINEER (Public Works), Northern Rhodesia (Ref. 27322/221)—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting the appropriate Ref. No.

TECHNICAL AUTHORS at a Ministry of Supply establishment at Chessington for the preparation of official instructional publications in the following groups: (Ref. D.376/51A) handbooks and circuit diagrams on the theoretical and practical (including servicing) aspects of airborne and ground electrical and electronic equipment, or on complete installations in aircraft, (Ref. D.378/51A) instructional publications on the theoretical and practical (including servicing) aspects of aircraft gun sights, bomb and torpedo sights, or complex types of aircraft navigation and computing instruments, (Ref. D.377/51A) instructional publications embracing aircraft and associated airborne and ground equipment, including airframes, electrical components and installation, air armaments, mechanical transport and airfield construction plant—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

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MOVEMENTS OF BOOKS ACROSS NATIONAL BOUNDARIES

EARLY last year Sir Stanley Unwin reviewed, in a pamphlet entitled "How Governments Treat Books", some of the obstacles which taxation policy offers to-day to the free flow of books from one country to another. Sir Stanley quoted his examples from a summary of the regulations which affect the export of British books, prepared by the Publishers Association of Great Britain and covering some fifty-five countries. With the exception of those for the United States, which still discriminate against the British Commonwealth, most of these regulations apply to books from all countries. Besides taxes and customs duties, forms and formalities, as well as currency difficulties, also constitute serious obstructions to the dissemination of knowledge by the circulation of books.

Sir Stanley in this pamphlet, rightly emphasizing the value of books for the transmission not merely of knowledge but also of thought, pointed out that post-war governments are treating with scant respect this unique and priceless instrument for giving continuity and permanence to the free expression of thought. In many otherwise civilized countries, there is an increasing tendency to treat books as if they were merely an ordinary commodity of commerce, without cultural value or importance. The fundamental principle that the one thing no country can afford to hamper, limit or tax is knowledge no longer receives the respect that it enjoyed a century ago; and in the climate of opinion that is engendered by security measures, once they escape beyond the limits that the national interest requires in such matters as atomic energy, the progress of knowledge is bound to slow down.

Sir Stanley maintained in this pamphlet that the surest way of remedying the situation is ruthless publicity and exposure of all obstacles to the obstruction of the circulation of books. He instanced the campaign in Great Britain which in 1940 led promptly to the withdrawal of the Chancellor of the Exchequer's proposal to levy purchase tax on books as an example of the fact that no government finds it easy to defend the taxation or obstruction of knowledge when once it is publicly challenged, or likes to be held up to ridicule over its treatment of books as so many pieces of merchandise. Books, however, are not the only media for the exchange of knowledge, thought and culture, and the United Nations Educational, Scientific and Cultural Organization has done well to prepare and publish "Trade Barriers to Knowledge" (Paris: Unesco; London: H.M. Stationery Office, 1941. 6s.).

In this are set forth the tariff and trade regulations affecting the movement of educational, scientific and cultural materials from one country to another. This covers some forty-three countries and embraces regulations affecting not only books, periodicals, newspapers, etc., but also works of art, films, scientific instruments and apparatus, and materials specially for the blind. The book was compiled primarily as a practical handbook for publishing houses, film libraries, scientific laboratories and all organizations, as well as individuals, interested in obtaining such materials from abroad, or in sending them to other countries.

This publication is undoubtedly a useful step towards overcoming the formidable obstacle to the international circulation of such material which is presented by the complexity and variety of trade regulations in different countries and the inaccessibility of information concerning them. Confronted with this maze of restrictions, many organizations and individuals are discouraged from embarking on international exchanges of such materials, or even their sale in countries abroad. Even more important, however, is the service which the book should render to the efforts now being made in many countries for the reduction and progressive elimination of obstacles to the international circulation of educational, scientific and cultural material. The facts it records provide material for a sustained attack on many of the absurdities of the present situation; and an admirable introductory chapter, in which the development of those restrictions is reviewed and the attempts already made by Unesco to deal with the situation are explained, should assist in putting the facts in a true perspective.

It is indeed no pleasant picture that is presented by this manual, nor does the United Kingdom make a good showing. No consolation can be found in the reflexion that while modern technology has made possible the transmission of books, periodicals, newspapers, and other educational material across frontiers on an unprecedented scale, the present restrictions to such a flow have developed fortuitously rather than by design. Revenue derived from duties on such materials is relatively small, and rarely is any serious danger of competition with domestic industry involved. Frequently the regulation or restriction is trivial in the extreme, as derisory as it is irritating: it is the official outlook or attitude of mind revealed in the regulation that is so depressing.

The question of 'book tallies' in itself is trivial; but the official obtuseness which subjected them to purchase tax is an example of the lack of imagination which is responsible for many of the regulations, and which should be attacked unceasingly by all who are convinced that the restrictions placed upon the free flow of knowledge can and should be lifted. While such lack of imagination persists, there will be continual danger, for example, that legitimate barriers on the ground of military secrecy to the exchange of knowledge in certain fields of physics will be converted into barriers to the exchange of general knowledge. Muddled thinking rather than illiberal intentions are likewise responsible for allowing paper and books and paintings and other materials for conveying knowledge to become entangled in the general web of tariffs and currency regulations. While it is true that in Great Britain there is no purchase tax on books, even learned scientific and technical books are subject to a quota system, of 200 per cent of the value of pre war imports. Rising prices, not to mention the expansion of scientific and industrial research and the doubling of the university population in science and technology, make nonsense of any such figure.

What is required over the whole field is the play of a critical and imaginative intelligence bringing the regulations or restrictions into relation with realities, as is so often vividly illustrated in the minutes recorded in Mr. Winston Churchill's war memoirs, and sweeping away the waste of man-power on the issue or refusal of licences that serve no purpose. Full use should be made of the Unesco book to secure that action and to challenge the dubious restrictions here revealed. Unesco itself has already sought to reduce trade barriers to knowledge by sponsoring two international agreements which would raise the standard of dispensation. One, the Agreement for Facilitating the International Circulation of Visual and Auditory Materials of an Educational, Scientific and Cultural Character, had, by the beginning of 1951, been signed by eighteen countries, but only four (Canada, Norway, Pakistan and Yugoslavia) of ten ratifications required to bring this convention into force had been forthcoming. The Agreement on the Importation of Educational, Scientific and Cultural Materials, which would grant duty-free entry to publications, works of art, visual and auditory materials, scientific materials and articles for the blind, consigned to approved institutions, has been signed by seventeen countries, but also awaits the necessary ten ratifications to bring it into force. Besides in this way attempting to reduce the barriers to the international circulation of such material, Unesco is also endeavouring to help countries to meet their needs in this field, despite shortages of foreign currency, by encouraging exchanges of information on needs and resources, promoting trade agreements and stimulating domestic production. Here Unesco is working with the regional economic commissions of the United Nations, and some indication of its activities is given in the introductory section of the book. But its prime importance is the further weapon it affords educated opinion, in every country, for pressing even more insistently for the sweeping away of pedantic obstructions to the exchange of educational, cultural and scientific material of all kinds, and insisting that only those regulations are retained for which a reasoned case, acceptable to responsible and informed opinion, can be presented.

NATURAL AND SYNTHETIC DRUGS

Medicinal Chemistry

Chemistry, Biochemistry, Therapeutic and Pharmacological Action of Natural and Synthetic Drugs. By Prof. Alfred Burger. Vol. 1. Pp. xviii+577. (New York and London: Interscience Publishers, Inc., 1951.) 10 dollars.

TWO of the most outstanding characteristics of twentieth-century organic chemistry have been the amount of attention devoted to biologically active compounds, both natural and synthetic, and the striking successes which have attended investigations in these fields. It is not surprising, therefore, that many books have been written to survey and coordinate the results of these researches. There have been monographs on chemotherapy, antibiotics, vitamins, hormones, sulphonamide drugs, and similar topics, as well as on more restricted subjects within these fields, and also more general works covering, for example, the whole range of synthetic drugs. Prof. Burger's book is the first of two volumes in which he plans to give a comprehensive account of all classes of natural and synthetic drugs. The treatment is not confined to their chemistry, but includes also a description of their pharmacology, with some discussion of the mechanism of their action and of the relationships which have been found between chemical structure and biological activity. This is a commendable if ambitious project. Prof. Burger has himself made many important contributions in studies on synthetic drugs. But he could scarcely be expected to have first-hand knowledge of all the subjects on which he has written in the present volume. The book is inevitably somewhat of a compilation, and the treatment rather superficial. On the whole, though, it is a well-arranged compilation which is not unduly afflicted with the shortcomings often found in such works, and is a valuable and interesting work of reference. There is sufficient bibliography to direct the reader's attention to more authoritative and more extensive surveys of individual topics.

The compounds dealt with are classified according to their pharmacological effects, and the grouping together in a single chapter of all the drugs of various chemical types which exert a given pharmacological action is a very valuable feature. Volume 1 is largely concerned with pharmacodynamic drugs, whereas Volume 2 will deal mainly with chemotherapeutic agents which are used for combating diseases due to bacteria and other parasitical organisms. The volume under review includes accounts of general and local anæsthetics, hypnotics, anticonvulsant drugs, analgesics, cardiovascular drugs, autonomic drugs and antihistamine compounds. In addition, there are a few chapters on unrelated groups such as the vitamins and diagnostic agents. The book is attractively produced and the structural formulæ are printed in a particularly clear and pleasing manner. An unusual but useful feature is that the number of the chapter is given on all the even-numbered pages. The formulæ are numbered in a novel manner which might well be adopted by other authors. To each formula is attached the number of the chapter, in Roman numerals, followed by a figure in Arabic numerals representing the number within the chapter. This facilitates cross-reference, provides a unique label for each of the many formulæ throughout the book, and at the same time avoids the cumbersome and sometimes difficultly decipherable expressions resulting from the use of Roman numerals for a long series of formulæ.

Much confusion exists in naming drugs which are put on the market for clinical use. Half a dozen different names may be assigned by different manufacturers to the same product. Prof. Burger has attempted to rationalize his nomenclature. The now usual practice of treating trade names as proper nouns is followed, and widespread use is also made of the alternative names assigned by the Council of the American Medical Association. The trade names used are, very naturally, mainly American, and this may sometimes mislead British readers. For example, in the section devoted to the synthetic analgesic, Demerol, there is no reference to the British name of pethidine, or even to the name (Dolantin) given by the German discoverers of this drug. Incidentally, perusal of the chapter on analgesics shows the very wide range of structures associated with such action. In the preceding chapter attention is directed to the close structural resemblances between some hypnotics, anticonvulsants, analgesics, spasmolytics and antihistaminics. Those who have a prejudice against the use of drugs will perhaps be interested in the estimate that the American people consume about five to six million kilograms of caffeine per year in coffee alone.

The treatment of the chemistry of the drugs is very sketchy. Although structural formulæ appear in great profusion, only in very few cases has any attempt been made to show how they were established. Synthetic procedures are sometimes outlined; but this appears to be restricted to actual manufacturing processes. One wonders whether this is a good principle. In a book of this sort it seems scarcely necessary to devote a whole page to a series of formulæ illustrating the synthetic production of theophylline.

It is easy to find imperfections and occasional inaccuracies in a book covering such a wide range of subjects. The statement that "Paracelsus was a superficial quack" invites rejoinder. The first lecturer in chemistry in the University of Glasgow, William Cullen, was better known as a distinguished physician; but it is a little odd to find him described as "the Scotch surgeon". The early American work on anæsthetics is faithfully reported; but there is no mention of the introduction of chloroform by Simpson, of Edinburgh. The preparation of androsterone from cholesterol is wrongly attributed to Butenandt, the final elucidation of the structure of strychnine is attributed to Woodward, and there are similar historical distortions in regard to the structure of colchicine and of the cardiac glycosides. There is no warrant for, neither is there any meaning in, the statement that the carcinogenic properties of 9-hydroxymethylbenzpyrenes are more pronounced than those of corresponding methyl derivatives.

Taken as a whole, however, this book is an excellent piece of work and will be extensively used by those interested in synthetic drugs.

J. W. Cook

HISTORICAL APPROACH TO BACTERIAL CYTOLOGY

Elements of Bacterial Cytology

By Prof. Georges Knaysi. Second edition. Pp. xix+375. (Ithaca, N.Y.: Comstock Publishing Co., Inc., 1951.) 5 dollars.

THIS book has been considerably expanded since the first edition; but it is apparent that Prof. Knaysi's fundamental views upon the subject have been little affected by the greatly increased body of evidence which has accumulated in recent years since the resurgence of interest which he has done so much to promote. Only the briefest recognition is accorded to the acid-hydrolysis techniques by which the bacterial nucleus was, in fact, first convincingly demonstrated. He does not appear to have grasped the significance of the findings which have been made by this means, but apparently believes that the dumb-bell shape of the bacterial chromosome indicates transverse fission at the point of constriction.

The extraordinarily low standard of the photomicrographs by which the acid-Giemsa stain is illustrated, in contrast to the general excellence of the plates with which the book is lavishly provided, may explain his distaste for the method.

The work of the early bacterial cytologists is well reviewed, and many of their original drawings are reproduced. The value of this historical research should not be underestimated; but it would be even greater if it were combined with an equally full account of studies performed since the early nineteen-thirties. There is, for example, only a single, brief reference to the work of Robinow, and the entire chapters upon the cytology of Actinomycetes and Myxobacteria make none at all to the exceedingly important papers of Klieneberger-Nobel, only one of which is quoted in the whole book. Phenomena now widely accepted and repeatedly confirmed, such as the *L*-form mode of reproduction, multicellularity of the higher bacteria, variety of types of cell-division, and the autogamous processes associated with sporulation, are either treated with exaggerated reserve or totally ignored.

The format of the book is very attractive and the illustrations are particularly good. Electron microscopists will find much to interest them in the numerous micrographs which are included.

K. A. Bisset

THE HOME LIFE OF AN ASTRONOMER

Ninth Astronomer Royal

The Life of Frank Watson Dyson. By Margaret Wilson. (Published for the Dyson Family.) Pp. xvi+294+14 plates. (Cambridge: W. Heffer and Sons, Ltd., 1951.) 25*s*. net.

The biography of Sir Frank Dyson, ninth Astronomer Royal, by his daughter, Mrs. Wilson, gives a vivid account of the home background to his professional life. To those many who knew him personally and enjoyed his friendly hospitality in Greenwich or Edinburgh, this book will bring back happy memories of Dyson himself, his gracious wife and his cheerful family. But it must be admitted that the book would have gained considerably in value if it had included a full account of his scientific career and work written by an astronomical colleague. A clear picture of Dyson the man, as seen from the family circle, is given: Dyson the astronomer, however, is seen mainly from the same limited point of view, the account being supplemented by too little scientific appreciation. The result is a lack of balance in the picture.

This being said, we may turn with gratitude to what Mrs. Wilson has done in relating with such obvious enjoyment the story of the Dyson family. Like so many scientific men both in Great Britain and in the United States, Dyson was a son of the manse. His father was a prominent Baptist minister, and it was natural that Dyson as a young Cambridge graduate should follow his friend, T. R. Glover, as president of the Cambridge University Nonconformist Union. Typical of interests maintained throughout his life were the two papers he read to that body on "Robert Browning" and "The London Poor". But we must not omit, in speaking of his early days, to refer to the influence of his school. Dyson was fortunate in his headmaster and schoolfellows: Bradford Grammar School under Keeling produced a notable set of brilliant boys who made a mark for themselves later in life—it must suffice to mention here Benjamin Gott, William Rothenstein and John Coates. In Cambridge Dyson graduated as second Wrangler (the Senior Wrangler of his year, Sir Gilbert Walker, still happily survives); he was first Smith's Prizeman the year after Sampson, whom he also followed a year later as Isaac Newton Student. Years later, Sampson was to follow Dyson as Astronomer Royal for Scotland.

Dyson's father, possibly influenced by the friendship of Dawes, a well-known observer of double stars, had foretold at his birth that he would become Astronomer Royal. The opportunity came when Christie invited him in 1894 to succeed Turner as chief assistant at the Royal Observatory, Greenwich. Dyson accepted with alacrity, and from that day his career was marked out clearly for him. His observational work at Greenwich was varied with solar eclipse expeditions to Oran, Pulo Aoer Gadang and Sfax, at all of which he was favoured with fine weather: his luck in this respect never deserted him, and he was successful in observing six total eclipses of the sun in six attempts.

In 1905 came the move to Edinburgh, where Dyson's experience as Astronomer Royal for Scotland prepared the way for a return to Greenwich five years later as Astronomer Royal. Here he proved to be an administrator of sound judgment and keen practical sense, a greatly loved chief. One of his most striking decisions was taken during the dark days of the spring of 1918: that was to back the preparations for the Einstein eclipse of 1919. It is in the account of this eclipse that we find this book at fault on the scientific side—Einstein's special theory of relativity being ascribed to Newton.

One feature of Dyson's great influence on the astronomical world of his day was his participation in the international side of astronomy. Both as a ready and genial host to foreign astronomers visiting England and as one who co-operated fully with them in congresses, he formed an important link in the network of joint schemes which covers the astronomical world. It was only natural that in due course he should become president of the International Astronomical Union. This was one of many richly deserved honours that came his way. Perhaps none pleased him more than the honorary degree of Sc.D. conferred upon him by the University of Cambridge. With the final passage in the speech of his old friend, T. R. Glover, the Public Orator, we may fitly close this review—*Litteris, amicitiis, scientiis humanitate—sic itur ad astra.*

F. J. M. Stratton

TROPICAL ANIMAL NUTRITION

The Feeding of Farm Animals in India

By Dr. P. E. Lander. (Animal Husbandry Manuals.) Pp. xii+492+lii+46 plates. (Calcutta, Bombay, Madras and London: Macmillan and Co., Ltd., 1949.) 14 rupees; 25*s*. net.

The temperate zones of the world are well supplied with text-books which give information obtained from experiments published in many different and often inaccessible journals and reports. If progress is to be made in agriculturally backward areas in the tropics, similar books are essential, for the soils, crops and livestock are so different in the tropics that text-books written for temperate zones are of little real use and in some cases are often misleading.

This book, the first of its kind on animal nutrition in India, compiled from experimental results which have been obtained there and by one who has spent a life-time working on the subject, should be most useful to those who are doing advisory work on animal production not only in India but also throughout the tropics. The tables of chemical composition and digestibility, mineral and vitamin content of Indian feeding-stuffs will be invaluable for the rationing of animals in tropical countries, for until this book appeared they were to be found only in inaccessible publications and reports. These tables will do for the tropics what the tables of Kellner, Armsby and others have done for temperate climates. In general, the book follows the traditional lines of those on animal nutrition, but with special reference to Indian conditions, and includes sections on the feeding of buffaloes and camels. A chapter on some harmful foods and famine fodders supplies useful information rarely found in nutrition books written for temperate climates.

Perhaps the most important respect in which the book differs from those written for temperate areas is that it starts with the soil and deals with its deterioration and erosion from overgrazing, an aspect of animal nutrition which is of special importance in the tropics. As the author states, the ultimate solution of the problem of feeding animals in India lies in the restoration of the proper equilibrium between the soil and the human and cattle population.

JOHN HAMMOND

BIRDS OF A LOW RAINFALL REGION

A Handbook of the Birds of Western Australia (with the exception of the Kimberley Division)
By D. L. Serventy and H. M. Whittell. Second edition. Pp. viii+384. (Perth: Paterson Brokensha Pty., Ltd., 1951.) n.p.

AUSTRALIA, scarcely less than Great Britain, has of recent years been flooded with 'Nature books' of dubious accuracy and of poor quality. These have been hastily put together in order to exploit the growing desire of the public for information about animals, particularly birds.

The present volume is a refreshing departure from the general run of ornithological literature. It is the result of much painstaking scholarship, and it contains information that will interest any biologist who is concerned with the effects of landscape aridity on form, of environmental change on distribution, or the influence of irregular and scanty rainfall on the breeding seasons of animals. It is, then, far more than a mere handbook of the fauna of a single restricted area within political boundaries.

Certain parts of the book are of especial interest in that they throw further doubt on the validity of the day-length hypothesis in the regulation of avian breeding seasons. This notion has gained almost universal acceptance since Rowan's epochal demonstration, about twenty-five years ago, that the reproductive mechanism of vertebrates can be stimulated by increased lighting. There can, of course, be no question that the hypophysis can be indirectly influenced and gonad modification induced in many species by artificial photostimulation; but the importance of day-length as an ultimate, or even as an initiating factor, in the timing of avian breeding seasons under natural conditions has been seriously questioned by recent work in Britain on British and Australian species. Serventy and Whittell point out in the volume under review that in Western Australia light increases in duration from June until December; but, in the southern parts of the country, many species ovulate from mid-April onwards. In the north-west, breeding occurs mostly in the winter, while in the south-west most birds ovulate during the spring months when light is increasing. In each region there is a very pretty correlation between sexual activity and rainfall, and as a consequence, the young are launched from region to region at times most propitious for their survival. In one area where spring ovulation is normal, a heavy and unseasonal deluge was followed by widespread autumn reproduction. A hundred miles away where the rains did not penetrate, breeding did not occur until the following spring. This kind of information supports the concept that after the post-nuptial period of gonad metamorphosis (which varies in duration from species to species) many birds are ready to undergo reproductive activity immediately there occurs in the environment the combination of external stimuli to which they are hereditarily attuned to respond. Breeding can occur quite irrespective of changes in day-length. Serventy and Whittell have further information that suggests the operation of an internal rhythm among sea-birds. The silver gull (*Larus novæ-hollandiæ*), for example, has a winter and a spring breeding population on the same small coastal island.

The present "Handbook" contains a great amount of detail that is chiefly important to local naturalists, including a most excellent history of Western Australian ornithology dating from the seventeenth century explorers such as van Hillegom, de Vlamingh (who discovered that a black swan was not a *rara avis* after all) and the remarkable English buccaneer, William Dampier. It is to be hoped that subsequent editions may include the birds of the remote Kimberley region with its 'incubator bird' (*Megapodius*), fruit-pigeons, pittas and other forms of tropical origin and affinity. In fact, one cannot think of two men better qualified to write a much-needed modern handbook covering the birds of the entire continent of Australia.

A. J. MARSHALL

SIX-FIGURE MATHEMATICAL TABLES

Chambers's Shorter Six-Figure Mathematical Tables
By Dr. L. J. Comrie. Pp. xxvi+388. (Edinburgh and London: W. and R. Chambers, Ltd., 1950.) 12s. 6d. net.

WHEN accuracy in simple numerical calculations greater than that attainable by the use of the common four- or five-figure tables has been desired, it has been usual to resort to Chambers's seven-figure tables, although they are restricted to common logarithms and the trigonometrical functions. The question of a revised edition of the latter tables was referred to Dr. L. J. Comrie, and the substance of his recommendations was that a wider range of elementary functions should be included and that they should be on a six- and not a seven-figure basis. The main reason for the latter recommendation was that it made linear interpolation possible within a reasonable compass, and it was defended on the grounds that, apart from certain specialist needs already adequately catered for, ordinary scientific and technological calculations would need higher accuracy only very rarely indeed. The result was "Chambers's Six-Figure Mathematical Tables", in two volumes. The volume now under review is essentially an abridged version of these, containing a selection of the more useful tables. Many users will find this collection adequate for their needs, and there is obvious convenience in a single volume, if its contents do indeed suffice.

Most of the pages have been taken direct from the two-volume edition, but some have been reset at a wider interval. As will be seen from a summary of the contents which is given below, the range of elementary functions is quite well covered, which was certainly not the case with the old 'Chambers'. Much more emphasis has been laid on natural than on logarithmic values, since the former are much more frequently required in these days of mechanical computation.

The main tables give common logarithms, logarithmic and natural trigonometric functions (with argument in degrees, minutes, and seconds), circular functions (argument in radians), exponential and hyperbolic functions, natural logarithms, inverse circular and hyperbolic functions, powers, roots, reciprocals, factors and factorials. Pages of formulæ relating to the functions tabulated, lists of series and integrals, formulæ and tables of coefficients for interpolation and for numerical differentiation and integration, and sundry conversion tables, are included, along with copious worked examples showing how the tables may be used most efficiently.

The tables are planned so that, in general, linear interpolation gives the greatest accuracy attainable from them, and in the main tables the appropriate proportional parts are provided at every opening. In the few ranges where the second difference correction cannot be neglected, the user's attention is directed to this fact by the printing of the first differences in italics. Bessel's formula for applying the necessary corrections is advocated, and tables of the values of the coefficients are given. Other cases where linear interpolation becomes difficult are met by auxiliary functions (for example, $s(x) = \log x - \log \sin x$ for small x). For slowly varying functions (and this includes most of the auxiliary functions just mentioned), so-called 'critical' tables are provided.

Apart from the refinements of typography and lay-out which one associates with the name of Dr. Comrie, one cannot fail to be impressed by the evidence of the thought given and the care taken to provide the user with the maximum of information in the minimum of space, and the maximum accuracy with the minimum labour. Almost every page contains some ingenious device—many invented by Dr. Comrie himself—directed to one or other of these ends. The book is well produced, and is bound so that it lies flat at any opening, a great convenience in use. It represents remarkable value for money.

This was the last of Dr. Comrie's projects which he was able to see completed. By it alone one can measure both his greatness as a maker of tables and the loss we have sustained by his passing.

W. G. Bickley

HUMANITY AND THE HELM

The Human Use of Human Beings

Cybernetics and Society. By Prof. Norbert Wiener. Pp. xi+241. (London: Eyre and Spottiswoode (Publishers), Ltd., 1950.) 18s. net.

SOME two years ago, Prof. Norbert Wiener published a book on cybernetics, in which he developed the subject mathematically, mainly with the object of clarifying certain researches in communication-engineering, to which he has made notable contributions.

He now follows this up with a volume more specifically aimed at the layman, and naturally hopes that it will keep its bearing fair and square upon the target (however erratic that target's course may be), as all good cybernetical devices should.

The sub-title "Cybernetics and Society" is appropriate, although we are told much more about the latter than about the former. Steering committees have become accepted in twentieth-century affairs: cybernetics and the whole armoury of calculating machines are means (theoretical and existential) of performing many functions for mankind from without rather than from within. The perils of all this are manifest, and need little emphasis.

Once the outlook is grasped, the course of this book follows almost automatically: entropy, language, semantics, communications, industrial revolutions (two), and the voices of rigidity. That Prof. Wiener has a profound respect for the human being is of the essence of these pages, and on that score alone his work commands both respect and gratitude. What, however, is less obvious—and sometimes a little irritating—is whether or not he is referring specifically to his own country (the United States) or whether his edicts are meant to apply universally. There are several instances wherein one discovers only at the end of a long disquisition that its purpose all along has been strictly limited, whereas whole paragraphs read like sweeping generalizations.

Some of the more physical concepts are especially valuable. One is our natural tendency to concentrate upon the 'islands' of decreasing entropy ("Let us eat and drink, for to-morrow we die", in fact), rather than upon the 'oceans' for which $S = k \log W$. Here 'Baltzmann' for Boltzmann (repeated in the index) is a deplorable slip, although the status of the *Wärmetod* needs some thought at the moment. This is on account of 'open systems' of thermodynamics recently investigated by Bertalanffy and others; they may turn out to be the thermodynamics of the biological world, and hence of major consequence for society and for cybernetics.

Prof. Wiener is forthright about educational matters. We all come under his lash; but the heaviest strokes are reserved for his own country. The present reviewer, however, would like to record his delight—in visiting Prof. Wiener's own institution on two separate occasions—in finding so much provision for the study of the humanities (in the midst of technics), and for the liberal arts; and again, there is the University of Buffalo, straining both its finances and its academic man-power in a noble effort to give individual teaching its highest expression. This, too, encourages the hope that all is not lost.

For the rest, Prof. Wiener's apocalyptic utterances will doubtless bide their time, for they speak of things perhaps unknowable as yet.

F. I. G. Rawlins

BRITAIN'S SCIENTIFIC SHRINES (6)

By ENG.-CAPTAIN EDGAR C. SMITH, O.B.E., R.N.

THE NORTH-WESTERN COUNTIES

AMONG the men of science who passed their lives in the north of England, a special place belongs to the young clergyman Jeremiah Horrocks (1619 ?–41) and his friend William Crabtree (1610–42 ?), the first of mankind to observe the passage of the planet Venus across the sun's disk. Both were Lancashire men, Horrocks being a native of Toxteth, now within the boundaries of Liverpool, and Crabtree a native of Broughton, near Manchester. The story of their achievement is fully told in Grant's "History of Physical Astronomy". From 1632 until 1635 Horrocks was at Emmanuel College, Cambridge. Home again, he became a tutor, then went as curate to Hoole, eight miles south-west of Preston. Crabtree, on the other hand, was a clothier, but by the age of twenty-six was in correspondence with Horrocks. Their calculations led to the prediction that the transit would occur on Sunday, November 24, 1639, and both prepared to observe it, one at Hoole, the other at Broughton. Favoured by breaks in the clouds at the critical time, both were successful and, as Grant wrote: "Thus did two young men, cultivating astronomy together in a state of almost complete seclusion in one of the northern counties of England, enjoy the privilege of witnessing a phenomenon which human eyes had never before beheld, and which no one was destined again to see until more than a hundred years had passed away". What Horrocks might have achieved had he lived longer no one can say, but his early death, on January 3, 1641, must be regarded as one of the great losses to science in Britain. Crabtree also passed away within a year or two, and owing to the upheaval of the Civil War, the papers and correspondence of both barely escaped destruction. Though in a letter sent to King George III in February 1768, asking for assistance in observing the transit of 1769, the Royal Society referred to Horrocks, neither then, nor for long afterwards, was anything done to honour Horrocks's memory, and it remained for the Lancashire gardener, weaver and scientific lecturer, Moses Holden (1777–1864), to erect at his own expense in 1826 a memorial to Horrocks in St. Michael's Church, Toxteth. Later on, in 1859, a memorial chapel and window were added to Hoole Church, and in 1879, when the transits of 1874 and 1882 were attracting much attention, a tablet with an inscription by Dean Stanley was placed at the west end of Westminster Abbey. Four years later, one of the frescoes by Ford Madox Brown in Manchester Town Hall was devoted to Crabtree and his observation of the transit.

Other frescoes in the Manchester Town Hall recall the work of the canal builders, Brindley and the Duke of Bridgewater, John Kay of Bury, the inventor of the 'fly shuttle', and Manchester's most famous man of science, the Quaker teacher, chemist and physicist, John Dalton. There was never any likelihood of Dalton's work being forgotten, for after his death on July 27, 1844, wrote Lord Playfair, "Manchester gave him the honours of a king. His body lay in state and his funeral was like that of a monarch". His massive granite tomb is in Ardwick Cemetery and his statue, together with that of his pupil and successor, James Prescott Joule, stands in the entrance to the Town Hall. Dalton hailed from Cumberland, being born on September 6, 1766, at Eaglesfield, near Cockermouth, and near by in the graveyard of Pardshaw Hall is a memorial to him erected a few years ago by the Society of Friends. Nearly a century before Dalton was born, Cumberland was the birthplace of another famous Quaker scientific worker, George Graham (1673–1751), who was born at Horsgills, in the parish of Kirklinton; but he went to London to serve an apprenticeship, and now lies with his master, Thomas Tompion, in Westminster Abbey, whither he was carried on the night of November 24, 1751, his pall being supported "by Dr. Knight, Mr. Watson, Mr. Canton, Mr. Short, fellows of the R.S., Mr. Catlyn, and Mr. Bird, intimate friends of his". In the eighteenth century, when the majority of British natural philosophers devoted themselves to physical inquiries and astronomy, London was a great centre for clock, instrument and telescope makers, among whom none had a higher reputation than Graham and his follows from the North Country, among whom were John Harrison (1693–1776), of Yorkshire; John Bird (1709–76), a native of Durham; Jesse Ramsden (1735–1800), another Yorkshireman; Thomas Earnshaw (1749–1829), who was born at Ashton-under-Lyne, Lancashire; and Edward Troughton (1753–1835), like Graham a native of Cumberland. The clocks, chronometers, sextants and telescopes of these great artists were found in ships and observatories all over the world. A bust of Troughton is in the keeping of the Royal Observatory, Greenwich, the tomb of John Harrison in Hampstead churchyard was reconstructed in 1879 by the Worshipful Company of Clockmakers, and in 1931 the Company joined with the British Horological Institute in erecting a tablet to Earnshaw outside the church of St. Giles-in-the-Fields, Bloomsbury, where Earnshaw worshipped and was buried. Of the other men of science of whom Cumberland can boast, Dr. William Browning (1711–1800) practised for many years at Whitehaven, where he made experiments on the gases from mines. In 1766 he was awarded the Copley Medal of the Royal Society for his "Experimental Enquiry into the Mineral Elastic Spirit or Air contained in Spa Water", and a few years later assisted Franklin with his experiments on stilling the waves of Derwentwater by the use of oil. Browning died in retirement at Ormathwaite, near Keswick. From Whitbeck in Cumberland came another original and versatile man of science, the Rev. William Pearson (1767–1847), a promoter of the Royal Institution, a founder of the Astronomical Society, and the owner of an observatory at South Kilworth, Leicestershire, of which he was rector for thirty years and in the church of which he has a memorial.

There are other names which might perhaps be included in this brief review of the worthies of Cumberland; but no excuse is needed for recalling that it was at Stoneraise Place, Wigton, on July 2, 1862, that Sir William Bragg was born. From 1923 he was Fullerian professor at the Royal Institution and director of the Davy Faraday Research Laboratory and during 1935–40 president of the Royal Society. He died on March 12, 1942.

Westmorland no less than Cumberland had her mathematicians and experimentalists, among whom were William Gibson (1720–91), a native of Boulton, near Appleby; Adam Walker (1731 ?–1821), who was born at Patterdale; and the blind John Gough (1757–1825), of Kendal. All having taught themselves taught others. Gibson, who had a school at Cartmel in Lancashire, was a correspondent with many other mathematicians; Adam Walker became a successful lecturer on scientific subjects in London and at Westminster, Eton, Winchester and other schools; and Gough, at his school at Kendal, counted among his pupils Dalton and Whewell. Though blind from the age of three, Gough made many contributions to the *Transactions of the Manchester Literary and Philosophical Society* and other periodicals. Among Walker's friends was the painter George Romney, who died in Kendal in 1802, and in the National Portrait Gallery is Romney's picture of Walker, his wife and daughter and three sons, the youngest of whom, Deane Franklin Walker (1778–1865), continued his father's lectures at the great public schools. The contemporaries of Gibson, Walker and Gough included the Rev. Anthony Shepherd (1721–96), a native of Kendal, who became Plumian professor at Cambridge, master of mechanics to George III and canon of Windsor; Bishop Richard Watson (1737–1816), who was born at Heversham and is buried and commemorated in Windermere Church; and Thomas Garnett (1766–1802), of Casterton, who was trained as a surgeon by John Dawson (1734–1820), of Sedburgh, and at Edinburgh, and became the first professor of natural philosophy in the Andersonian Institution, Glasgow, and also the first professor of natural philosophy in the Royal Institution. His early death was due to typhus fever. Watson, like Shepherd, was educated at Cambridge, and though, as he himself admitted, he knew nothing of chemistry, was appointed professor of that subject. The post, however, was admirably filled, and Watson afterwards published volumes of chemical essays. To him the Navy owed its first lightning conductor, a chain of copper rods, one end of which, on the approach of a thunderstorm, was triced to the masthead while the other end was allowed to trail in the sea. Like others, Watson was a pluralist—he held several livings and during 1782–87 was Bishop of Llandaff. He died at his estate, Calgarth Park, Westmorland.

The mention of that rather remarkable character, John Dawson, justifies a short detour from Westmorland to Sedburgh and Dent in the north-west of Yorkshire, for Dawson, overcoming his early lack of schooling, not only became a competent surgeon but also a good mathematician, who saw several of his private pupils become senior wranglers. Among this group was Adam Sedgwick (1785–1873), the great geologist, son of the curate of Dent, in the beautiful Dentdale, which was described in a letter by Airy in 1841 and again by A. C. Ramsay in a letter in 1865, who from "Dent, Kendal" wrote: "to old Adam Sedgwick telling him how pleased I am to be in his old home . . .". Sedgwick was perhaps the most popular man in Cambridge, and Geikie wrote of his "hard featured yet noble face, eyes like an eagle's, manly alike in body and mind, full of enthusiasm, ready and graphic in talk, generous and sympathetic, shrinking from no toil either at home or abroad in furtherance of his chosen branch of science". He was buried in Trinity College Chapel, and his name is perpetuated by the Sedgwick Museum of Geology, in which is his statue.

Entering Lancashire from Westmorland, just across the border are found Whittington, the birthplace of the shoemaker, gunner, experimenter and lecturer, William Sturgeon (1783–1850), who gave the world its first electromagnet, and Lindale, where can be seen the cast-iron column erected to the famous iron-master John Wilkinson, who lies in a cast-iron coffin not far away. Another column, but of stone and fashioned like a lighthouse, can be seen on Hoad Hill, Ulverston. This was erected in 1850 in memory of Sir John Barrow (1764–1848), who, long the secretary of the Admiralty, promoted Arctic exploration and was the virtual founder in 1830 of the Royal Geographical Society. Barrow's birthplace was a small cottage at Dragley Beck, Ulverston, and in this is a tablet recalling his services and referring to the remarkable vigour of his mind. The cottage was presented to Barrow's son, who gave it to the Ulverston Urban District Council together with the plans of the monument on Hoad Hill. Another spot near Ulverston, Lowick, was the birthplace of Dr. Joshua King (1778–1857), another of Gough's pupils. He became a fellow of Queens' College, Cambridge, and died in the President's Lodge; he was the predecessor of Sir George Stokes in the Lucasian chair of mathematics. Sturgeon's career began with his apprenticeship to a harsh and mean shoemaker, but it took him into the Westmorland Militia, into the Royal Artillery at Woolwich, to the East India Company's College at Addiscombe, to the Adelaide Gallery of Practical Science in London, and in 1840 to the Royal Victoria Gallery at Manchester. Known to Dalton and Joule and a contributor to the *Transactions of the Manchester Literary and Philosophical Society*, he died as poor as when he was born, and was buried at Prestwich, near Manchester. In 1847, it is recorded, he gave four lectures on electricity and optics at the Green Dragon Inn, Kirkby Lonsdale, Westmorland, two miles from his birthplace, and in Kirkby Lonsdale Church is a marble tablet to his memory.

If a century ago Sedgwick was the most popular man in Cambridge, William Whewell (1794–1866), who was born at Lancaster, was certainly the most masterful. His energy, learning and influence were immense, and he ruled Trinity College like a captain does a battleship. The son of a carpenter, he attended Lancaster Grammar School, and before entering the University of Cambridge read mathematics with John Gough. From his eighteenth year Cambridge was his home. Sir Francis Galton, who belonged to a younger generation, and who graduated from Trinity College in 1844, in his "Memories of my Life", gave an amusing account of the great man courting Lady Affleck, and quoted the lines:

> "You may roam where you will through the
> realms of infinity
> And find nothing so great as the Master of
> Trinity"

which he had from Lord Kelvin; he also said that readers of Whewell's "Life" would gather from it "little idea of the rough power of the man and his too frequent overbearing attitude. In after days," Galton added, "he invited me to the Lodge, where I found him unexpectedly gracious." To-day, a statue of Whewell stands in the ante-chapel of Trinity College beside those of Bacon, Barrow, Newton, Macaulay and Tennyson, and in Lancaster Church he has a memorial window. Lancaster was also the birthplace of Whewell's famous friend and contemporary, Sir Richard Owen (1804–92), whose destiny took him first to Edinburgh and then to London. Yet another son of Lancaster was Henry Cort (1740–1800), the Navy Agent who revolutionized the wrought-iron industry and gave the new race of engineers and shipbuilders the bars and plates needed for their rails, boilers, engines, bridges and ships. Misfortune dogged his later years, and like many another benefactor who has died poor, he passed away unhonoured and unsung. His grave in Hampstead churchyard long lay neglected, until in 1905 an American citizen, Charles H. Morgan (1831–1911), of Worcester, Mass., a past president of the American Institute of Mining Engineers, found and renovated the tombstone and provided a bronze tablet for the porch of the church at Hampstead and another for the church at Lancaster.

From Lancaster to Preston is a matter of eighteen miles, and at Preston begins the great manufacturing area associated with the eighteenth century pioneers of the textile industry. Preston itself was the birthplace of Richard Arkwright; Blackburn and Accrington were the scene of the early labours of James Hargreaves (1720 ?–78). Bury was the home of John Kay (1704–?), and Bolton the birthplace of Samuel Crompton (1753–1827). Hargreaves appears to have no memorial; but Kay's cottage is still standing and the Bury and District Textile Society is trying to have it preserved. Bolton has long done justice to the memory of Crompton, for his statue stands in one of its squares and his old home, "Hall-i'-th'-Wood", a small timbered mansion, has been preserved through the action of another famous son of Bolton, the first Lord Leverhulme (1851–1925). Horrocks's connexion with Hoole, near Preston, has already been mentioned, and Preston now, in Moor Park, has its own Jeremiah Horrocks Observatory. To the north of the town at Woodplumpton is to be seen the memorial to the clergyman's son, Lieutenant Henry Foster (1796–1831), R.N., who accidentally lost his life in the Chargres River. He had entered the Navy at the age of sixteen as a volunteer, and his scientific work during Arctic voyages had gained for him in 1824 the fellowship of the Royal Society and in 1827 the Copley Medal. In 1828, given the command of the *Chanticleer*, he set out on a long voyage of scientific research from which he never returned.

"At the time of Crompton's birth," said *The Times* on the occasion of his centenary in 1927, "Lancashire was a wild stretch of country and the towns in it contemptible; at the time of his death it was a hive of prosperity." This prosperity was shown by the great increase in population. It is believed that in 1700 the five most populous counties of England were Middlesex, Somerset, Gloucestershire, Wiltshire and Northamptonshire; in 1800 they were Middlesex, Lancashire, the West Riding of Yorkshire, Staffordshire and Warwickshire. With this increase of population had come the construction of canals, the improvement of roads and the speeding-up of traffic. No place felt the impact of the Industrial Revolution more than Manchester, the population of which increased from 22,000 in 1780 to 160,000 in 1824.

It was the beginning of this period which saw, in 1781, the foundation of the Manchester Literary and Philosophical Society, which became almost a Royal Society for the north-west. Since the days of Crabtree, until the middle of the eighteenth century, Manchester had produced few if any notable men of science; but with the founding of the Literary and Philosophical Society it became a centre for the scientifically minded, and the story of the Society and of the College founded by the will of John Owens (1790–1846), and of the University to which the College gave birth, would fill many a volume. But all that can be done here is to recall the beginnings of things and some of the men who brought them to pass. As in so many matters, it was the medical men who set the ball rolling, and the two names most closely associated with the founding of the Society are those of Dr. Thomas Percival (1740–1804) and the surgeon-apothecary Thomas Henry (1734–1816). It was at the house of Percival that the Society was brought into being; it was Percival who was its first president and it was Henry who was its first secretary. Born at Warrington, and a student of the Warrington Academy, where Priestley at one time taught, Percival took his degree of M.D. at Leyden in 1765 and two years later set up in practice in Manchester, becoming known as one of her most public-spirited citizens. He died in Manchester but was buried in Warrington Church. Henry was no less active in the interests of science and the people of Manchester, and when he died he left a son, Dr. William Henry (1774–1836), who, like his contemporary Dalton, added greatly to the fame of the Philosophical Society and gained for himself the coveted Copley Medal. Refined in manner, eloquent in speech, his society was much coveted. "He was an accomplished and original man; one who advanced science and took a prominent place among the chemists of the age." It was in 1794 that Dalton became a member of the Society, and for more than forty years it was his scientific home. Within its walls he taught, lectured, wrote and experimented and was its president from the time of the death of Thomas Henry, being elected each year unanimously save for a single vote—his own! Joule, who was born at Salford in 1818 and died at Sale, Cheshire, in 1889, of course, belonged to a later generation, but it was on him Dalton's mantle fell.

From 1799 onwards, the home of the Society was at 36 George Street, and when the Society in 1931 celebrated its one hundred and fiftieth birthday, it was addressed by Sir J. J. Thomson (1856–1940), who was born at Cheetham, Manchester. At that time it was said that No. 36 George Street "has externally an old world appearance, with pillars in front and a porch finely panelled in mahogany. Internally it is most attractive and preserves an atmosphere of studious calm in a district long ago given up to commercial activities. . . . Of Dalton relics the Society has an unequalled collection." On the night of December 24, 1940, during an air-raid, the building, its memorial tablet to Percival, its busts and portraits of distinguished men, and its library of 50,000 volumes, were completely destroyed, and from the debris all that was recovered relating to Dalton was his watch, a eudiometer and some charred papers. The same fate also overtook the Cross Street Unitarian Chapel, where both the Henrys were buried.

The temptation is to continue the story of the scientific worthies of south Lancashire, and to review the work of the founders of her great chemical industry, to visit the haunts of some of her famous engineers, to trace the birth and development of the scientific institutions of Liverpool and to say something of the interesting Liverpool Observatory and Tidal Institute, which, like the Royal Greenwich Observatory, was founded in the interests of navigation.

But perhaps sufficient has been said of the work of the pioneers in a county which, in more recent times, has seen some of the most notable triumphs of the methods of scientific research of which Dalton and Joule were such masters.

WORLD COMMUNICATIONS: THE IMPACT OF SPEED

THE Division for Social and International Relations of Science of the British Association held an open meeting on "World Communications: The Impact of Speed" in the Pollock Hall, University of Edinburgh, on August 13; Sir Harold Hartley was in the chair.

Sir Edward Appleton, principal and vice chancellor of the University of Edinburgh, opened the discussion by sketching briefly the technical advances of radio which permit intelligence to girdle the earth almost instantaneously. He emphasized that these changes have all occurred within approximately the past half-century. Marconi's morse signals were the first relatively simple step; but even they were capable of trans-Atlantic transmission by the then unexplained natural bonus provided by the Heaviside layer, which reflects radio waves back to earth and continues to zig-zag them around its circumference. It required, however, the development of the radio valve to make the more complicated speech and music signals amenable to transmission.

The importance of research into the reflecting properties of the ionosphere in the technical advance of international radio communications was emphasized by Sir Edward, and he explained how its variation demands the use of compromise wave-lengths the value of which changes over the twenty-four hours. Ionospheric 'radio weather' is subject, however, only to slow and small change, which, after twenty years research, is predictable.

The competition for the short wave bands which girdle the earth is tremendous, because of their unique value to instantaneous world-wide transmission, and this impact of speed encourages disregard of international agreement of wave-bands, especially for purposes of propaganda.

For broadcasting within fairly narrow national boundaries, the medium wave-lengths are favoured. But here the increase of night-range caused by reflexion creates the international interference nuisance, and for this reason very short, non-interfering, escaping wave-lengths are being favoured for broadcasting speech and vision domestically. They would also relieve the congestion on the longer wave bands. The impact of speed is the demand for more people to use more of it.

Concern is being felt about the amount of radio noise and the need to reduce the unnecessary element in it. The prime need for simple code message, speech or television is to convey it untrammelled. There is enough radio noise inherent in broadcasting. In addition, the wastage of radio channel space on propaganda was deplored by Sir Edward, for large areas must be flooded with strong signals to reach inferior receivers. If the speed of radio communications could be accompanied by world peace and co-operation, greater radio efficiency would result. Verbiage in the air could be cut down to advantage, more especially in English. These points emphasized the urge to economy in radio channel space which these much-sought speedy communications demand.

Sir Edward concluded that the disadvantages faced by radio to-day are largely of man's own making. Science is neutral and will continue to seek truth, and, if the impact of speed is to be for good, it is for ourselves to make it so.

Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, followed, tracing the impact of speed in aviation. The 10 miles per hour flight of the Wright Brothers heralded a transport revolution because of hitherto unsurmountable barriers being lowered. But the Wright aircraft was all excrescences, and, as these were shorn away in later types, ever-improving speeds were achieved. Cockpits were built in, struts and bracing wires disappeared, monoplane replaced biplane, undercarriages were retracted, and all manner of gear was built flush in the structure to give the streamlined modern aircraft. But with the streamlining of the aerodynamicist had to come the research of the structural engineer and engine designer to reduce weight as well as drag. With increasing speed comes increasing drag; but an economic margin of pay load and range must be maintained for military or commercial purposes, and the impact of speed is to induce the collaboration of all scientific workers to reduce structural weight, engine weight per horse power and fuel consumption. Metallurgist, structural engineer and aero engine makers have combined to reduce weight, and fuel consumption was reduced until the arrival of 100 octane fuel.

Profile drag has been cut to a minimum by wind-tunnel experiment and the mathematical analysis of results by aerodynamicists.

Despite all these gains in speed, a halt to increase would have come in 1945, but for Whittle's jet engine, with its high thrust and propulsive efficiency increasing with speed, enabling the shock waves near the sonic barrier to be overcome. The propeller-driven aircraft was unlikely to have exceeded 550 miles per hour.

New aerodynamic design with swept-back wing, delaying onset of shock waves, combined with the use of thin wings, slim fuselage, swept-back tail and fin surfaces and jet engines have created the new efficiency embodied in the British Comet transport aircraft, the impact of the speed of which will bring London within 18 hours of Johannesburg.

The historical review of world communications over the past half-century having been traced by the first two speakers, Dr. Edward Warner, director of the International Civil Aviation Organization, considered the impact of speed on contemporary world society, and especially the impact of the aeroplane's speed. Here he gave a warning that increased speed is not the only significant characteristic of air transport. Of all the revolutionary changes in world transport, aircraft spell the greatest flexibility and emancipation from routes and permanent way.

Air transport has created quite new social, economic and political conditions. The 'remote places of the earth' have become economically accessible and new culture contacts have sprung up, with inevitable awakening of interest in world affairs for remote peoples. The aeroplane has brought medical services where there were none before. Commercial relations, economically prohibited hitherto, have flourished, and the aeroplane has become the *raison d'être* for many new communities and for the revitalization or altered status of older ones. This is true even in such densely populated areas as the United Kingdom, as witness the Scottish Islands. This is the more spectacular impact of speed and flexibility in air transport.

Of more consequence is sheer speed between established centres of population and commerce. Transport of persons between such areas may be for personal or business reasons, each with its peculiar consequences. Air transport has eliminated the time-factor as a deterrent to travel or shipment, but economic deterrents remain. Cost per mile compares favourably with other modes of transport, but cost per hour is enormously higher, and for this reason helicopter services, although technically possible, are unlikely to enlarge the dormitory radius of large cities. International tourism has not advanced because of air travel, for although the time-factor is favourable, the cost remains prohibitive, and total trans-Atlantic travel has not, for example, increased with the possible air speed of the journey. Dr. Warner doubted whether an increase in real income in the higher ranges would be accompanied by a proportionate increase in air travel for personal reasons, such as was the case when the motor-car developed. Drastic reduction in cost or increase in income would be required before inter-continental air travellers could be numbered in millions. Goods, even more than passengers, have to be able to stand high freight-rates by air.

Low costs might promote better inter-continental understanding, assuming it is admitted that the thousands of intra-continental air travellers in Europe have promoted goodwill between their nations. Thousands fly between Britain, France, and the Low Countries, but few go thence as far as Peru or Thailand for personal reasons. But travel is no panacea for world relations. The quality of the traveller will be the measure of its success, and the greater the cultural difference the greater is the need for the understanding which the impact of speed can provide. The disadvantage may be that with greater potentiality of range may come a more superficial knowledge of countries and peoples, to the detriment of understanding. The man on the camel may travel slowly, but he has the time to observe and digest. The antidote is in better education and preparation for travel in order to absorb the lessons to be learned abroad.

The greatest consequence of speedy air travel, however, lies in the transportation of statesmen and functional specialists. It facilitates centralization of an authority covering huge areas. It makes for the mobility of the narrow specialist and the meeting of principals of States. With these men time is at a premium and cost is disregarded. It may be that this creates a tendency to enter prematurely into negotiations and is a debatable asset. Here again it is for man to muster the impact of speed on his side and use it wisely. It could be used for promoting the decentralization of government and population, considered by many to be so desirable, to promote healthy regionalism and disseminate cultural amenities.

Among the indubitable benefits of air transport is the ability to respond quickly to an emergency where peace is threatened, and neutral commissions can quickly attend a trouble-spot while negotiation is possible. Greater use may be made of specialist knowledge with this greater speed and mobility. In business it allows quick personal inspection abroad, quick demonstrations in the field, access to remote markets, and should promote the realization of the need for healthy international trade as opposed to domestic protection. The aeroplane had, however, the misfortune to grow up in an era when States were struggling for autarchy, when its military potential made it suspect, and sovereign rights were jealously guarded. Since 1945, prospects have brightened for co-operation, and the further impact of speed envisaged by Sir Ben Lockspeiser might make a critical difference to the travelling statesman.

In the following discussion Mr. Ritchie Calder, chairman of the Division for the Social and International Relations of Science, suggested that the impact of speed demands a geo-psychology—a study of the impact on world society of high-speed communications—and still further, physiological research into the effect of high speed on the ordinary traveller. He doubted whether the effects of speed, psychological or physiological, on the normal man are understood; he remains tense and strained after a long air flight, and occasionally feels after sudden translation that he has left his 'psyche' behind.

Mr. Calder wondered whether much of the bitterness and rancour of international diplomacy may be attributable to physiological and psychological maladjustment, due to the impact of speed, rather than to political irritability. He wished to have enlightenment on whether the repeated 'breakfast-table crisis' creates either an unhealthy and prolonged nervous tension or an equally unhealthy apathy to international danger. He wished for clarification of the impact of speed. He, too, emphasized the neutrality of science, and pointed out that man's lying propaganda on the air can be even more devastating than his misuse of applied science in destructive weapons.

Historically, crises often die naturally before they can be developed; to-day, each international crisis brings immediate and often dangerous reaction. Mr. Calder fears, too, that speedy communications may be to the detriment of local culture, that a uniform and dull standardized culture may result, devoid of all graciousness and pleasing eccentricity. The white light of universal enlightenment includes in its spectrum the colours of all the cultures of the world. He asked whether we can reasonably impose the impact of speed on primitive societies and offer them our neuroses and physical sicknesses with it; he suggested that one of the most serious problems of scientific men is to discover the impact of speed in world communications upon our society.

Prof. D. W. Bronk, president of the Johns Hopkins University and chairman-elect of the American Association for the Advancement of Science, as a physiologist suggested that the questions Mr. Calder had posed are as yet unanswerable, though he doubted whether the 'psyche' is temporarily left behind on sudden translation from continent to continent. The impact of speed certainly demands of man quick decisions on his day-to-day problems, and a quickening in his mental reactions; but he also made it clear that the essentials for bringing world order from chaos are present if we chose to use them. The same swift aeroplane can bomb an enemy or carry a sick friend to a remote hospital.

Prof. A. V. Hill, president-elect of the British Association, then gave a warning that there is a limit to the rate at which man can accommodate himself to faster travel. On foot, man has improved on the mile running record by 12 seconds, in the same time as he has taken to change from 10 miles per hour to 600 miles per hour flight. The effect of such rapid change is bound to be tiring and inconducive to sustained first-class work. He mentioned that the accelerated process of burning frequently becomes an uncontrollable conflagration, and left his listeners to draw their own conclusions. Isolated wars and isolated diseases may now, with the impact of speed, get quickly into the general circulation with disastrous results. Speed has explosive tendencies and man should inquire into and attempt to control such tendency.

Dr. L. B. Cacciapuoti, deputy-director of the Social Science Department of the United Nations Educational, Scientific and Cultural Organization, winding up, struck a hopeful note, suggesting that the impact of speed will make for the quicker and wider dissemination of scientific knowledge in a manner similar to that following on the development of the art of printing. The impact of speed means that associations of scientific workers may now congregate from the corners of the earth, and with radio communication and air transport, no man of science need find the latest developments or the greatest men inaccessible to him. Such easy access to discuss calmly, with the aim of seeking truth about natural phenomena, promotes fraternal feeling transcending artificial political and racial barriers. Dr. Cacciapuoti's fear is that over-specialization may defeat this end by losing sight of the wholeness of science; but here again he hoped the impact of speed would overcome the difficulty, by spreading scientific knowledge, below technical specialization, but at a high level. He professed great faith in the potential for international association of men of science which the impact of speed on world communications makes possible, and in which he trusted lies the germ of world peace and understanding.

JOHN MACPHERSON

HISTORY OF CULTIVATED PLANTS

A SERIES of papers on cultivated plants, with special reference to their origins and histories, was given in Section K (Botany) of the British Association at the recent Edinburgh meeting.

Sir John Milne Home opened with a discussion of the introduction of exotic conifers into Great Britain and their influence on forestry. Several of these have been long established in Britain; thus, the Norway spruce (*Picea abies*), which is suited to the rainfall, was introduced about four hundred years ago. Other species long known in cultivation in the British Isles include the sitka spruce, Japanese larch, Douglas fir, giant silver fir, western hemlock and the western arborvitæ. More recently many species have been, and are being, given trials; but their value as forest trees in Britain remains more or less uncertain. Included in this category are the Monterey cypress, the Serbian and oriental spruces, two firs (*Abies amabilis* and *A. nobilis*), and the giant redwood. Many of the new introductions thrive well under certain conditions, but have limits to their sylvicultural value. Exotic conifers have had a great influence on British forestry, and this may be increased in the future.

Mr. J. M. S. Potter dealt with the history of the apple. It is not possible to say exactly where the cultivated apple originated; but it spread through Europe from east to west. *Pyrus malus* (*Malus communis*) was certainly one of the most important of its ancestors; but botanists are not entirely in agreement regarding the classification of the subdivisions of this aggregate species. The Romans may have introduced the cultivated apple to Britain. It was widely grown in monastery gardens, and since the monks were in contact with monasteries on the Continent new sorts of apples were frequently introduced. South-east England, from its nearness to the Continent and by the immigration of refugees, became a centre of fruit-growing in Tudor times. Many names of cultivated apple varieties are of French or Flemish origin. The distribution of apple cultivation on a commercial scale in Britain largely depends on ecological factors; dessert apples are mainly grown in drier areas, since fungal diseases can be more easily controlled than where the rainfall is heavy. Turning to more recent times, T. A. Knight may be regarded as the father of fruit breeding. In 1894, Pickering, at Woburn, started the first modern studies on fruit research in Britain, and in the succeeding years three institutions dealing with research in fruit were founded: the Long Ashton Research Station in 1903, the John Innes Horticultural Institution in 1910, and the East Malling Research Station in 1912. Apple cultivation has been revolutionized by studies on rootstocks, fertilizer treatment, pruning methods, general orchard practice, diseases and pests, fertility and sterility, and the breeding of new varieties. It remains to be seen if scientific research will result in the production of varieties better than those left to us by our forefathers.

The subject of olives was considered by Dr. W. B. Turrill, who said that both the wild and cultivated plants are characteristic of the countries bordering the Mediterranean Sea. The cultivated olive is of very great importance to the countries of southern Europe, northern Africa and western Asia for its fruits and the oil produced from these. Before the Second World War the area covered by olive plantations was estimated at 22,580 square miles, yielding 160,000 tons of oil and 20,000 tons of fruit for table use. Spain, Italy, French North Africa and Greece were the largest producers in the order named. *Olea europæa*, the common olive, is an evergreen tree up to fifteen metres in height or a shrub. Its opposite leaves are narrowly elliptic to linear-lanceolate of a subdued green on the adaxial and whitish grey on the abaxial surface. Its small white flowers are produced in May, and the best oil comes from the pulp of the drupes. The tree requires warm, well-drained soil, and responds quickly to proper treatment, especially to pruning. A large number of varieties, based on fruit shape, have been named and described. These are mainly propagated by vegetative means, and the varieties, as with so many other cultispecies, therefore occur as clones. The wild olives of the macchie, usually referred to as var. *oleaster*, are a heterogeneous assemblage, a mixture of microvarieties that need detailed cytogenetical investigation. The two or three published records of chromosome counts give $2n = 46$; but all are based on cultivated material.

About eighty-five species have been described within the genus *Olea*; but recent research shows that many of these are not valid species. The genus is mainly tropical, apart from *O. europaea*, and ranges through tropical and south Africa, the Mascarenes, western China, the Indian subcontinent, Malaya and Australasia. It does not occur in the New World. *Olea chrysophylla*, to which several species have been reduced, has the widest range throughout the greater part of Africa south of the Sahara and in Asia from Afghanistan to western China. In the Sudan and the southern Sahara there are plants intermediate between *O. chrysophylla* and *O. europaea*, and others occur also in Madeira. In particular, specimens named *Olea laperrini* from the Hoggar Mountains and from Jebel Marra are of great interest.

The place, time and immediate ancestry of the cultivated olive are unknown. It is frequently referred to in the Old Testament and in ancient Greek literature. The legends of Greek mythology point to its origin outside Greece and its introduction as a plant already in full cultivation. In ancient Egypt, the olive was certainly known, even in pre-dynastic times, and recent archæological evidence suggests that it was of greater importance than was formerly thought. Unfortunately, there is no known reliable evidence of *Olea* as fossils, and the few cytological studies published throw no light on the origin of the cultivated olive. After a careful consideration of various possibilities, it is concluded that *Olea europaea* may have arisen from *O. chrysophylla* in northern tropical Africa and that it was introduced into the countries of the Mediterranean Basin via Egypt and then Crete or Palestine, Syria and Asia Minor.

In outlining the history of the more important cereals, Dr. G. D. H. Bell pointed out that the chief centres of origin of these are the Mediterranean basin, Persia, Abyssinia, far-eastern Asia, south-eastern Asia, central Asia, and South America. These centres for the most part coincide with areas of ancient civilization. The genera mainly considered by Dr. Bell were *Triticum*, *Secale*, *Hordeum* and *Avena*. The oats are taxonomically quite distinct from the first three of these genera, for which a prototype with $2n = 14$ chromosomes has to be postulated. In the genus *Triticum*, mutations gave rise to various species and were followed by polyploidy. Wheat, however, did not evolve within the one genus. A cross between a diploid *Triticum* and a diploid *Agropyron* followed by allopolyploidy gave the chromosome number of $2n = 28$. A second intergeneric cross between a *Triticum* with $2n = 28$ and an *Aegilops* with $2n = 14$, again followed by chromosome doubling, gave the important wheats with $2n = 42$. Cytogenetical researches on barley and rye have thrown much light on the constitution and origin of these cereals; but the history of cultivated oats is less well understood in spite of the fact that they are of more recent origin than the other plants here considered. The infinite range of morphological and ecological types of the cultivated cereals was emphasized.

Dr. J. G. Hawkes reminded the meeting that the potato was introduced into Europe at the end of the sixteenth century and was regarded as one species until the early part of this century. Now about fifteen species are recognized in place of *Solanum tuberosum*. The basic chromosome number of these is $x = 12$. South Peru and north Bolivia, centres of ancient Andean civilizations, are included in the range of the *Tuberosa* series. Chromosome numbers ranging from diploid to pentaploid occur in the cultivated potatoes and to hexaploid in wild species. Probably wild tetraploids were taken into cultivation. In nearly all areas of western South America there occur wild potatoes with long stolons. These grow in places where competition with natural vegetation is not great and where the soil is rich in nitrogen. Hence they take full advantage of areas disturbed by man. They survive from one season to the next by pieces of the long stolons being left behind in the soil by the early users of the tubers. The original ancestor of the cultivated potato, however, probably no longer exists—it was all taken into cultivation. No doubt the modern potatoes show little resemblance to the first cultivated plants.

ANIMALS AND FORESTRY

SECTIONS D (Zoology) and K* (Forestry) of the British Association held a combined symposium at the recent meeting in Edinburgh in order to discuss the relation of animals to forestry. Dr. F. Fraser Darling, a member of the Scottish Committee of Nature Conservancy and formerly director of the West Highland Survey, opening the symposium with a contribution on mammals, said that the relation of mammals to forest growth is a critical one, for its survival or extinction, and it is one of the most dramatic complexes in Nature. The advent of pastoral, agricultural and civilized man has complicated the situation ecologically. Forests are either climaxes or stages well on the way to the climax, a feature of which is the increasing variety of organic forms and degree of stability. This stability may be interpreted as self-regulation, and the biological system becomes a continuum. Climaxes are constantly being broken by natural catastrophes such as hurricane and fire, but in limited areas, so that the set-back in ecological succession creates edge effects and allows the continued existence of forms which could not endure in the absolute climax. The over-all biological picture is enriched by periodic natural catastrophe.

The profound benign or depressive influence of mammals in the natural chequerboard of climax forest, secondary growth and primary colonization is clearer if the animals are classified according to what they do—predators, browsers and grazers, rodents and insectivores. The predators as a group, of which several species have been lost by extinction, form the insurance company, ensuring the forest as a continuum by controlling the populations of rodents and grazers and browsers. The insectivores share with birds and predatory insects the control of invertebrate populations which tend to depress forest growth. Control is never absolute and no one species is critical; control rests with the complex. The depletion of the predators in the interests of particular forms of land use has endangered the maintenance of old forests and is a grave handicap to the establishment of new ones. Dr. Darling suggested that human ingenuity is not yet equal to controlling small rodents in an extensive habitat, for example, wood mice (*Apodemus*) and squirrels. Their vast numbers and fecundity, their smallness and capacity for evasion are too much for us. A good and varied stock of small carnivores is not only our best insurance but also the cheapest.

The grazers and browsers are comparatively few in numbers, but represent a considerable bio-mass. Although depressive to forest, a low density (the ratio of 1 red deer to 133 acres or thereabout in the Forest of Fontainebleau was cited) may be positively useful. Nevertheless, said Dr. Darling, it is doubtful whether the new artificial forest of Britain can endure the red deer, or even the fallow. Natural forest as a continuum, used by man on a selective felling basis, can accommodate deer with advantage, but not the plantation intended to be clear-felled and replanted. Some North American forests were described, where the upset in natural predation on deer is leading to some serious situations through over-population. The success of Theodore Roosevelt's promotion of the sporting and sentimental status of deer has been immense in the United States, but there is a lag in public opinion between the conditions of scarcity half a century ago and those of the present day when, in a country of much secondary growth, there are probably more deer than there have ever been before. Dr. Darling asked for much more enlightened critical appreciation of forest health, which would make us sensitive to damage in woodlands before situations become irremediable. The animal populations are more flexible than the forest habitat. The deer-forest era in Scotland, which encouraged an artificially high density, was responsible for the slow death of much natural forest. Forest growth in our day needs constant and highly skilled wild-life management, and the woodlands of Britain are not getting it. The wild-life complex is an immanent entity, benign in habitat maintenance if it is in a state of gentle oscillation, but a menace to our own survival if a warped complex begins to oscillate violently and percussively.

Mr. J. M. D. Mackenzie, formerly of the Indian Forest Service, described his work with nest boxes for birds in woodlands in Britain. The 1⅛-in. hole is desirable for many small species, and, though orientation is important, a clear fly-way to the box is more so. A desirable height for small boxes is 5–6 ft.; but the degree of human interference makes a height of 10–15 ft. much safer. There are specific preferences, for example, a concave bottom is essential for woodpeckers, which do not use nesting material. To get optimum numbers of birds (that is, below the level of intra-specific competition) a fifty per cent surplus of boxes is desirable. Spacing is important, not only for the species of birds but also for the size, species-type and age of the woodland. Mixed forest cut on a selection basis carries the biggest and most varied populations, a finding in line with Dr. Darling's remarks.

The employment of nest boxes, said Mr. Mackenzie, can throw light on problems of distribution, in that it would seem that the presence or absence of nesting sites is often crucial when food may appear abundant. The spread of the pied flycatcher is an interesting example in that this is a species on the increase, but one which has occupied some valleys only after the provision of boxes. The flycatchers arrive in Great Britain when other species have already occupied most of the nesting sites. Interspecific competition is real. In 1947, after the hard winter, resident tits using boxes in the Forest of Dean fell from 54 to 20. Migrant flycatchers rose from 39 to 54, doubtless taking advantage of vacant sites.

Mr. Mackenzie's paper, which was accompanied by interesting comparative graphs, showed that the careful use of nest boxes and the results to be obtained from them after a series of years can be useful tools in the hands of the investigator into problems of forest ecology involving the dynamics of avian populations and their insect prey—a field in which there is little certain knowledge at the present time.

Dr. R. N. Chrystal, of the Department of Forestry, University of Oxford, dealt with the role of insects in forestry. He divided the forest regions of the world into those of temperate and tropical regions, indicating that the temperate forests consist of large areas of conifers of various kinds, some pure hardwood stands, such as oak, beech and birch, and some mixtures of conifers and hardwoods, whereas the tropical forests consist mainly of mixed stands of hardwoods of varying types. The insects can be classified into clearly recognizable biological types—defoliators, bud and seed borers, bark and wood borers, and the immense host of predators and parasites which attack the other insects at all stages of their lives. Insect control, indeed, largely rests with the predatory and parasitic Hymenoptera and Coleoptera.

Insect attack on the growing stand is most obvious in the temperate regions and particularly in solid coniferous forests. It is much less severe in mixed conifer–hardwood stands and at a minimum in hardwood areas. Insect attacks on the highly complex mixtures of tropical jungle forests are negligible. Thus, Dr. Chrystal expressed in his own way the principle emphasized by Dr. Darling and endorsed by Mr. Mackenzie, that the climax mixed forest as a continuum can accommodate a vastly richer fauna than the coniferous stand which in Nature is but a successional phase. Dr. Chrystal drove his point home in discussing the plantation forestry which is being established in Britain, in parts of Europe and in the Antipodes. Faulty choice of species may lead to failure through insect attack—for example, silver fir in some parts of Britain and Denmark—and if we see things aright, such attacks should be looked upon as indicators of unsuitability of site rather than an uncomplicated building-up of insect assault. The artificial coniferous plantation is a hostage to fortune from the nursery to maturity, insects becoming pests which are innocuous in the natural forest. The wood wasp *Sirex* is attacking *Pinus radiata* in New Zealand and acts as carrier of a fungus which helps to cause death of the trees. The present laborious method of trapping *Hylobius* and *Hylastes* beetles with fresh pine logs and bark is quite uneoological and must be looked upon as a makeshift until forestry establishment itself adopts ecological principles.

Britain has as yet suffered little compared with some of the coniferous forests of Europe and North America, and the root causes of insect attacks in these places has still to be accurately determined. Hurricanes, for example, favour virulent attacks on the fallen trees by several species of Coleoptera. Human warfare, causing neglect of forest hygiene, must also be considered as a contributory factor in the large-scale attack of bark beetles in the forests of central and southern Europe. Fire damage in the Landes of Gascony has helped to establish the conditions for attack by the spruce bark beetle, *Ips typographicus*. Conversely, killing attacks of bark beetles of the genus *Dendroctonus* increase fire risk. Drought is another predisposing factor to the build-up of beetle attack. The intermixture of aspen and birch with conifers is now recommended in America, and we are gradually reaching the notion in Great Britain that a conifer–deciduous ratio must be determined and put into practice. All would agree with Dr. Chrystal that such a departure from the pure stand would be as pleasing to the eye as it would be some insurance against fire and insects.

Mr. A. B. Duncan, a landowner and member of the Nature Conservancy, discussed birds in relation to forestry and reached the conclusion that they are of little importance. He confessed to a greater interest in forestry in relation to birds, and described vividly the different associations of birds characteristic of different kinds and phases of forests and plantations. From the pipit–wheatear–merlin association of the bare moor, the very young plantation passes to the short-eared owl–kestrel association when voles are the prey, on to the willow warbler–yellowhammer grouping and then the tit–chaffinch–wood-pigeon–crossbill phase. Prof. H. G. Champion, of Oxford, emphasized in discussion that as forestry gets into going order in Britain all these phases will be in evidence, and there should be no impoverishment of the avian fauna by destruction of habitat.

Sir Henry Beresford-Peirse, in summing up, remarked that the fact which crystallized from the symposium was the widely ramifying consequences of interference by man, and that we had much to learn as to how our inevitable continued interference might be wisely done.

SEPARATION OF STABLE ISOTOPES BY ELECTROMAGNETIC MEANS

By W. D. ALLEN

Atomic Energy Research Establishment

DURING the War, the urgent need for large amounts of fissile material led to developments which, under peace-time conditions, would have matured much more slowly, if at all. Among these developments was the electromagnetic separation plant at Oakridge[1], based upon the research and development at Berkeley under E. O. Lawrence. Before the War, the production of ion beams (usually proton beams) of currents up to a few milliamperes was a normal laboratory problem: also the analysis of ion beams in the mass spectrometer, with mean currents of 10^{-10} amp. The production of large amounts of uranium-235, however, can be achieved only by developing much larger currents at high resolution: and the accomplishment of this in the space of two to three years represented a remarkable achievement.

Since the War, some of the plant at Oakridge has been used for the separation or enhancement of a wide range of elements in quantities ranging from one to several hundred grams[2]. At Harwell, a small separator has been operating since 1948 on the separation of milligram quantities of the lighter elements, chiefly boron and lithium. In 1950 a larger plant, based in broad principle on the Berkeley design, began separation. In Denmark, and also in Sweden, two small separators have studied problems chiefly concerned with gaseous isotopes; and in Holland, a medium-sized separator is nearing production.

As regards the description of the American project, some of the fundamental research reports on the ion source have been collected together by Guthrie and Wakerling ("Characteristics of Electrical Discharges in Magnetic Fields." U.S. National Nuclear Energy Series, vol. 1-5); but most of the technical detail is still classified. Some general comments about the quality of the products may, however, be made, together with a description of the types of experiments in which separated isotopes have been used.

Comparison with Other Methods

The performance of the present larger electromagnetic separation plants is that some tens of grams of almost all polyisotopic elements can be separated into enriched isotopes, the enrichment factor of which varies between approximately 20 and 1,000. As compared with other methods, the greatest advantage of this process is its versatility; in effect, the separation can be undertaken in a single stage of any element of which a vaporizable compound can be fed into the ion source. This means that almost all elements, except for a few in the platinum and rhodium groups, can be readily subjected to analysis. The other major advantage of the electromagnetic method is that all isotopes can be collected simultaneously: the range of mass is never very great (calcium, with six isotopes ranging from 40 to 48 has the widest relative spread), so that, provided the system of focusing covers a moderate range of mass, all the isotopes can be collected simultaneously—in theory. In practice, this sometimes involves minor technical difficulties; for the heavier elements, for example, the relative separation of neighbouring isotopes is small, and the close juxtaposition of many collectors is not easy. However, the difficulties are negligible compared with the problems which would be encountered in enhancing, say, some of the intermediate-weight tin isotopes by methods other than the electromagnetic method.

All other major methods of isotope separation which have been put on a practical basis (diffusion; thermal diffusion; electrolysis and fractional distillation; and chemical exchange) depend by contrast on the development of plant in which the enhancement per stage is small but the number of stages is large. Some of the methods have limited versatility; methods of diffusion and thermal diffusion, for example, are generally applicable to elements which have gaseous compounds and few isotopes. In general, however, a special method has to be worked out for each element: chemical exchange for nitrogen, fractional distillation for carbon (as carbon monoxide), thermal diffusion for helium, etc. Once these plants have been set up and developed, however, the running costs are very much less than the costs of producing parallel quantities by electromagnetic separation. Boron, for example, can be separated by electromagnetic methods; but the beam currents are not high, even compared with other elements, in the electromagnetic process, and the costs per gram are very large compared with boron enriched by other methods.

Enhancements

For most applications of separated isotopes, the degree of enhancement (or enrichment) is the most important factor of the separation process. For a two-component system, we define C, the concentration, as the fraction of the isotope compared with the element as a whole; and the isotope ratio as $C/(1-C)$. Then if C_0 is the initial concentration, and C_1 the final, the degree of enhancement is defined as the ratio of the isotope ratios after and before enrichment, that is

$$\left(\frac{C_1}{1-C_1}\right)\cdot\left(\frac{1-C_0}{C_0}\right).$$

Thus, an isotope of initial concentration 10 per cent enriched by a factor 500 has a final concentration of 98·2 per cent; an isotope of natural concentration 1 per cent enriched by a factor of 100 has a final concentration of 50 per cent. For a multicomponent system (several elements have eight isotopes), such a definition is obviously over-simplified; the accurate description of the enriched sample can only be given in terms of a complete isotopic analysis. However, the enrichment factor, defined above, is still a useful criterion of the quality of the product.

In the electromagnetic separations at Harwell and Oakridge, the enhancements are not infinite, and the products are better described as enriched rather than separated. The enhancements for isotopes of large relative mass separation (lithium-6 and -7) are rather more than 1,000; but if the relative mass separation is small, the enhancements are considerably less, and, while they vary widely from element to element, are usually in the range 20–200. There are several reasons for this: they are all bound up with the fact that one is trying to get quantity separation at high resolution, and in general a compromise must be made. On the whole, however, quality counts for more than quantity, and it is better to reduce output in favour of improved enhancement.

Since the enhancement of the average isotope is not infinite, it might be asked why methods of re-cycling once-separated isotopes cannot be employed. This might be reasonably possible with the isotopes naturally most abundant, where the quantities collected can run to the order of tens of grams. The demand for high enrichment, however, usually applies to the rarer isotopes; and the quantities of these available when initially separated are usually insufficient for re-cycling—or, more precisely, the demand does not justify the effort involved.

Applications of Separated Isotopes

The availability of separated isotopes has opened up many lines of study, the chief of which may be summarized under the following headings.

Nuclear physics. The chief applications of separated isotopes are in nuclear physics. Of the various properties of the individual nucleus, the charge, determining the chemistry of the element, is only one; the spin, the electric quadrupole moment of the nucleus, the energy levels, etc., will vary from isotope to isotope of any given element. For the lighter elements, of course, which have relatively few isotopes, a qualitative picture can be built up without separated isotopes, but a complete analysis of individual properties is difficult. With separated or enriched isotopes, however, the properties of individual nuclei can be studied without difficulty; and, since for most of these studies only small quantities are required, the relatively low output of the electromagnetic plant, as compared with other separation processes, is not a serious limitation.

A good illustration is the example of boron. As noted above, boron enriched in boron-10 is widely used as a neutron detector, having five times the sensitivity as a detector containing the same quantity of natural element. The quantities required are relatively large, and would prove very costly to provide by electromagnetic methods. For studies of the nuclear properties of boron, however, films of only some 100 μgm. per sq. cm. are adequate; and, as boron is deposited from the electromagnetic beam without sputtering, targets can readily be prepared for nuclear analysis. The latter property is a fortunate accident, since boron is an active element at high temperatures, and the preparation of boron films by evaporation is difficult. Films made in this way at Harwell have been used in several studies, including the ($\alpha\gamma$) correlation in the reaction ${}^{10}\mathrm{B}(n,\alpha){}^{7}\mathrm{Li}$ [3], the Q-value of the ${}^{10}\mathrm{B}(p,\alpha)$ [4] reaction, nuclear-levels determined in $\mathrm{B}(d,n)$ [5] and $\mathrm{B}(p,\gamma)$ [6] reactions, and so on. The example of boron has been singled out, but it could be amplified by many references to work on nuclear reactions with isotopes of light or intermediate mass. For those elements which have as many as ten isotopes, it would appear that accurate quantitative work will normally be impossible without highly enriched isotopes.

Enriched isotopes are sometimes used in the study of reactions where it is important not only to eliminate competing reactions but also to concentrate a relatively rare isotope. For example, the quantity of lithium salt which can be loaded into a photographic plate is limited; so that, by using lithium enriched in lithium-6 (natural abundance 7 per cent) the study of a reaction such as ${}^{6}\mathrm{Li}(\gamma,n){}^{5}\mathrm{Li}$ is considerably facilitated[7]. Similarly, in recent accurate work on the Q-values of reactions in light nuclei, the use of enriched isotopes magnesium-25 and 26, silicon-29 and 30 (natural abundances 10, 11, 4·7 and 3 per cent respectively) has enabled the intensity to be maintained with thin targets, and the accuracy of experiment thereby held the same as for the abundant isotopes[8].

As regards overall surveys of the properties of nuclides, a study has recently been published of the neutron scattering due to individual isotopes[9]. When the scattering amplitude is plotted against atomic weight, a curve showing quasi-resonance effects is obtained.

Another interesting field for the application of concentrated rare isotopes is the study of weak natural radioactivities. Thus, the products of Oakridge have been used to establish that the natural radioactivity of indium is due to indium-115 [10]; that the natural alpha-activity of samarium is due to samarium-147 [11]; and have promoted several studies in potassium-40 by enriching it from the natural concentration of 0·01 to 7 per cent[12].

Spectroscopic work. Various types of spectroscopic study can be carried out with the aid of enriched isotopes. There are several examples of rare isotopes of odd atomic weight, the study of the hyperfine structure and spin properties of which has been made difficult by the presence of their much more abundant neighbours of even atomic weight. By using the separated rare isotope, the Copenhagen group has studied the hyperfine structure properties of neon-21 and krypton-83 [13]. As regards the even atomic weight isotopes, the availability of enriched isotopes makes possible a detailed study and survey of the little explored phenomenon of isotope shift. Finally, the concentration of individual even isotopes makes possible the availability of better standard wave-length light sources. Thus, mercury and cadmium have been widely used as wave-length standards: mercury has seven isotopes and cadmium eight, so that in both there is broadening of the lines by isotope shift due to the even isotopes and (generally) hyperfine structure for the odd isotopes. Mercury-198 formed by pile irradiation of gold has been for some time used as a light source free from these defects; but other even isotopes (mercury-202) have recently been separated[14], as a more abundant supply, and krypton-84 has been used for similar purposes[15].

Medical applications. The high cost of separation makes stable isotopes too expensive an item for most medical experiments; one application, however, is a promising exception. Natural iron (iron-54, 56, 57 and 58), when irradiated in a pile, produces radioactive iron-55 and 59. Iron-59 has a half-life (46 days) which makes it suitable as a tracer in experiments with human beings; iron-55, while satisfactory for general biological experiments, has a half-life (four years) which makes it a hazard in experiments on humans. Attempts to obtain iron-59 from pile-irradiated cobalt have proved difficult, owing to the high concentration of cobalt-60. If, however, one forms a 'source' of iron-58, from which the exclusion of iron-54 by electromagnetic separation is easy, then the iron-59 produced by pile irradiation can be extracted by a Szilard–Chalmers process, and the bulk of the iron-58, by repeated irradiation, is eventually converted to iron-59. In this way an adequate supply of suitable radioactive iron is made possible.

Superconductivity. Isotopic effects are usually confined to nuclear interactions, but a recent discovery by Serin, Reynolds and Nesbitt[16] has shown a variation in the superconductive transition temperature of mercury with variation in mean isotopic mass. This effect has been confirmed in Britain and in America[17] by using the separated isotopes of tin, and the theoretical prediction, $T \times m^{1/2} =$ constant, has been approximately confirmed. The British results suggest that possibly the exponent of the mass factor is slightly less than ½.

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OBITUARIES

Dr. Yoshio Nishina

The death occurred on January 10, at the age of sixty, of Dr. Yoshio Nishina, president of the Scientific Research Institute, Ltd. By his death, the Japanese scientific world lost an eminent leader.

Dr. Nishina was born on December 6, 1890. Graduating from Tokyo Imperial University in 1918, he entered the Institute of Physical and Chemical Research. In 1921 he went to Europe to study at the Cavendish Laboratory, Cambridge, under Lord Rutherford, then at the University of Göttingen, and later at Copenhagen under Prof. N. Bohr. While working in Copenhagen during 1923–27, he published several important papers, such as "Study on *L*-series X-ray Absorption Spectra of the Elements from Sn to W", "Study on the Effect of Chemical Combination upon X-ray Spectra", and "Study on Quantitative Chemical Analysis by X-ray Spectroscopic Method". Collaborating with Dr. O. Klein, he calculated the scattering cross-section of hard X-rays by a free electron and deduced the well-known Klein–Nishina formula in 1928. In November 1928, he returned to the Institute of Physical and Chemical Research by way of the United States and initiated the pioneer work in the fields of cosmic rays and nuclear physics in Japan.

In 1937 Nishina constructed a 27-in. cyclotron to pursue nuclear research. One of his investigations in this field was to assign the elements ruthenium, rhodium, palladium, silver, cadmium, indium, tin and antimony to fission products of uranium and thorium. He showed that uranium-237 is produced from uranium-238 and uranium Y from thorium-232 by the $(n, 2n)$ reaction. The mechanism of metabolism of plants and animals was studied, using radiosodium and radiophosphorus as tracer. In 1944 a 60-in. cyclotron was constructed by which 18-MeV. deuterons could be produced. Nishina flew to Hiroshima and Nagasaki to investigate the effects of the atomic bombs just after the explosion in 1945.

He was also interested in cosmic ray research. He measured the intensity of cosmic rays in 1944 in the Shimizu Tunnel at a depth equivalent to 1,400 m. of water. The continuous measurement of cosmic ray intensity which is still being carried on was started by him in 1935.

Theoretical physics in Japan also owes much to his leadership.

Dr. Nishina was appointed as the first president when the Institute of Physical and Chemical Research was reorganized as the Science Research Institute, Ltd., in 1948. In 1949 and 1950 he visited Copenhagen and the United States as a representative of the Japan Science Council. As president of the Scientific Research Institute, Ltd., as vice-president of the Japan Science Council and as president of the Japan Federation of Unesco Cooperative Associations, his activities were many and varied.

His death is a great loss not only for the rehabilitation of science and technology in Japan but also for her progress in general. KENJIRO KIMURA

Sir Frank Lindley, C.B.

SIR FRANK LINDLEY, who died at Ditchling on August 15 at the age of seventy, spent practically the whole of his working life in the service of the Patent Office, of which he was comptroller-general from December 1932 to September 1944.

He was educated at Brighton Science School and graduated with an honours degree in physics at University College, London. After entering the Patent Office in 1903 he studied law and also found time to take part in student activities at Birkbeck College. When reading for the Bar he was elected Barstow Law Scholar, took a University scholarship in the LL.B. examination, and became a King Edward VII research scholar of the Middle Temple. He became a senior examiner in the Patent Office in 1922, transferred to the Trade Marks side as assistant comptroller in 1926, and succeeded Sir William Jarratt as Comptroller-General of Patents, Designs, and Trade Marks in 1932.

The earlier period of Sir Frank's comptrollership was dominated by the dual tasks of administering the recently passed Patents Act of 1932, which extended the official search for novelty of inventions to general literature, and taking a very active part in the reform of the Trade Marks law which resulted in the passing of the Trade Marks Act of 1938. The later period was dominated by administration of the Patent Office in war-time when, in spite of bomb and fire damage and much devastation, the work of the Office was carried on continuously. During this period he worked unsparingly at settling the terms of licences for working enemy-owned patents and copyrights, and in dealing with emergency legislation in all branches of Patent Office work. After retiring from the Patent Office he acted for two years as scientific adviser to the Appointments Department of the Ministry of Labour and National Service, in spite of failing health. He endured the progress of Parkinson's disease with conspicuous courage and was bravely upheld by Lady Lindley, whom he first met at Birkbeck College and who survives him with a son and daughter.

NEWS and VIEWS

Dr. Elizabeth A. Fraser

With the departure of Dr. E. A. Fraser, the Department of Zoology at University College, London, loses its member of the longest standing. When she joined the Department as a student in 1905 it was headed by E. A. Minchin; but it was under his successor J. P. Hill that she began those original studies in vertebrate development which have been her chief scientific interest ever since. This work has, among other things, contributed much to our understanding of the evolutionary morphology of the excretory organ of the vertebrates, and has provided the basis of our knowledge of the segmental structures of the marsupial head. All her work shows the accuracy and care in minute observation that is an important part of the heritage of classical embryology. With this she combines an appreciation at once sympathetic and critical of the schools of experimental morphology that has served as an admirable stimulus to her many students. Past students of the Department have, indeed, much to thank her for. Whether as assistant, senior lecturer, reader, acting head of the Department (during its war-time evacuation), or since the War as an honorary research associate, she has followed their progress with helpful interest and has never spared herself in their service.

John Kidd, F.R.S. (1775–1851)

John Kidd, who died a century ago on September 17, 1851, studied medicine at Guy's Hospital, London, and in 1801, after graduating, was appointed reader in chemistry in the University of Oxford. He held the Aldrichian professorship of chemistry from 1803 until 1822, when, through the influence of his former teacher, Sir Astley Cooper, he became regius professor of medicine. He was also physician to the Radcliffe Infirmary and, though he had a large private practice, found time for chemical, geological and mineralogical pursuits. He published "The Outlines of Mineralogy" in 1809 and enriched the Ashmolean Museum's collection of geological specimens. A Fellow of the Royal Society, Kidd's contributions to the *Philosophical Transactions* included an "Essay on the Spontaneous Production of Salt-Petre" (1815) and a paper on "The Anatomy of the Mole-cricket" (1825). Elected keeper of the Radcliffe Library in 1834, he supervised the compilation of the section on medicine and natural history of its catalogue. His Bridgewater treatise "On the Adaptation of External Nature to the Physical Condition of Man" (1837) reached its sixth edition in 1852. Kidd's dislike of ostentation led him to abandon the wig, large hat and gold-headed cane, beloved of his medical colleagues at that time.

Nuffield Foundation Grant for Research at King's College, London

It is announced by the University of London that the Court of the University has accepted a grant of £10,000 from the Nuffield Foundation for research in biophysics in King's College under the direction of Prof. J. T. Randall, Wheatstone professor of physics. The grant is available over a period of three years and makes provision for a number of fellowships. The present work of the Laboratory, already supported by the Medical Research Council and the Rockefeller Foundation, is to be extended so as to develop the use of electronic devices in conjunction with ultra-violet and infra-red radiations in the study of cells and the structure of biologically important molecules.

Laboratoires: Bilingual Review of French Technology

A new quarterly review in French and English, *Laboratoires* (No. 1, April–June, 1951; pp. 56; Paris: Laboratoires, 11 rue Tronchet; 400 francs or 1500 francs a year), is devoted to French scientific instruments and technical developments. As Prof. G. Yvon explains in the foreword, the aim of the review is to present an accurate picture of research and technical activities in France to-day, and in this way to enable the world to appreciate more fully the work done by French men of science, technologists and industrialists. The first number contains seven articles by leading French scientific workers and technologists. The first, by L. de Broglie, is a discussion of the position of science in general culture, and this is followed by a description by L. Binet of two series of experiments which serve to illustrate the importance of the use of fish in the study of antitoxins. A condensed version of the first part, dealing with precision in metallurgy, of P. Chevenard's important address on January 15 to the members of the Société des Ingénieurs civils de France is given in the third article. "The Engineer and Technical Research" is discussed by M. Roy, a leading French aeronautical authority; and in an illustrated paper on French optics, by P. Fleury, director of the Institut d'Optique, Paris, the development of optical science and of the optical industry in France is outlined. Finally, the number concludes with two interesting articles: one on the influence of the electrical and electronic industries on the evolution of scientific research, by M. Ponte, director-general of the Compagnie Général de T.S.F.; and the other on calculating machines and human thought, by V. Zelbstein, president of the French association of electronic engineers, in which he maintains that many of the ideas involved in cybernetics date back to Descartes, Pascal and others. The English and French versions of the text are printed in parallel columns. The English translation is on the whole good; but there are, however, several peculiar phrases, mis spellings and too-literal translations.

Activities of the Department of Scientific and Industrial Research

THE Department of Scientific and Industrial Research has issued a "Brief Guide to the Research Activities of the D.S.I.R. and the Research Associations", in which, following an alphabetical list of the research associations and research stations of the Department, research activities are listed by subject according to the Universal Decimal Classification, with an entry indicating the organization or station where the research in question is proceeding. An alphabetical index of the U.D.C. numbers used is supplied. This first attempt to group the activities of the Department according to the subjects concerned helps to fill in the picture of scientific research in Great Britain which was given in the "Notes on Current Scientific Researches" prepared for the Royal Society Empire Scientific Conference in 1948, and which will be supplemented later this year by a companion volume "Scientific Research in British Universities" now in preparation. Copies of the present publication are being made available on request to libraries, research organizations, university departments and industrial organizations (D.S.I.R., 5–11 Regent's Street, London, S.W.1).

Artificial Rock for Display Purposes

IN the July issue of the *Museums Journal*, Mr W. T. Stirling, of the Royal Scottish Museum, Edinburgh, describes two methods of making artificial rocks. One of these is applicable to large exhibits and is built up in sections. After roughly arranging the specimens in position, a permanent wooden framework is constructed. This can be covered with tinned sheet iron of 0·005 gauge. When the structure has assumed the desired shape, which in all cases should be based on a photograph of a natural scene, the tin is covered with irregularly torn pieces of brown paper. These are soaked in hot water—for softened in this way they accommodate themselves readily to the required shape—and then fixed with a mixture of equal parts of flour-paste and thin glue. Smaller exhibits can be constructed in peat, and fine detail obtained easily with the use of a penknife. Loose fibres are singed with a gas flame and the charred surface brushed clean. At this point the two methods coincide, and the prepared rockwork receives a coating of thin plaster made by mixing one part of glue in five parts of boiling water and stirring in plaster of Paris until the mixture is of the consistency of cream. This is applied warm, and well brushed into the rockwork. It is advisable to apply a final coating of a thicker mixture of the above ingredients, or preferably of papier mâché. The rock should then be coloured, paying particular attention to detail.

Dunsink Observatory: Work during 1950

DR. H. A. BRUCK, director of Dunsink Observatory, gives a short account of the work of the Observatory during 1950 in the June issue of the *Irish Astronomical Journal* (1, No. 6; 1951). The chief instrument, the solar installation, has been completed, and the large concave-grating spectroscope has been mounted in its double-walled box the internal temperature of which will be controlled by a thermostat. New photoelectric photometers for the 12-in. refractor and the 15-in. reflector, involving the use of photomultiplier tubes, have been constructed. The reflector, with a photomultiplier photoelectric photometer, the output of which is recorded by an oscilloscope, has been used for precision measurement of the time of lunar occultations, and an occultation can be timed with an accuracy of a hundredth of a second by this method.

Royal Anthropological Institute: Annual Report

THE annual report of the Royal Anthropological Institute is more heartening than has been the case for some years. Finance is still the major worry; but this will ease when the Institute with certain other selected learned societies is housed in the new science centre to be built in London. On January 1 this year *Man* achieved its golden jubilee—a notable achievement for any learned journal. The Institute has decided to set up a blood-group centre as part of its work. Collation and synthesis can probably be best served by such an organization run in association with anthropologists. The library of the Institute has been largely transformed, thanks to a grant of 5,000 dollars from the Viking Fund. The fellowship of the Institute is mounting slowly; but, considering the services rendered, it is surprising that the number of Fellows is not greater.

Manchester Public Libraries: Annual Report for 1949–50

THE ninety-eighth annual report of the Manchester Public Libraries Committee for the year ended March 31, 1950 (pp. 40+4 plates; Manchester: Central Library, 1950), records a reduction in the combined issues of all departments, despite an increase in the use of the reference libraries. The reduction is most marked in the circulation of fiction; within the limits of the present book fund it has been impossible to replace many thousands of volumes withdrawn after very heavy use during and after the War years, and this is regarded as the basic factor in the reduction of total issues from 6,537,939 volumes to 6,124,747, thus interrupting the continuous increase of recent years. While issues in the Reference Library increased by some 3·5 per cent, issues in the Technical Library decreased by 5·5 per cent in spite of an increase of 6·5 per cent in the number of readers using the Library. The demand for more advanced technical books seems to follow supply; libraries which are able to maintain a good range of such works all report that good use is made of them. Stress is laid on the inadequacy of the seating accommodation in the General Reference Library, which is often monopolized by students, while the staff are fully occupied in the routine of providing books for readers and have little time to assist those unfamiliar with the Library or requiring expert assistance. Records of issues in the Technical Library show a transfer of interest from the sciences to the useful arts, and calls on the Technical Library's resources by local firms urgently needing special articles or books increased by 72 per cent.

Nottingham Research Discussions on Engineering Technology

A SERIES of research discussions on various branches of engineering technology, which is being arranged by the Departments of Civil and Mechanical Engineering of the University of Nottingham, will be held at the University during October 1951–May 1952. The meetings will consist of lectures and discussions on topics on which research is being carried out at the University, and the object of the series is to facilitate co-operation between the University and industry. The subjects, which will be discussed on consecutive Wednesday afternoons (2.30–4.30 p.m.) between the dates as shown, are as follows: dynamic properties of metals (October 17–31), fatigue of metals (November 21–December 11), structural analysis and the use of models (January 16–30), use of analogies in fluid mechanics (February 13–20), photoelasticity (March 5–19), and dynamic properties of rubber (April 23–May 7). Admission to the meetings is free. Enrolment forms and further details can be obtained from the Registrar of the University, University Park, Nottingham.

Use of Solid Carbon Dioxide in preparing a Cold Bath

L. G. E. Bell, Department of Zoology, King's College, Strand, London, W.C.2, writes: "Making up a cooling bath by adding solid carbon dioxide to industrial methylated spirit often involves considerable frothing of the spirit unless the addition is made very slowly. I have found that a few drops of a light paraffin sprinkled on the surface of such a bath reduces this frothing very considerably. Three or four drops of cigarette-lighter fuel are sufficient to control a surface of thirty inches square and enable a rapid addition of solid carbon dioxide to be made."

Announcements

With the retirement of Prof. H. Hartridge in May last, the Vision Research Unit of the Medical Research Council has been re-formed as the Group for Research in the Physiology of Vision, under the directorship of Dr. L. C. Thomson. The scope of the work undertaken by the members of the new Group is essentially similar to that of the Vision Research Unit, and the address remains the same, namely, Institute of Ophthalmology (University of London), Judd Street, London, W.C.1.

The Royal Society of Arts has awarded the R. B. Bennett Empire Prize for 1951 to Mr. E. Bruce Levy, director of the Grasslands Research Division of the New Zealand Department of Scientific and Industrial Research, for his work on grassland farming. This Prize, which is worth 100 guineas, was endowed in 1944 by the late Lord Bennett and is awarded every three years for the most outstanding contribution from the Dominions and Colonies of the British Commonwealth to the promotion of the arts, agriculture, industries or commerce.

Prof. N. F. Astbury, professor of applied physics in the New South Wales University of Technology, has been appointed to the chair of physics at the Gordon Memorial College, Khartoum.

The National Conference of the Institute of Personnel Management, which includes the annual general meeting of the Institute, will be held at the Royal Hotel, Harrogate, during October 5–7, the theme being "Personnel Management and Productivity". The Conference will begin at 8.30 p.m. on October 5, and prior to this on the same day a one-day course on "Personnel Management" will be held in the Lounge Hall, Royal Baths, Harrogate. Further details of both meetings can be obtained from the Institute at Management House, Hill Street, London, W.1.

A symposium on the corrosion of buried metals, organized by the Iron and Steel Institute in conjunction with the British Iron and Steel Research Association and the Corrosion Group of the Society of Chemical Industry, will be held at the offices of the Iron and Steel Institute, at 4 Grosvenor Gardens, London, S.W.1, during December 12, with Sir Charles Goodeve, director of the British Iron and Steel Research Association, in the chair. The symposium will be open to all, free of charge. Admission tickets (application to be made before October 13) and further details can be obtained from the secretary of the Institute at the above address.

A second conference on coastal engineering, sponsored by the Southwest Research Institute, San Antonio, Texas, in co-operation with the University of California, Texas A. and M. Research Foundation, Rice Institute, University of Houston and the American Society of Civil Engineers (Houston Branch), will be held at the Rice Hotel, Houston, Texas, during November 7–10. The major topics to be discussed will be the fundamentals of wave action, development of basic design data, natural and artificial movement of sediment, site criteria for harbours and other coastal works, design and construction of structures exposed to wave action, and the biological impact of marine structures. Further information can be obtained from the conference secretary, Charles E. Balleisen, c/o Southwest Research Institute, 8500 Culebra Road, San Antonio 6, Texas.

The Chemical-Biological Coordination Center of the National Research Council is organizing the second Symposium on Chemical–Biological Correlation, to be held at the National Academy of Sciences in Washington, D.C., during October 24–25, 1952, and it is intended to include in the programme one or several scientific films which deal specifically with the effect of chemicals upon biological systems, such as organisms, organs, tissues, cells, etc. Any information about the availability of such films should be sent to the Center at 2101 Constitution Avenue, Washington, D.C.

The second International Congress of Biochemistry will be held in Paris during July 21–27, 1952. The programme has been provisionally arranged in seven sections, as follows: biochemistry of steroids, biochemistry of hæmatopoiesis, biogenesis of proteins, tricarboxylic acid cycles, bacterial metabolism, mechanism of action of antibiotics, protein hormones and hormones derived from proteins. Communications dealing with other biochemical problems will be grouped together in further appropriate sections. Those intending to read papers should send in the titles before March 1, 1952, and a summary of less than two hundred words before April 1, 1952, to the general secretary of the Congress, Prof. J. E. Courtois, 4 Avenue de l'Observatoire, Paris 6^{e}.

The Board of Greenkeeping Research has recently been registered as a public company limited by guarantee under the provisions of the Companies Act, 1948, and will henceforth be known as the Sports Turf Research Institute. The new Institute remains as previously a non-commercial, non-profit-making organization and will maintain the work of the old Board as a research, advisory and educational body in problems of turf (see *Nature*, 166, 22; 1950). The headquarters will continue to be at the St. Ives Research Station, Bingley, Yorkshire.

PROBLEMS OF MARGINAL LAND FARMING

By SIR PATRICK LAIRD, C.B.

Secretary, Department of Agriculture for Scotland

UNDER this title a subject which has attracted much attention in recent years was discussed at the Edinburgh meeting of the British Association in a joint session of Sections F (Economics) and M (Agriculture) at which I had been invited to preside. Before vacating the chair, the president of Section M (Dr. E. M. Crowther) opened the proceedings by posing a question as to the precise meaning of the title. None of the speakers, however, gave an unequivocal answer to Dr. Crowther's question. Indeed, it was pointed out that when it had come to drafting legislation designed to give assistance to marginal land farmers for the rehabilitation of their holdings, nobody would venture to use the phrase marginal land at all; it became 'livestock-rearing land'.

All the papers read and the contributions to the debate did, in fact, accept that the main problems involved are those of the farmers (mostly small farmers) in the upland areas the main productive function of which is the rearing of store cattle and sheep. The chairman pointed out that there are at least three aspects of the problems involved: first, that of the technical agricultural difficulties in the management and improvement of land and stock; secondly, that of the economic and sociological factors affecting the welfare and prosperity of this sector of agriculture; and thirdly, that of the wider economic justification, or otherwise, of devoting national resources to food production on the less fertile land of Great Britain. It is at least arguable that the country would need to use to the utmost both the better and the poorer land.

Prof. W. Ellison, of Aberystwyth, gave a most interesting analysis, based on surveys and investigations in England and Wales and Scotland, of the probable costs involved in the rehabilitation of land and equipment in the upland areas, and of the increased returns which might be expected after the improvements had been carried out. Broadly, it appeared that costs working out at about £32·5 per acre could, over a period of years, be almost exactly recovered in higher returns. In Prof. Ellison's view this would not be attractive without the present subsidies (for liming, drainage, hill cattle, etc.) *plus* the 50 per cent grants for rehabilitation schemes now available under the Livestock Rearing Act, 1951. The money available under this Act, it was pointed out, would probably enable at least one million acres (out of some 3·75 million 'improvable' acres in Great Britain) to be rehabilitated. It was estimated that more than 50 per cent of all improvement expenditure would be on equipment, that is, rehabilitation of the holding rather than improvement of the land.

If *all* the improvable livestock-rearing land could be dealt with on these lines, Prof. Ellison concluded, additional output could be obtained equivalent to between 350,000 and 400,000 store cattle, providing when fattened an extra 100,000 tons of meat. This is rather more than a third of the meat imported from Argentine in 1949 and a little less than Australian supplies.

Mr. O. J. Beilby, advisory officer on agricultural economics in the Scottish Department, emphasized at the outset that while the agriculturist thinks of marginal land as being 'land on the margin of cultivation', the economist thinks in terms of the margin of profitability, and therefore of the farm rather than of the land. He pointed out that it has been roughly estimated that there are some 45,000 stock-rearing farms in Great Britain. They account for about 12 per cent of the acreage of all crops and grass, and support some 23 per cent of the sheep and 12 per cent of the cattle in the country. A sample of 122 such farms in Scotland has shown that cattle account for 24 per cent of the output, sheep 29 per cent, crops 26 per cent and poultry and eggs 15 per cent.

Nearly 60 per cent of stock-rearing farms in Scotland are rented at less than £50 per annum. The sample showed an average net income of £488 per annum (including £272 from subsidies). It appears that if the thirteen larger farms in the sample were excluded, the figure would be only £366 (including £220 of subsidies !).

The basic problem, according to Mr. Beilby, is to increase the earning capacity of the farm unit, by increased size of farm, or greater intensity of production. The former method would reduce the number of farmers: it would therefore raise problems of rural depopulation and, by leading to a more *extensive* system of farming, it might well be inconsistent with the needs of the country for maximum food production.

The sociological problems thus touched on by Mr. Beilby were followed up by Dr. Joseph Duncan in the third paper of the morning. The conditions in which marginal land farming is commonly found—such as high altitude, inherently poor soil, exposed situation, short growing-season, distance from markets—do not make it attractive to farmers with capital, and it is carried on usually with the aid of family labour by small men accustomed to a frugal standard of living. The more enterprising tend to leave such areas, and in the past hundred years there has been in many districts a marked depopulation trend. In such conditions the quality of the social life is bound to deteriorate. The community "tends to become a closed one and to lose variety. A shrinking community sheds its tradesmen and its functionaries".

Very many of the farmers on upland farms do not now earn as much as do wage earners on the lowland farms, and because of this and the social isolation there is a constant drain away of young people, who have, thanks to improved transport, discovered that there are more attractive places in which to live and work.

More capital and larger farms seem to Dr. Duncan to be the best solution of the economic problem, though as an alternative upland farms might be taken over by lowland farmers and run in conjunction with lowland farms. Neither method would, however, ease the social problem; and to ensure the kind of community which would solve that problem, it seemed to Dr. Duncan that forestry is essential; there is no good reason why farming and forestry should be regarded as competitive, and on the social side, forests offer more hope of a re-integration of community life in the uplands than anything else.

In opening the general discussion, Mr. A. R. Wannop, technical development officer in the Scottish Department, stressed the importance of maintaining the necessary interdependence of lowlands and uplands as regards both cattle and sheep. He thought we should be careful not to over-capitalize the upland farms, and pointed out that expenditure on the scale suggested by Prof. Ellison might add £2–£3 per cwt. to the cost of production of a weaned suckled calf. There is great need, he said, for a new building technique to cheapen the costs of rehabilitation. A self-feeding pit silo, as used in America, would be a boon. Above all, greater attention should be given to advisory work, directed more to the economy of the whole farm than to details of land improvement.

Mr. Phillips Price and Mr. Gorrie (Ceylon) took up and supported Dr. Duncan's plea for afforestation. As Mr. Price pointed out, Nature abhors continuous cropping, and lack of balance is just as detrimental in the case of livestock as in cultivation. Mr. Gorrie spoke of the benefits derived from the shelter belts established in the eighteenth century, and suggested that progress in the upland areas is dependent on the supply of labour and machinery.

Three or four farmers, from both sides of the Border, made useful contributions to the debate, in which varying views were expressed as to the economics of the business. Mr. J. A. Symon, formerly chief inspector of the Scottish Department, thought that too much attention is paid to that aspect and referred to the go-ahead enterprise of some farmers in the reclamation of land in Orkney and elsewhere.

Perhaps the question still remains: What exactly is marginal land? I am tempted to quote from a delightful little 'essay' written in the early 'forties by a member of a war-time executive committee in the Border country:

'Marginal land was discovered by the Farmers' Union in 1940. Prior to that date there was none of it: to-day there is little else but. The Department, later, recognized its existence. They have regretted their action ever since. Nobody quite knows where it is except the man who farms it. But Members should be suspicious of any land situated near a margin. Such land is almost certain to be marginal land.

"Sub-marginal land is found under marginal land. Sub-soil is not the same thing. Super-marginal land was also discovered on the same day by the same explorer. All land situated above marginal land is super-marginal. These sub and super discoveries should greatly simplify the work of Members."

However, this member and his colleagues, and those of other executive committees in Scotland, have done a good and conscientious job during the past eight years in the administration of the Marginal Agricultural Production Scheme. There are undoubtedly long-term problems still to be solved, but at least these upland farmers, contributing some 10 per cent of the total agricultural output of the country, have been enabled with State assistance to keep going and to make a reasonable contribution to the nation's food supplies.

HIGHER TECHNOLOGICAL EDUCATION IN GREAT BRITAIN

AT a discussion on higher technological education on August 13 before Section L (Education) at the British Association meeting at Edinburgh, over which Sir Hector Hetherington presided, Mr. H. J. Cull gave a well-balanced and concise review of the technical colleges and their development and an appreciation of the contribution they could make in this field. He claimed that higher technological work is a natural part of the development of these institutions, as is indicated by the growth and success of their work in providing courses for Ordinary and Higher National Certificates and for external University of London degrees, as well as, in the larger colleges, for general science degrees, special science degrees and engineering degrees. A technological course of degree standard is a natural development if the needs of industry are to be met, and such a course should include more fundamental science than is usual in National Certificate and diploma courses, and more applied science and technology than finds a place in the external degree syllabuses. If liaison with industry is maintained and developed, the colleges consider that they could provide courses which, with the freedom of an internal examining system, could well be different from the external degree.

Mr. Cull emphasized here that periods of full-time study would be necessary, but that with the co-operation and goodwill of industry there should be no major problem in planning the association of study with experience as a vital part of the course. On the question of the award to be received by the successful student, Mr. Cull indicated the alternative proposals, but urged that early decision is imperative and that any award should carry national recognition. Post-graduate training, he thought, would present less formidable problems if such schemes were allowed to develop, and particularly if the postgraduate courses were developed in association with neighbouring universities. Here, particularly, questions of accommodation and of staff, in his opinion, are important, and equipment and apparatus are expensive items; on the staff side, quality is as important as numbers, and to obtain staff of the requisite quality with real experience of industry and its needs is not easy. He thought that, if properly used, the scales of the recent Burnham report give scope for such appointments to be made. Solution of the problems of accommodation of staff would, moreover, permit the gradual establishment of real centres of research, with teams of research workers, including staff and students, and possibly, in some problems, some workers on a part-time basis from industry. Many of the problems investigated might conceivably come from industry itself, and just as some industrial firms find themselves touching the field of fundamental science, so some investigations in the technical colleges might be concerned with direct industrial problems.

Mr. Cull recognized that not every technical college could or should be called on to provide higher technological courses, and that some regional planning would be necessary. He recognized, too, the critical importance of finance, though he passed over the question of local administration in relation to the academic freedom of the teacher and investigator. He was confident, however, that the technical colleges could provide not only the technicians but also the technologists needed in Great Britain, and that there is in the colleges the enthusiasm to do this work once it is given direction and the student the necessary incentive.

Prof. J. C. Prescott, dealing with the university aspect of the problem, distinguished at the outset between two schools of thought: one regards higher technological courses as providing an opportunity of treating specific advances in technology; the other advocates courses in which the emphasis is upon fundamentals and in which recent technological developments appear as illustrations of the more general theory. In the universities, the mode of study is to approach the particular example by way of the most general principle, to consider specific phenomena in terms of, and by the light of, fundamental theory. This method is in general followed in their schools of applied science, and accordingly, Prof. Prescott suggested, universities could provide the proper environment only for the second type of course. If they attempted to do more they would forsake their legitimate function.

Prof. Prescott pointed out in passing that the rapid advances in technology have created teaching difficulties for the universities, where reorganization to allow greater attention being given to the study of the fundamental sciences has left less time available for the study of their application in technology. Nevertheless, he thought that university courses which first of all establish the fundamental principles upon which technology is created and then show their application by examples selected from among modern developments would provide a satisfactory solution. While a better medium of education from the point of view of technology, they could not be so comprehensive as regards new advances as the courses which they replace. Advanced courses in technology should be regarded by the universities as the natural continuation of their undergraduate courses. Even here, however, the university should be circumspect and insist that the courses approach the particular through the general, and seek to educate rather than to instruct. He did not believe that a university could usefully conduct courses containing little more than an isolated description of recent developments in technology.

Prof. Prescott said that the results of postgraduate courses of the type he advocated, so far as he has seen them, have been excellent. He thought there is no evidence that the courses have had any narrowing effect, because a systematic study of the sciences involved is as essential as their informed and logical application in the technology. Moreover, the increasingly sympathetic understanding of the engineer's outlook by the scientific worker, strengthened by the latter's growing reliance on the engineer for the design of special apparatus, has largely dissipated fears that such courses might turn promising engineers into indifferent physicists or chemists. Indeed, this clear understanding between the engineer and the scientific worker is fostering happier relations between pure and applied science departments in the universities. Higher technological education, in fact, offers the universities, and particularly their faculties of applied science, a great opportunity of giving systematic education to an advanced standard in subjects which in the past they have only been able to treat sporadically, or at a comparatively elementary level.

Neither of these papers gave any attention to the quantitative aspect of the question, on which clearly a decision as to where the expansion of facilities for higher technological education should take place must partly depend ; nor did the ensuing discussion, which was opened by Sir Arthur Fleming, give any clearer lead there, or as to the desirability of any new award. Sir Arthur, commenting on industry's need for the technologist as well as the technician, observed that the number of corporate members of the great engineering institutions who have qualified through National Certificate courses is about the same as the number from university degrees. He endorsed what had been said as to the necessity of teaching of the highest order and the value of postgraduate courses, but added that the chief anxiety in recruitment is as to whether we are securing men of the right type for industry. Sir Arthur urged that the personal qualities of courage, powers of decision, judgment, leadership and the ability to mix well with others should count as much or more than technical or scientific ability. These personal qualities are formed before the young men reach industry, and he knew of firms which for this reason are turning to the public schools, because the technical knowledge could be imparted.

The importance of personal qualities was equally stressed by Wing-Comdr. T. R. Cave-Browne-Cave, who commented that the same qualities of leadership and decision which the Fighting Services seek are needed in industry. The syllabuses of courses should not be so full as to require a concentration on academic work which hinders the development of personal qualities. He thought, too, that it is important for higher technological education to develop independently of the universities, and that the technical colleges should not depend on the universities for their higher award.

The discussion, on the whole, was disappointing in that, although attention was directed to the main factors on which the expansion of technological education in Great Britain turns, no clear lead was given as to their relative importance or the form in which that expansion should immediately proceed. The need for early decision was rightly stressed ; but even in the emphasis on the importance of personal qualities, no suggestions were advanced as to whether these would be better fostered in the universities or in the technical colleges. Sir Arthur Fleming's suggestion regarding travelling fellowships relates to the postgraduate stage and the acquiring of the experience and outlook required to fill the highest positions in industry.

CATALYTIC CONVERSION OF A DIENE INTO DEEPLY COLOURED POLYENES

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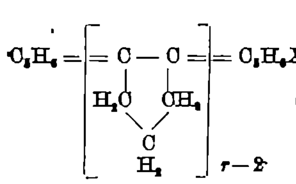
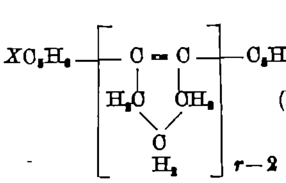
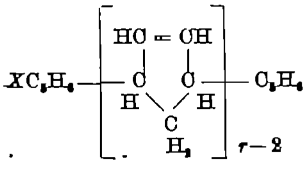
PROPERTIES indicating the presence of conjugated double bonds. *Cyclo*pentadiene can be converted catalytically into a deep red poly*cyclo*pentadiene-trichloroacetic acid adduct (I), the yield under suitable conditions being more than 90 per cent of the theoretical amount. Analyses, molecular weight determinations and fractional precipitation tests make it probable that a mixture of polymer homologues, of composition $(C_5H_6)_r(XY)$ and a number average degree of polymerization $r = 18 \pm 2$, is formed, (XY) being here and later the symbol for trichloroacetic acid. The unsaturated nature of (I) is shown by its large consumption of potassium permanganate, under relatively mild conditions ; and the interaction with molecular oxygen, ozone, nitric acid, perbenzoic acid and hydrogen, in presence of



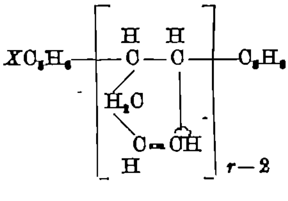
(Ia)



(Ib)



(Ic)



(Id)

platinum oxide, proves that there is one double bond in each *cyclo*pentadiene unit. The deep red colour of the chromatographically purified substance (I), the formation of deeply coloured blue molecular compounds with strong acids, or antimony trichloride, and their decomposition by proton acceptors is compatible with (Ia) or (Ib) rather than with (Ic) or (Id)[1].

The supposition that this polymerization involves a migration of hydrogen atoms with formation of conjugated double bonds is supported by the fact that compound (I) is capable of forming an addition product with maleic anhydride and by its infra-red absorption spectrum in the range of the double-bond vibrations. It has been observed, moreover, that on addition of dry trichloroacetic acid to a solution of compound (I) in carefully dried benzene, with the formation of a dark blue molecular compound, the specific conductivity (which at a given concentration of (I) is approximately proportional to the trichloroacetic acid concentration) shows a marked increase; this indicates salt formation, due to the transfer of a proton to the molecule containing the conjugated double bond[2].

In dilute solution, each *cyclo*pentadiene unit of (I) consumes two bromine atoms. A polymer of composition $(C_5H_6Br_2)_r(XY)$ could not be isolated, however, because hydrogen bromide is lost with great ease and a stable derivative is formed the approximate formula of which is $(C_5H_5Br)_r(XY)$. This product is deep red, like (I); this is probably due to the re-formation of some conjugated double bonds.

Light absorption. Long-chain conjugated polyenes are known to be characterized by sharp absorption bands in the near ultra-violet and visible region[3]. In contrast to this, a band structure in the spectrum of (I) could only be observed between 2500 A. and 2800 A., while in the range 2800–10,000 A. the extinction coefficients decrease continuously; and there are also no bands due to electronic transitions between 10,000 A. and 30,000 A. Account must, however, be taken of the fact that (I) is a mixture of homologues, not an individual conjugated polyene, and it is reasonable to assume that the lack of bands at wave-lengths larger than 2800 A. is due to the fact that the light absorption of the individual components is modified by optical superposition. This hypothesis is supported by the results of experiments (to be described elsewhere) dealing with the light absorption of artificially prepared mixtures of authentic polyenes, containing respectively four, six, eight and ten conjugated double bonds.

Kinetic measurements. These show that the conversion of *cyclo*pentadiene into compound (I) is a chain polymerization involving intermediates of short life-time, and that the course of the reaction can be adequately represented by three elementary steps, namely, initiation, propagation and termination; so far, no indications of chain transfer or marked effects due to traces of water have been observed. The initial rate of the monomer consumption in carbon tetrachloride solution is proportional respectively to the first power and to the square of the *cyclo*pentadiene and trichloroacetic acid concentrations; and the number average degree of polymerization does not depend on the initial concentration of the reactants or on the degree of conversion, up to 80 per cent reaction. These observations can be interpreted by the following initiation reaction involving the trichloroacetic acid-catalysed addition of trichloroacetic acid to *cyclo*pentadiene, and by a termination stage in which the growing polymer reacts with monomer:

$$C_5H_6 + 2(XY) \rightarrow C_5H_6(XY) + (XY).$$

It has previously been found[4] that the rate of the trichloroacetic acid-catalysed dimerization of *cyclo*pentadiene is proportional to the first power of the trichloroacetic acid concentration. If, therefore, the catalyst concentration is sufficiently low, the formation of compound (I) is completely overshadowed by the dimerization reaction. Proton acceptors inhibit both the polymerization process and the catalysed reaction leading to the dimeride[4], and it is probable, therefore, that both processes involve ionic intermediates. It is recognized, however, that the mode of linkage of the *cyclo*pentadiene units in di*cyclo*pentadiene and in compound (I) is fundamentally different, the former substance being the product of a 1:4–1:2-addition[5], which does not involve the migration of hydrogen atoms.

The end group. It is known from previous investigations[6] that trichloroacetic acid adds readily to isolated or conjugated double bonds to form esters. By analogy, it is probable that the initiation reaction already indicated also leads to an ester and that, therefore, the end groups X and Y in compound (I) are respectively Cl_3CCOO and H, rather than Cl_3CCOOH and Cl. This conclusion is in concordance with results of experiments showing that compound (I) is not capable of forming pyridinium, potassium, sodium, calcium, barium, copper or silver salts: and it is proved by the fact that alkaline hydrolysis of (I) gives rise to the formation of alkali trichloroacetate (identified by conversion into the benzyl*iso*thiourea salt), and of a chlorine-free polymer without liberation of chloride ions. If, on the other hand, compound (I) contained a free carboxyl group, the removal of chlorine from the polymer by alkaline hydrolysis would liberate three equivalents of chloride.

Colloid chemical effects. Solutions of compound (I) in benzene are strongly associated; this follows from a comparison of cryoscopic and end-group molecular weight determinations. If the benzene or carbon tetrachloride solution is shaken with aqueous solutions of salts, acids or bases, stable and remarkably viscous emulsions are formed.

A detailed account of this work and the results of similar experiments dealing with other molecular compounds, halogenoacetic acids and dienes will be published elsewhere. We are grateful to Drs. H. Steiner and E. T. Borrows for discussions, to Dr. A. Elliott for some of the infra-red absorption measurements, and Dr. Rubin and Mr. Street for experimental assistance.

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[1] Staudinger and Bruson, *Annalen*, **447**, 103, 110 (1926), and Carmondy, Sheehan and Kelly, *Indust. Eng. Chem.*, **30**, 245 (1938), prepared poly*cyclo*pentadienes and suggested repeating units as in (Ie) or (Id); it is possible that some of the poly*cyclo*pentadienes described in the recent patent literature are also built up according to this latter structural principle; cf., for example, Soddy, U.S.A. Patent, 2319271.

[2] Cf. Weiss, *J. Chem. Soc.*, 245 (1942).

[3] Hausser, Kuhn and Smakula, *Z. phys. Chem.*, (B), **29**, 384 (1935). Karrer and Jucker, "Carotinoide" (Basle, 1948). Blout and Fields, *J. Amer. Chem. Soc.*, **70**, 189 (1948).

[4] Rubin, Steiner and Wassermann, *J. Chem. Soc.*, 3046 (1949).

[5] Alder and Stein, *Annalen*, **504**, 216 (1933).

[6] Nernst and Hohmann, *Z. phys. Chem.*, **11**, 352 (1893). Clark, Ph.D. thesis, University of Missouri (1937). Wassermann (unpublished experiments).

PAPER CHROMATOGRAPHY OF MUSCLE TISSUE CONSTITUENTS

Paper Chromatography of Adenosine Phosphates

CARTER[1] has devised a method for paper chromatography of adenosine phosphates. He uses as solvent a 5 per cent dibasic sodium phosphate solution and *iso*-amyl alcohol. For developing the spots after drying, he sprays the paper with fluorescein and localizes the spots with an ultra-violet lamp ('Mineralight').

We have modified the partition coefficient between the two phases by using a solution of 0·5 per cent lauryl amine in *n*-amyl alcohol instead of *iso*-amyl alcohol. The resolution of the spots has much improved by this method. We believe that this method can be adapted to other substances; thus, for substances of basic character laurylic acid can be used to improve the resolution.

We have compared our method with the original method of Carter on adenosine phosphates. With Carter's method, using an adenylic acid preparation (Merck), two spots were obtained with R_F 0·73 and R_F 0·66, and, according to Carter, who obtained identical results, identified as the adenosine-2-phosphate and adenosine-3-phosphate. Besides these substances, a smaller spot due to inosinic acid was visible. Adenosine diphosphate obtained by splitting adenosine triphosphate with myosin gave a longer spot, which sometimes seemed to consist of two spots of R_F 0·80 and 0·75. Adenosine triphosphate from muscle gave only one spot (R_F = 0·82), but often this was somewhat extended.

Using our method, we obtained the following components from the adenylic acid preparation, which tentatively have been identified as follows:

Substance	R_F
Inosinic acid	0·86
Adenosine-2-phosphate	0·69
Adenosine-3-phosphate	0·61
Adenosine	0·48

The component with R_F 0·69 has the same R_F-value as adenosine-5-phosphate, which can be obtained from muscle adenosine triphosphate by cautious hydrolysis or prolonged storage. The components have been identified from the discussions given by Carter[1] and Kornberg[2].

Adenosine diphosphate here clearly showed two spots with R_F 0·76 and 0·69 respectively. The first one is due to the diphosphate; the other one is adenosine-5-phosphate, probably obtained through a small contamination of the myosin by myokinase.

Even adenosine triphosphate from muscle gave two spots, R_F 0·83 and 0·76. The first one is due to the triphosphate, the other to the diphosphate. Adenosine triphosphate is apparently very often contaminated with adenosine diphosphate owing to the instability of the triphosphate.

Our examples show that the modification of the partition coefficient with lauryl amine in amyl alcohol very much facilitates the resolution of the different derivatives of adenosine phosphatos, and is superior to Carter's original method.

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[1] Carter, C. E., *J. Amer. Chem. Soc.*, **72**, 1466 (1950).

[2] Kornberg, A., and Pricer, jun., W. E., *J. Biol. Chem.*, **186**, 557 (195

A Phosphate-absorbing Protein from Muscular Tissue

IN connexion with the preparation of myosin from cardiac muscle[1], a protein containing a nucleotide has been isolated. This protein seems to be firmly bound to the actomyosin complex. However, it is freed to a certain extent when the complex is dissociated into myosin and actin. Only by treatment with organic solvents has it been possible to separate the protein from undissociated actomyosin.

The interesting feature of this substance is its ability to absorb the phosphoric acid residue, which is split from adenosine triphosphate by the enzymatic action of myosin.

The protein is not myosin. It more resembles actin, but it is not an actin in the usual sense. It does not polymerize and does not combine with myosin as actin does.

The present communication records an attempt to analyse the prosthetic group of the protein. This has been done mainly with the aid of paper chromatography and measurements of the ultra-violet absorption spectra in a Beckman spectrophotometer. The absorption curves have a maximum at 260 mμ in neutral and alkaline solutions. In acid solutions a maximum at 263 mμ is obtained, and here also the curve becomes asymmetric. This is different from that of adenylic compounds. Chromatographic measurements[2] by the method described elsewhere show that the preparations contain not more than two components, or sometimes only one. In the system 5 per cent dibasic sodium phosphate – 0·5 per cent lauryl amine in amyl alcohol, it gives an R_F value of 0·67. In some cases a double spot is obtained with R_F 0·63 and 0·67.

After hydrolysis (0·1 *M* hydrochloric acid, 30 min. at 100° C.) two components appear in the chromatograms. One of these, with R_F 0·40, is identical with adenine, while the other, with R_F 0·85, has not yet been identified. This component seems to be some pyridine or pyrimidine derivative with basic properties. A prolonged hydrolysis causes no changes in this component, and furthermore the chromatographed substance is soluble in acids only. Milder hydrolysis (alkaline hydrolysis or 0·1 *M* hydrochloric acid, 5 min. at 100° C.) gives, in addition to the two spots of R_F 0·40 and R_F 0·85, two other spots with R_F 0·57 and R_F 0·68. The former of these may be adenosine-3-phosphate and the latter probably adenosine-5-phosphate. The component with R_F 0·68 may also be unhydrolysed nucleotide. Extraction of the spots and identification by ultra-violet absorption measurements has not been successful, since the amyl alcohol used in the chromatography is contaminated by a substance with absorption in this region. Purification of the amyl alcohol has been unsuccessful, and it has not yet been possible to get a synthesized amyl alcohol.

These investigations show that the prosthetic group is a dinucleotide. Kornberg[3] has shown that diphosphopyridine nucleotide (co-zymase, co-enzyme I) can undergo a direct phosphorylation to triphosphopyridine nucleotide (co-enzyme II) by adenosine triphosphate and a yeast enzyme. Since the dinucleotide described here has the same characteristic, one may suppose an analogous structure. However, it does not seem to contain nicotinic amide but another as yet unidentified substance with basic properties.

Further investigations are going on, and a more detailed description will appear elsewhere.

The investigation is being supported financially by the Swedish Natural Science Research Council.

BERTIL GELOTTE

[1] Gelotte, B., *Biochim. Biophys. Acta* (in the press).

[2] Snellman, O., and Gelotte, B. (see preceding communications).

[3] Kornberg, A., *J. Biol. Chem.*, 182, 805 (1950).

The Prosthetic Group of Actin

A STUDY of the prosthetic group of *G*-actin and *F*-actin has been made with paper chromatography, using as solvent an aqueous solution of 5 per cent dibasic sodium phosphate and a solution of 0·5 per cent lauryl amine in amyl alcohol as described elsewhere[1]. We could detect only one spot when investigating the prosthetic group of *F*-actin, the R_F value of which was 0·67. From *G*-actin also only one spot was visible, with the R_F value 0·64. These R_F values correspond to the values found for the phosphate-absorbing protein derived from the actomyosin complex reported in another communication[2]. Acid hydrolysis of the prosthetic groups from the two kinds of actin showed, upon paper chromatography, identical spots with the R_F values 0·40 and 0·85 respectively. The prosthetic group of actin is a dinucleotide containing adenosine and another hitherto unidentified base. This dinucleotide can occur in two forms, one richer in phosphorus (in *G*-actin) and the other poorer in phosphorus (in *F*-actin). It may be mentioned that in no circumstances have any spots derived from adenosine tri- or di-phosphate been detected. The R_F values for these substances under the same conditions are 0·83 and 0·76, so they must occur in insignificant amounts.

Earlier, Straub *et al.*[3] have found that actin contains a prosthetic group which they consider to be adenosine triphosphate in *G*-actin, and which during the polymerization of *G*-actin to *F*-actin splits off one phosphoric acid residue and is transformed into adenosine diphosphate.

The absorption spectrum of the isolated prosthetic group in a Beckman spectrophotometer gives a curve which resembles that of an adenosine derivative. The relation of the absorption curve to *p*H, however, is different from that of an adenosine phosphoric acid. It seems also that the prosthetic group can in certain circumstances be split, giving off adenosine-5-phosphate, which can be deaminated by Schmidt's deaminase. These results have supported the incorrect assumption that the prosthetic group is adenosine triphosphate instead of the dinucleotide.

G-actin contains the dinucleotide which is rich in phosphorus, and *F*-actin contains the dinucleotide poorer in phosphorus. During the transformation of *G*-actin into *F*-actin, the phosphorus-rich and therefore more labile dinucleotide gives off one phosphoric acid residue and is transformed into the dinucleotide of *F*-actin.

Upon contraction *in vitro* of actomyosin with adenosine triphosphate, the myosin splits off a phosphoric acid residue of the triphosphate. It is possible for the energy-poor dinucleotide in *F*-actin to take up such a phosphoric acid residue in the nascent state. *F*-actin is thus transformed to *G*-actin during the contraction.

Straub *et al.* have found that when *F*-actin is dialysed against a solution of adenosine triphosphate for a longer time, the *F*-actin is converted into *G*-actin. At the same time adenosine triphosphate disappears and adenosine diphosphate appears. He assumes that the diphosphate in *F*-actin takes the place of triphosphate. From our results the process is better explained by assuming that the dinucleotide takes up a phosphoric acid residue from the adenosine triphosphate on account of its instability; it always loses phosphorus gradually with time. We have also found that the dinucleotide can take up phosphoric acid residues given off by the adenosine triphosphate in such a manner.

It seems thus that adenosine triphosphate does not play the dominant part previously assigned to it in the contraction process. This role may be taken by a dinucleotide (one group of which is adenosine, the other is not yet identified) which can take up and give off a phosphoric acid residue. The adenosine triphosphate acts as a phosphorus donor.

In many respects this dinucleotide resembles cozymase, which also occurs both as a phosphorus-rich and a phosphorus-poor compound (co-enzyme II and I). A comparison of the dinucleotide with cozymase has shown that they are not identical.

Further details of these investigations, which were supported financially by the Swedish Natural Science Research Council, will be given elsewhere.

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April 25.

[1] Snellman, O., and Gelotte, B. (see preceding communication).

[2] Gelotte, B. (see preceding communication).

[3] Straub, F. B., and Feuer, G., *Biochim. Biophys. Acta*, 4, 455 (1950).

CHEMISTRY OF CANCER

A MEETING, under the joint auspices of the Chemical Society, the Royal Institute of Chemistry, the Society of Chemical Industry, and the Institute of Petroleum, was held in Manchester on March 15, with the general title "The Chemistry of Cell Division". The proceedings were sadly interrupted by the sudden death of Prof. G. A. R. Kon while contributing to the discussion at the end of the morning session, and the meeting was abandoned. Three papers were, however, read.

In his introductory survey, Prof. A. Haddow dealt with the biological effects (tumour-inhibitory, cytological and carcinogenic) of cytotoxic substances, with special reference to the nitrogen mustards. It is difficult to improve on the activity of *bis*-β-chloroethylamine (HN2), but *bis*(β-chloroethyl) β-naphthylamine (R.48) has certain advantages and its clinical effects were discussed in some detail. In the case of cancer-producing compounds earlier studied, there is still no knowledge of their exact site of action in the cell. However, the carcinogenic nitrogen mustards, first investigated as potential war gases, and related compounds appear to act directly on the chromosome structure and in so doing bring about effects in many ways indistinguishable from those due to X-rays.

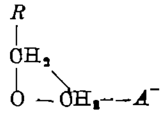
Tumours induced by injection or feeding of these compounds have cytological abnormalities which persist through many generations of transplantation in certain tumours, but which, in other tumours, vanish after a few transplantations. While these observed cytological effects are almost certainly not those primarily responsible for the induction of cancer, they can be regarded as associated phenomena. Chemical features of the nitrogen mustards have suggested the examination of related types of compound such as ethylene oxides and imines, which are of interest on account of their capacity for chemically cross-linking textile fibres and which have been shown to produce similar cytological effects. All these types are believed to react by a carbonium-ion mechanism with reactive centres in protein and nucleo-protein. From studies of the action of such compounds on chromosome organization, Prof. Haddow suggested that the production of cancer in these cases is due first of all to their chemical combination with hereditary material in the cell, and secondly to resultant change in chemical and genetic properties expressing itself as alterations in growth behaviour.

Dr. W. C. J. Ross then delivered a paper entitled "Cytotoxic Action in Relation to Chemical Reactivity" in which he elaborated the carbonium-ion reaction mechanism of radiomimetic cytotoxic compounds. These compounds include sulphur and nitrogen mustards, methylolamides, epoxides, ethyleneimines and some sulphonic esters. All these types can be regarded chemically as alkylating agents.

In the case of the β-chloroethylamines, the carbonium ion is produced either by elimination of the chlorine atom as chloride ion under the electron-repelling influence of the nitrogen atom, or alternatively via the cyclic ethyleneimonium ion, which, though reasonably stable in aliphatic mustards, would not be expected to be stable in aromatic analogues. In the case of the ethylene oxides and imines and the sulphonic esters, the reaction is bimolecular, the ion having no separate existence. Thus, for example, the reaction of an ethylene oxide ring with an active centre involves the displacement of the oxygen atom from the reacting carbon atom with the formation of the transition complex (I).

The ease with which various groups react with carbonium ions has been investigated in detail, and in protein the most reactive centres are the ionized carboxyl group followed by terminal and histidine amino groups; in nucleic acids the reaction occurs preferentially with phosphoryl and aromatic-type amino groups. No reaction takes place, at physiological *p*H, with aliphatic hydroxyl groups.

Dr. Ross showed the influence of structure on the activity of the mustard type of compound by an examination of a series of *bis*-(β-chloroethyl) anilines. If electron-repelling groups are introduced into the nucleus, separation of the chlorine atoms as ions is facilitated, reactivity, as measured by rate of hydrolysis in aqueous acetone, is increased, and so is tumour-inhibitory activity. Electron-attracting groups have the converse effect. Similarly, replacement of the chlorine atoms by bromine or iodine, or introduction of β-methyl groups into the chloro compound, leads to enhanced activity in certain weakly active substances. Increasing the separation between active centres in this type of molecule seems to lead to decrease in biological activity, though chemical reactivity is not appreciably affected.



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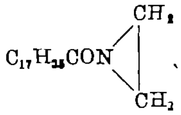

II

In presenting his paper entitled "Cytotoxic Action in Relation to Molecular Shape", Dr. F. L. Rose dealt with the role taken by the whole molecule of the cytotoxic agent (as distinct from the formation of chemically reactive centres discussed by Dr. Ross). He showed that not only may the methylolamides, epoxides and ethyleneimines react with cell components, but, in addition, as they are all groupings which are known to lead to polymer formation, polymeric molecules may be the ultimate units which react in the cell. The nitrogen mustards can be regarded as a special case of the ethyleneimines, and a linear polymer with quaternized nitrogen atoms is a possibility.

As a corollary it follows that the activity of certain other cytotoxic agents such as the polycyclic hydrocarbons and the dimethylaminoazobenzenes and stilbenes can be explained on a similar basis, by supposing that the 'polymer' units are made up of micelles or bundles of molecules held together by residual valency forces, each individual molecule being linked by conjugation to cell protein. Certain dyestuffs containing azobenzene or stilbene nuclei are known to have micelle-forming properties, and the large flat polycyclic hydrocarbons may well behave similarly.

This hypothesis has been tested by preparing and examining a long-chain aliphatic hydrocarbon molecule which carries a group capable of reacting with protein and which by virtue of its long chain also forms micelles. This compound, stearoyl ethyleneimine (II), shows cytotoxic action and is a potent carcinogen.

In his introduction to the discussion, Prof. Kon stressed the satisfactory correlation between cytotoxic activity and the degree of purely chemical reactivity of the nitrogen mustards as measured by hydrolysis-rates. On the question whether the effect of chain-length can be attributed to steric or to polar factors, the answer seemed to him to be fairly clear, namely, that the two ends of the chain can be separated within limits, but that if the distance of the terminal carbon atom from the nitrogen atom is much increased beyond two carbon atoms, the activity falls off sharply, as does the rate of hydrolysis. If, however, this separation is achieved by inserting CH_2-groups between two nitrogen atoms so placed as to exert their polar effect and favour the production of a carbonium ion, the lengthening of the chain effects but little decrease in biological activity. Prof. Kon said that he had every hope from all this work of eventual results with a very positive bearing on the cancer problem as a whole.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Localization of Bacterial Nucleic Acids and Mechanism of the Gram Reaction

As a consequence of the brilliant studies of Stacey and co-workers, reviewed by Webb[1], many investigators of the Gram reaction in bacteria are agreed that the Gram complex is a combination of basic dye and pentose nucleoprotein, apparently localized at or in the cell wall. However, as Lison[2] has pointed out, the problem of localization in cytochemistry is a difficult one, and it is not altogether certain that the basophilic component of the Gram complex normally occurs at the cell wall.

The site of production of pentose nucleotides has an obvious bearing upon the problem of localization of the Gram complex. From their study of both Gram-positive and Gram-negative bacteria, Malmgren and Hedén[3] concluded that bacteria have two nucleotide-forming systems, one of pentose and the other of deoxypentose type, which form a functional unit but are located in separate organelles within the cell.

Our own studies of fusobacteria, clostridia and lactobacilli indicate that the two structures concerned with nucleotide production form a single morphological unit. But regardless of which view is correct, it becomes evident that the presence of pentose nucleoprotein at the bacterial cell wall represents secondary localization. We have attempted to determine whether this secondary localization is the result of a normal physiological process or an artefact produced by the Gram-staining procedure itself.

Young lactobacilli in smear preparations were stained rapidly with dilute basic dye. Large basophilic polar areas were thus revealed, but there were no basophilic areas adjacent to the cytoplasmic membrane as in the Gram reaction. Gram-stained cells decolorized with acid alcohol and restained with dilute basic dye had diffusely distributed basophilia. When the iodine 'mordant' was omitted in this last experiment, the original distribution of basophilia in simply-stained cells was found. It was concluded, therefore, that the iodine solution is responsible for shifting basophilia from the polar areas to the cell wall.

To test this, a series of preparations were stained with Stirling's gentian violet solution, and then placed in an iodine – potassium iodide solution of pH 9·1. Slides were withdrawn at intervals and the Gram staining completed. After 15 min. exposure to the iodine solution, the lactobacilli were Gram-positive, after 30 min. Gram-negative, with Gram-positive polar zones, and after 45 min. again completely Gram-positive. Further treatment failed to effect another reversal of the Gram reaction.

By varying the hydrogen ion concentration, as well as the potassium iodide, it was found possible to influence the speed at which the Gram-negative phase appeared. As the hydrogen ion concentration increased, the time required to reach the Gram-negative phase also increased, while an increase in potassium iodide concentration accelerated the appearance of the Gram-negative phase. It was concluded that there are two basophilic components in lactobacilli which give the Gram reaction; one component is relatively quickly mobilized and can be extracted with iodine solution, whereas the other is only slowly mobilized and cannot be extracted with iodine. Since both basophilic components were hydrolysed by Kunitz-type ribonuclease or $N/1$ hydrochloric acid, it is possible they are pentose nucleoproteins.

The second pentose nucleoprotein component was found as a cortex to nucleal-positive (deoxypentose nucleic acid) polar granules. It differed significantly from the other, since it retained gentian violet staining when the cells were subjected to decolorization without prior iodine treatment.

A less detailed study of *Clostridium septicum* gave results essentially the same as those obtained with lactobacilli.

It is evident that the iodine treatment in the Gram-staining procedure is a complex process involving at least three effects upon various pentose nucleoprotein fractions in the bacterial cell, namely, increased strength of dye binding, alteration of position, and extraction.

The mechanism by which iodine increases dye binding has not yet been elucidated. According to Stearn and Stearn[4], it is due to a greater lowering in the isoelectric point of a protoplasmic component in the Gram-positive organisms than in the Gram-negative. Although no data are on hand to settle the point, a difference in tyrosine content between the pentose nucleoproteins of the Gram-positive and Gram-negative forms could account for such a mechanism, since the iodination of tyrosine increases its acidity[5]. We therefore have reason for suspecting that tyrosine may play an important part in the functioning of cytoplasmic nucleoproteins, and it is of interest to note that Bradfield[6] has postulated that since peptidases do not attack peptides containing phosphotyrosine, it may be possible that combination of tyrosine groups with nucleic acid phosphate might be a means of preventing peptidases from splitting protein during the synthesis of the latter.

This study is from Project No. 323 of the Ohio State University Research Foundation, sponsored by Procter and Gamble of Cincinnati and supervised by Drs. Paul C. Kitchin and Hamilton B. G. Robinson.

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Alkaline Phosphatase and Contractile Proteins

ALKALINE phosphomonoesterase is usually defined as an enzyme with a pH optimum around 9·5 which splits monoesters of phosphoric acid. Relatively recently it was found that the comparable acid phosphatase can act as a phosphokinase (Axelrod[1]), and afterwards Meyerhoff[2] showed that alkaline phosphatase also may act as a phosphokinase. The characteristic action of a phosphokinase is the ability to catalyse the transfer of phosphate from one organic molecule to another.

Cytochemical studies have shown that alkaline phosphatase exists characteristically on chromosomes[3], newly formed collagen[4] and at the secretory border of a wide variety of secretory cells[5]. Studies by Rothstein and Meier[6] and Brown[7] have shown that enzymes, including phosphatase, are present even on the external surface of cells. Wilbrandt and Rosenberg[8] have shown that phosphatase is closely associated with the secretory transfer of molecules across cell membranes. Whereas individual theories have been advanced in attempts to explain the association of alkaline phosphatase with individual items of this variety of cytological sites and functions, the explanations as a group have lacked unity. But a unity of pattern emerges immediately if it is assumed that in all cases we are concerned with *contractile proteins*.

It is now well established that the contractility of the protein myosin is closely associated with adenosinetriphosphatase activity. The general theory which is now advanced is that in all the phenomena mentioned in the previous paragraph a not greatly dissimilar contractile protein and phosphatase activity are concerned.

Goldacre[9] has advanced an elegant theory, in which he suggests that amœboid movement and secretion may both be accomplished by contractile proteins. If his theory were correct, contractile proteins would be required at the surfaces of cells, and particularly at those cellular surface sites at which alkaline phosphatase has been discovered by cytochemical methods. It may now be suggested that the function of the alkaline phosphatase at these sites is not simply to hydrolyse phosphate esters, as has hitherto been supposed, but to provide the focal points for release of the energy required for protein contraction and extension. In some cases the whole energy of hydrolysis of a phosphate bond may be required for the process of transfer, so that for each molecule transferred across the cell membrane an orthophosphate ion will appear. But it would be much more economical of energy, and is therefore intrinsically more probable, that for the most part the enzyme acts, not as a phosphatase, but as a phosphokinase, transferring a phosphate group from a high-energy bonding, as in adenosinetriphosphate, to a lower-energy bonding. In such a process the difference in energy between the two bondings would be available for the protein contraction : the transferred phosphate group may appear on the transferred molecule, giving the transfer the overall character of a trans phosphorylation.

Chromosomes are known to contract to a very marked degree in mitosis and meiosis. Phosphatase is commonly present on meiotic and mitotic chromosomes : it is now suggested that the phosphatase represents a key enzymic centre of a contractile protein system which is responsible for the contraction of chromosomes. It is notable that phosphatase is also commonly found in the chromocentres of intermitotic nuclei, which are probably regions of persistent, or perhaps intermittent, chromosome contraction : here also, phosphatase may be an integral part of the contractile protein of the chromosome.

A similar view may be taken of the phosphatase of newly formed collagen. One of the most striking features of the healing of a wound is the contraction which occurs as collagen is laid down. The collagen at the time of contraction is rich in phosphatase, and it is now suggested that collagen is fundamentally a contractile protein and that the phosphatase represents the enzymically active centres concerned either in contraction or in extension. When collagen contraction is complete, there is no further requirement of contractile energy, and it is thus not surprising that mature collagen contains little phosphatase. In vitamin C-deficient guinea pigs, although much protein is formed in healing wounds, it lacks phosphatase, and, as is required by the present theory, no contraction occurs.

Thus all the facts available at the present time are compatible with the view that many of the phosphatases found in animal cells are integral parts of contractile proteins. To separate the enzyme from cells it is often necessary to resort to drastic procedures, including partial autolysis. Thus the soluble phosphatases of the biochemist (for example, kidney phosphatase) often are likely to be, in the strict sense, artefacts.

It is well known that the biological function of a molecule depends upon the nature of the colloids in its environment. Thus when hæm is associated with different proteins, one obtains hæmoglobins of various types, cytochromes, cytochrome oxidases, catalases or peroxidases, according to the natures of the proteins. Further, even with an established type of enzyme activity, the specific degree of activity may vary notably when different supernumerary colloids are in the environment. Keilin and Mann[10] have shown this is the case with carbonic anhydrase, and Keilin and Hartree[11] have observed this phenomenon with succinic dehydrogenase. Consequently, when we consider purified isolated phosphatase, it must be remembered that the protein of the enzyme may well be much modified from that originally present in the cell, and that the remaining enzyme activity may be a very poor guide to the function of the enzyme in the cell. We may even speculate whether the co-existence inside cells of phosphatases and phosphate esters is not made possible by the so-called phosphatases having little or no phosphatase activity when in their correct cellular environment.

With these points in mind, it seems advisable to regard all purified enzymes as at least partial artefacts, until the contrary has been demonstrated.

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Histamine Release by Anaphylatoxin

Early studies of the mechanism of anaphylaxis led to two apparently contradictory views : the so-called 'humoral theory', according to which the blood is the site of production of a toxin, the anaphylatoxin[1–4]; and the 'cellular theory', which localizes the anaphylactic reaction in the cells, and assumes that this reaction causes the release of histamine from the tissues[5,6]. The anaphylatoxin theory was based on the finding that guinea pig serum treated with the specific precipitate or with kaolin, barium sulphate, agar, starch or inulin, becomes toxic for the guinea pig and, if injected intravenously, produces symptoms indistinguishable from true anaphylaxis.

The finding by various authors[7,8] that contact of the antigen with washed, perfused lungs of the guinea pig in the absence of blood is sufficient to release histamine led to the general acceptance of the cellular theory and completely obscured the humoral theory. However, in other species, such as the rabbit and the dog, the blood is known to participate in the anaphylactic reaction of histamine liberation[9]. Evidence that the blood, when activated, contains a powerful agent for the release of histamine was first presented by one of us in experiments in which the dog's liver was either perfused with Tyrode solution or with blood. It was known[10,11] that, *in vivo*, enormous quantities of histamine, amounting to milligrams, are released from the dog's liver during anaphylactic and peptone shock. On the other hand, the release of histamine by antigen or peptone from a dog's liver perfused with Tyrode solution amounted to a few micrograms only. If, however, whole blood was used for the perfusion, and particularly if the blood was collected without any anticoagulant in flasks covered with silicone, an entirely different result was obtained. When peptone was added to such blood, which was then pumped through the liver, as much as 8 mgm. of histamine and 25 mgm. of heparine were released[12]. This finding suggested the existence of a powerful histamine-releasing agent in the blood of the dog. A similar discrepancy concerning the release of histamine from the dog's liver was found by Reid[13] with *d*-tubocurarine when it was either injected intravenously or perfused through the isolated liver.

Recently, Hahn[14] has shown that antihistamine substances are able to prevent the shock which is produced in guinea pigs by an anaphylatoxin prepared from a guinea pig serum incubated with inulin. This observation would suggest that anaphylatoxins also act through histamine release, a possibility which was tested and proved to be true by the following experiments.

The lungs of fifteen guinea pigs were perfused with Tyrode solution at a rate of 15–25 ml. per min. After a few minutes perfusion, 4 ml. of 'activated' guinea pig serum was injected into the cannula and the perfusate assayed for histamine on guinea pig's gut. The histamine values were expressed as base. Activation of the serum was by incubation with 0·2 ml./ml. of an agar suspension prepared according to Bordet[3], the so-called agar-anaphylatoxin.

During the first few minutes after the injection of the activated serum, large amounts of histamine were released from the lungs. In one experiment in which the serum had been dialysed before agar treatment, its injection caused the release of 103 μgm. histamine in the course of 10 min.; the maximal output per minute was 23·2 μgm. In other experiments in which activated serum without previous dialysis was injected, the total outputs ranged from 14·3 to 32·6 μgm. (average 23·5 μgm.) and the maximal outputs per minute from 7·3 to 21·3 μgm. (average 14·5 μgm.). These values have to be contrasted with the few micrograms of histamine released by contact of antigen with washed guinea pig's lungs. In such experiments Bartosch, Feldberg and Nagel[7] obtained between 0·5 and 4 μgm., and Daly, Peat and Schild[8] between 0·17 and 12 μgm. of histamine only.

Heating the serum for 30 min. at 60° C. before the addition of the agar suspension abolished, and at 56° C. reduced, the activating effect of the agar. After activation, somewhat higher temperatures were required. Heating activated serum for 1–2 hr. at 60–65° C. diminished its potency in releasing histamine. For example, in four lungs the average output of histamine after the injections of unheated serum was 23·5 μgm. as compared with the average output of 9·5 μgm. from four other lungs following the injection of heated serum. This difference is significant ($t = 4 \cdot 5$; $P < 0 \cdot 02$). After precipitation of the proteins with alcohol at boiling point, or for 15 min. at 65° C., the filtrate, dried *in vacuo* and taken up in 4 ml. water, no longer released histamine from perfused lungs. Dialysis of activated serum did not affect its histamine-releasing property.

The results of these experiments enable us to bridge the two main opposing views concerning the mechanisms underlying anaphylaxis and related phenomena. The presence, in circulating blood, of a powerful histamine-releasing agent which can easily be activated may be of importance not only for anaphylaxis but also for the etiology of a number of other pathological conditions, particularly of allergic phenomena.

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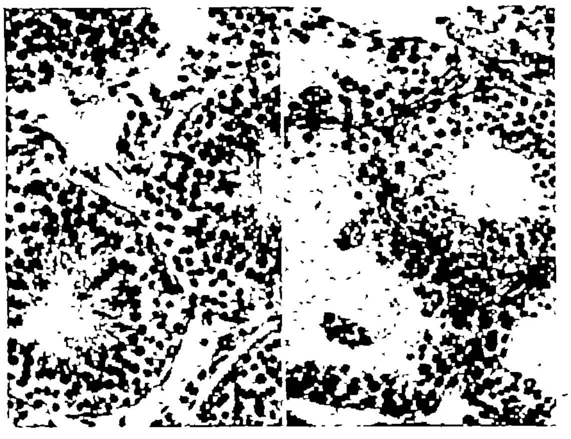
Thyroxine Therapy in Male Infertility

Very little systematic work has been done on the influence of the administration of thyroxine in physiological doses on male infertility in animals of different ages. This seems to have some practical value in the field of reproductive physiology, as male fertility decreases with advancing age and so does the rate of secretion of thyroxine. The question then arises whether any relationship exists between poor fertility and the decline in the rate of secretion of thyroxine in older animals and, if so, what is the effect of the administration of different doses of thyroxine on the male reproductive processes. In the present experiment, nine buck rabbits (inbred strains), which were classed as infertile in view of their poor breeding records, were used for studying the effects of the administration of known doses of thyroxine on libido, semen qualities and testis histology.

Two weeks before the start of the experiment and for eight weeks during the period of treatment with thyroxine, semen samples were collected biweekly by means of an artificial vagina. Sexual desire and semen qualities were estimated for the individual bucks. The results suggested that one of the causes of low fertility in the buck rabbits is a decrease in the rate of secretion of thyroxine which occurs with advancing age, because the administration of moderate doses of thyroxine greatly improved the sexual desire and semen qualities and stimulated the process of spermatogenesis in the seminiferous tubules of the testis of the treated rabbits, which before starting the treatment showed poor sexual desire, deterioration in semen qualities and arrested spermatogenesis (Figs. 1 and 2). A number of giant cells were observed in some of the seminiferous tubules of the testes of the untreated infertile buck rabbits (Fig. 2). The formation of these giant cells appears to be associated with arrested spermatogenesis. A peculiar type of sperm abnormality observed in the semen samples collected from these untreated buck rabbits[1] disappeared with thyroxine treatment, evidently due to the marked stimulation of the process of spermatogenesis, which was observed on histological examination of the testes. The younger buck rabbits responded to the thyroxine treatment comparatively better than the older ones.

The poor sexual desire in the untreated buck rabbits seems to have been due to the interference with the production of the male sex hormone by the interstitial cells of the testes, since on histological examination the interstitial cells showed atrophic changes, with a decrease in number and an increase in the intertubular stroma. I found[2,3] that during the non-breeding season in the young ram there occurs a similar marked decline in libido, semen qualities and in the process of spermatogenesis. Administration of thyroxine in physiological doses to young rams during the non-breeding season practically maintained the sexual desire, semen qualities and the process of spermatogenesis at the same level as that estimated during the breeding season. I have discussed elsewhere[4] the mechanism responsible for the seasonal decline in male fertility. Thyroxine therapy greatly improved the libido and fertility-rate of a young Essex boar, which before treatment showed poor libido and a marked decline in the fertility-rate observed during the summer months.



Sections of the testes of infertile buck rabbits: (1) showing arrested spermatogenesis; the lumina of the tubules contain protoplasmic debris; (2) showing atrophic and degenerative changes, with giant cells in the seminiferous tubules. × 200

The mechanism whereby the thyroid gland influences the male reproductive processes has already been briefly outlined by me[5], and it has been suggested that there is an interrelation between the thyroid, adrenals and gonads[5,6]. Further, addition of thyroxine in critical concentrations to bull semen samples resulted in an increase in the oxygen uptake of the spermatozoa after storage for 24–44 hr. at + 5° C. *in vitro*[7]. The present results show that the administration of thyroxine in physiological doses considerably improves the libido, semen qualities and the process of spermatogenesis in infertile buck rabbits. Detailed results will be published elsewhere.

I would like to thank Dr. J. Hammond and Dr. A. Walton for their help during the course of the present investigation.

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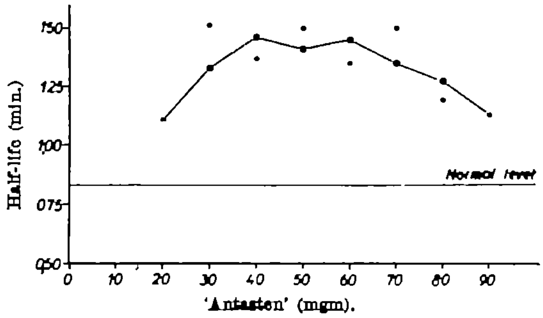
Effect of Antihistamine on the Reticulo-endothelial System; Investigation of Reticulo-endothelial Function with the Aid of Radioactive Chromium Phosphate

IN 1947, Jancsó[1] put forward the view that histamine is an activator of the reticulo-endothelial system and antihistamine is an inhibitor. Halpern and his co-workers[2] carried out investigations on the subject which supported Jancsó's observations. Biozzi[3] has reported that antihistamines prevented the absorption of indian ink by endothelial cells.

In the investigations here, the influence of antihistamine on the colloid-absorbing ability of the reticulo-epithelial system was examined by means of intravenous injection of a radioactive chromium phosphate suspension (labelled with phosphorus-32),



Biological half-life in the blood of intravenously injected labelled chromium phosphate in rats after subcutaneous treatment with different doses of 'Antasten'. ○, Mean of individual observations (10 animals in each group). ●, Moving mean values

Method. The antihistamine used was 'Antasten' (Ciba, Switzerland: 2-phenylbenzylaminomethyl-imidazol). The colloid-absorbing ability of the reticulo-endothelial system was estimated in two ways:

(*a*) By determining the biological half-life of intravenously injected radioactive chromium phosphate in the blood of animals treated with 'Antasten' and comparison with normal values. This shows the rate at which the reticulo-endothelial system removes the colloid from the blood circulation.

(*b*) By investigating the effect of 'Antasten' treatment on the distribution in the body of the intravenously injected radioactive chromium phosphate[4,5].

All experiments were carried out on white laboratory rats of a body-weight of 140–150 gm. and of both sexes. Eighty rats were injected with different doses of 'Antasten', as was done by Jancsó. Ten rats in each group were injected with 20, 30, 40, 50, 60, 70, 80 and 90 mgm. in two equal portions at 30-min. intervals. Fifteen minutes after the last injection, the reticulo-endothelial system functional test was carried out, and the biological half-life of the radioactive chromium phosphate in the blood was determined.

In the second series, thirty rats were used. Five groups of five animals were treated with different doses of 'Antasten', 20, 40, 60 and 80 mgm., in the same way as in the first series; as a control, five rats were injected with an isotonic saline solution instead of 'Antasten'. Fifteen minutes later, all the animals were injected with the chromium phosphate preparation, and two hours later they were killed and the radioactivity of the different organs was determined.

Table 1. BIOLOGICAL HALF-LIFE OF RADIOACTIVE CHROMIUM PHOSPHATE IN THE BLOOD AFTER SUBCUTANEOUS INJECTION OF VARIOUS DOSES OF 'ANTASTEN' (COMPARED WITH CONTROLS WITHOUT 'ANTASTEN' INJECTION)

Dose of 'Antasten' in mgm.	Biological half-life (min.)	
	Exp. animals (10 per group)	Control animals (25)
20	1·11 ± 0·05 0·147	
30	1·51 ± 0·15 0·460	
40	1·37 ± 0·07 0·218	
50	1·50 ± 0·07 0·224	0·83 ± 0·05 0·250
60	1·35 ± 0·11 0·334	
70	1·50 ± 0·09 0·293	
80	1·19 ± 0·08 0·266	
90	1·13 ± 0·09 0·271	

$\bar{X} \pm s\bar{X}$ = mean of individual observations and its standard error

σ = standard deviation of observations

Results and Discussion. Table 1 and the accompanying graph show the collected results of the biological half-life determinations in the series of eighty rats. The radioactive colloid circulates longer in the blood after treatment with 'Antasten' than it does in normal animals, and the uptake of the colloid in the reticulo-endothelial system is retarded. The biological half-life is distinctly prolonged after 20 mgm. of 'Antasten' and still further prolonged with 30 mgm. There is no further increase with doses between 30–70 mgm., and with doses of 80 and 90 mgm. the biological half-life approaches the normal value. Table 2 shows the statistical analysis of the results obtained.

Table 2. DIFFERENCE IN BIOLOGICAL HALF-LIFE AFTER VARIOUS DOSES OF 'ANTASTEN' (CF. TABLE 1 AND GRAPH). ANALYSIS OF VARIANCE

Type of variance	Sums of squares	d.f.	Variance	*F*	*P*
Between class	2·03	7	0·29	3·41	$0·01 < P < 0·001$
Within class	6·08	72	0·08		
Total	8·11	79			

The analysis of variance (Table 2) shows that the variation between the half-life values in the graph could not have arisen at random. Furthermore, the component mean values which constitute the curve differ significantly from the control values, as is obvious on mere inspection of the values in Table 1 and the graph.

In a previous report[5], it was shown that the ratio of distribution of radioactive colloids was constant in normal animals for the liver, spleen and lungs. The control animals injected with an isotonic saline solution exhibited similar amounts of radioactivity in the liver, spleen and lungs as those treated with various doses of 'Antasten'. These experiments have shown that 'Antasten' does not have any particular point of attack in the reticulo-endothelial system.

The results above indicate that 'Antasten' has a significantly inhibitory effect on the rate of colloid absorption in the reticulo-endothelial system; but with the methods employed it was not possible to show any special inhibition of the reticulo-endothelial cells of the liver, spleen or lungs.

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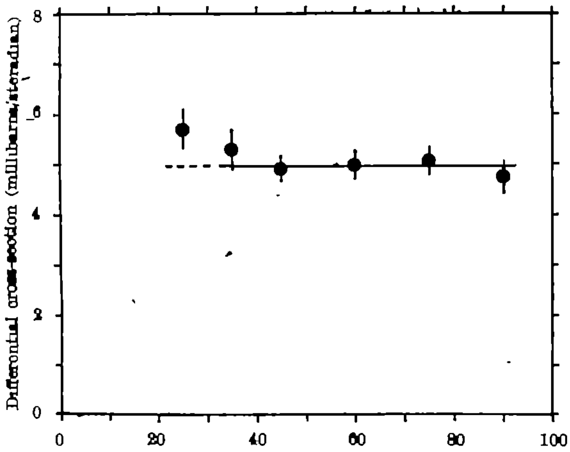
Proton–Proton Scattering at 146 MeV.

A PROTON beam has been extracted from the 110-in. Harwell cyclotron by scattering the internal beam at a uranium target[1]. Deflected protons escape from the cyclotron along a path sheltered from the magnetic field by an arrangement of iron bars[2]; but sufficient field remains to separate outgoing protons of different energies. Protons of 147 ± 1 MeV., as determined by their corrected[3] range in aluminium, are selected by slits and passed down an evacuated tube 12·7 metres long to a point behind a concrete screening wall. A flux of 2×10^6 protons-cm.$^{-2}$-sec.$^{-1}$ is available at the end of the tube, and this is monitored by an ionization chamber and an integrating D.C. amplifier.

The external beam has been used first for a study of proton–proton scattering with the results shown in the accompanying graph. The experiment has been carried out with polyethylene scatterers, the effect of the carbon present being subtracted with the help of graphite scatterers.

Relative cross-sections between 35° and 90° were measured by coincidence counting of both the protons involved in each collision. At 35° a very thin scatterer had to be used because the energy of one of the protons is much reduced at small angles of scattering. At 25° only the 'forward' proton could be detected, and the results at this one angle may



Differential cross-section for proton–proton scattering as a function of centre of mass angle. The incident protons had a laboratory energy of 146 ± 1 MeV. The errors shown are statistical standard deviations on the relative measurements at the various angles. The absolute cross-section at 90° has been found to be 4·99 ± 0·31 millibarns-steradian^{-1}, and the weighted mean of the points between 35° and 90° has been normalized to this value

have been affected by systematic errors. When only one proton was being counted the carbon effect increased greatly, so that the final result was obtained from a small difference between two much larger counting-rates. The errors given in the graph are the statistical standard deviations on these relative measurements.

The absolute cross-section was obtained through a comparison of the differential proton–proton cross-section at 90° with the cross-section for the $^{12}C(p,pn)^{11}C$ reaction. This reaction was observed by irradiating a clear naphthalene crystal and afterwards examining it with an *E.M.I.* photomultiplier, guard crystals being used to prevent any of the carbon-11 decay positrons from escaping. The efficiency of detection of these positrons during the calibration run was found to be 87·2 ± 1·7 per cent by fitting an integrated Fermi distribution to the bias curve of counting-rate against discriminator voltage. This value for the efficiency was checked by the usual coincidence method, using a sodium iodide crystal to detect annihilation γ-rays. The ratio of the differential proton–proton cross-section at 90° to the $^{12}C(p,pn)^{11}C$ cross-section was found to be 0·0787 ± 0·0031 at an effective energy of 146 ± 1 MeV., allowance being made for the slowing down of the primary protons in the scatterer and crystal. The stated standard deviation is intended to cover likely systematic errors. Adopting[4] 63·4 ± 3·0 millibarns for the $^{12}C(p,pn)^{11}C$ cross-section, the differential proton–proton cross-section at 90° was calculated to be 4·99 ± 0·31 millibarns-steradian^{-1}. Since the relative cross-sections between 35° and 90° showed no evidence of anisotropy, the angular distribution measurements were normalized so that the weighted mean of these five points was equal to 4·99 millibarns-steradian^{-1}.

Proton–proton scattering at high energies has previously[5–7] been found to be isotropic at 100, 240 and 345 MeV. The absolute magnitude of the cross-section given here is also quite consistent with these three sets of results, but it is rather higher than that found by Chamberlain, Segrè and Wiegand[8] in another series of experiments, in which the external proton beam of the Berkeley cyclotron was slowed down by absorbers. In terms of the theory of Jastrow[9], the higher cross-section suggests that the proposed central repulsion in the proton–proton interaction is at a radius not greater than 0·50 × 10^{-13} cm.

Much of the apparatus used in this experiment was made by Mr. R. A. Gibbons and assembled by Messrs. P. H. Bowen and L. Bird. The proton monitor was supplied by Mr. L. Pittendrigh. The work was greatly assisted by the enthusiastic co-operation of Mr. A. O. Edmunds and the cyclotron crew.

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Radiocrystallographic Study and Molecular Weight of Actinomycin from *Streptomyces* S-67

THE crystals of actinomycin obtained by one of us[1] are prismatic monoclinic needles, with the length parallel to the binary axis. The mean values of the angles between the most frequent faces are:

$p(001)$	:	$h^1(100)$	00° 17′
$h^1(100)$		$a^1(10\bar{1})$	71° 20′
$p(001)$	·	$a^1(\bar{1}01)$	39° 23′
$e^1(011)$	:	$g^1(010)$	63° 35′
$m(110)$	:	$g^1(010)$	53° 27′

The ratios of the parameters obtained from these values are:

$$a : b : c = 0{\cdot}793 : 1 : 0{\cdot}531$$

and the angle β is 110° 43′.

The crystals are optically positive. A thin plate (001) shows an optic axis pole at the limit of the field. The plane of the optic axes is parallel to $g^1(010)$ and the greatest refractive index n_γ is in the direction nearly perpendicular to $p(001)$ in the obtuse angle of the b- and c-axes. No dichroism was observed.

Rotating crystal radiograms were taken with a, b, c and [101] as rotating axes. The pictures generally show diffraction spots only in the proximity of the direct beam.

The spots corresponding to the b- and [101]-axes are sharp and the length of the axes deduced from these radiograms are:

$$b = 27{\cdot}30\ kX. \quad (101) = 21{\cdot}72\ kX.$$

The radiogram corresponding to the c-axis is not very well defined; apparently, however, there is a periodicity which together with that of the b-axis gives the value $c/b = 0{\cdot}524$, in agreement with the goniometric results.

From the very accurate value of the b-axis, and using the goniometric ratios, the length of the a-

and *c*-axes may be calculated with an accuracy which we think is better than that obtained by the absolute measure of the axes. So we have

$$a = 21\cdot 64\ k\text{X.}; \quad c = 14\cdot 50\ k\text{X.}$$

The volume of the unit cell, $V = abc \sin \beta$, is 8,012 $k\text{X.}^3 \pm 1$ per cent.

The density, measured accurately with the Berman torsion balance, is $1\cdot 18 \pm 1/2$ per cent.

From the well-known formula

$$n = \frac{V.d}{M \times 1\cdot 65},$$

we have *nM* (molecular weight of the unit cell) = 5,730.

The number of molecules in the unit cell is unknown.

We determined the proline in actinomycin hydrolysate by microbiological assay[2] and calculated the molecular weight on this basis. 100 mgm. of actinomycin were hydrolysed by refluxing for 48 hr. with 6 *N* hydrochloric acid at 110°. The residue was evaporated to dryness, a small quantity of water was added and the suspension was filtered. The volume of the filtrate was made up to 100 c.c. by washing the filter. For the microbiological assay, 15 c.c. of the resulting solution was diluted to 100 c.c., to give a solution containing 150 γ of actinomycin per c.c.; 24·3 γ per c.c. of proline was found. The probable accuracy of this result appears to be ± 5 per cent, judging from simultaneous assay of a known mixture of amino-acids.

From the molecular weight of proline (115), it is possible to calculate the molecular weight of actinomycin:

$$\frac{150 \times 115}{24\cdot 3} = 710 \pm 35$$

(assuming one mole of proline per mole of actinomycin).

On the basis of the above calculations, the number of molecules per unit cell appears to be eight, and the molecular weight of actinomycin would be 716 ± 15.

The Rast cryoscopic method, however, gives a lower value (576)[1], and in this case the calculated molecular weight may be 573 (assuming that there are ten molecules per unit cell).

The value obtained from the microbiological assay appears to be better than the one obtained by cryoscopy, because of the very low solubility of the actinomycin in camphor.

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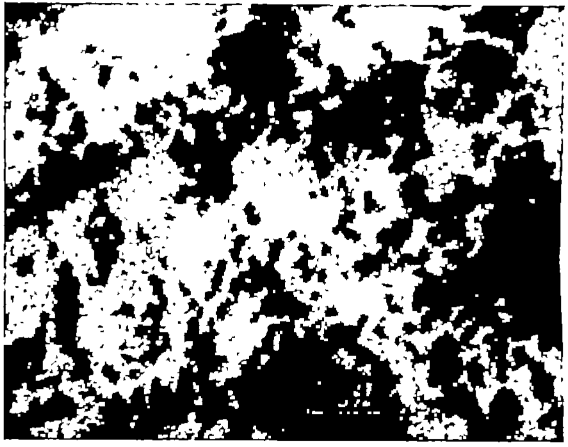
An Electron Microscope Study of Nucleic Acid

Probably the only macromolecules which have been observed directly are some of the larger proteins seen with the electron microscope. Although many polymers have a molecular size as great as these proteins, the width of the polymer chains is too small for them to be visible. The following observations on nucleic acid, however, suggest that these molecules can be seen individually.



A preliminary study has been made in the electron microscope of calf thymus sodium nucleate prepared by Signer, Butler and Fraser. In general, micrographs were obtained of replicas of the surfaces of dried drops from aqueous solution or smeared sheets of thymonucleate, the replicas being prepared by shadowing the thymonucleate with palladium – gold at $\tan^{-1} 1/6$ and coating with a 'Formvar' film. The replica was then floated off on the surface of water or a dilute solution of sodium hydroxide, when the thymonucleate dissolved. Other methods of preparation were also used; but that described is superior in avoiding shadowing of structure due to the 'Formvar' itself. The specimens before replicating were all faintly birefringent.

All the specimens examined showed globules of varying diameter with an average value of about 100 A. This would be compatible with a polymer having a distribution of molecular weights about a mean value of approximately 10^6. Close examination of the clear regions of the micrographs (see accompanying reproduction) suggests that they are genuinely free of globules; that is, the thymonucleate molecules are in a form the details of which are below the resolving power of the electron microscope. A spurious effect, due possibly to diffraction or shadowing, was seen on a few micrographs which could be interpreted as showing the molecules as fibres of about 50 A. diameter, in support of Oster and Nixon's observations[1]; but otherwise no evidence has yet been obtained of any fibrillar structure, although occasionally globules tend to align themselves to give the appearance of a fibre similar to those found by Scott[2]; it is not certain, however, to what extent this effect is due to drying.

A tentative explanation of these results is that, on drying, surface molecules are unstable and coil up; but in the bulk of the material the molecules remain extended owing to the intermolecular forces and lie parallel to one another, as shown by X-ray diffraction, birefringence, etc. (see, for example, ref. 3). The breadth of a polynucleotide chain is expected to be about 15–20 A., so that in the extended state the molecules are below the resolution of the microscope. Occasionally, therefore, the 'smooth' formation of the bulk material is seen in regions free from coiled molecules.

Further work is in progress, and a more detailed account will be published later.

I wish to thank Prof. R. Signer, Dr. J. A. V. Butler and Dr. M. J. Fraser for sodium thymonucleate; Prof. J. T. Randall for advice and encouragement throughout the work; and Dr. M. H. F. Wilkins for the preparation of some of the specimens and for valuable discussions.

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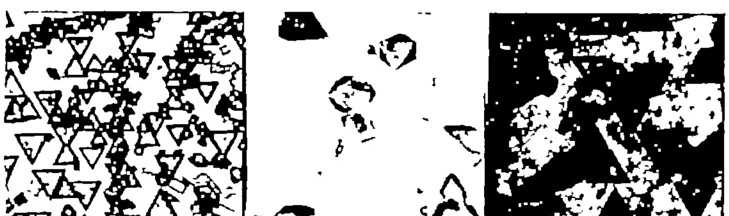
Epitaxis of Rubidium Iodide on a Barium Stearate Substrate Deposited on Mica

The oriented overgrowth formed by rubidium iodide on a mica substrate has been recorded by Royer[1] and others. In the course of repeating these experiments the substrate was modified; instead of a muscovite substrate, barium stearate deposited on freshly cleaved muscovite was used, the deposit being built up as a succession of monomolecular layers.

Rubidium iodide crystallizing from an aqueous solution on a substrate of glass or of barium stearate (one to nine molecular layers) on glass does so in the cubic habit, whereas on mica the crystal outline is in most cases an equilateral triangle with sides parallel to the traces of the (010), (110) and ($1\bar{1}0$) planes of mica, the (111) plane of rubidium iodide being parallel to the (001) plane of mica. Some crystals, however, assume the cubic habit in random orientation with respect to the mica; but if dilute solutions are used their number is very much reduced. If the crystallization is carried out on barium stearate layers deposited on the mica, the proportion of unoriented cubic crystals increases with the thickness of the barium stearate barrier.

Layers of one, three, five, six, seven and nine monolayers were used, and with nine layers oriented crystals only occasionally appeared. It appeared, therefore, that a barium stearate barrier of nine molecules thick was sufficient to eliminate the influence of the mica.

In the (111) plane of rubidium iodide, the directions of greatest atom density are those which form the boundaries of the triangular crystals. The directions next to these in atom density would outline a hexagon; hexagonal crystals, which are absent when rubidium iodide crystallized directly on mica, appeared when a barrier of barium stearate of three, five or seven layers was interposed; also the triangular crystals frequently grew in connected groups of three, especially when deposition was on a monomolecular barrier.



(1) Rubidium iodide crystals grown on mica. (2) Rubidium iodide crystals grown on a three-molecule layer of barium stearate deposited on mica, showing the development of hexagonal outlines (*a*), an unoriented cubic crystal (*b*), and a connected group of three (*c*). (3) Connected groups of three crystals growing on a monolayer of barium stearate on mica. In each photograph the longest side is parallel to the *b*-axis of the mica, and the magnification × 60

The layers of barium stearate were deposited by dipping a freshly cleaved mica slip, c. 50 mm. × 7·5 mm., through a monomolecular layer of barium stearate spread on a water surface, the technique being that described by Blodgett[2].

I wish to acknowledge the assistance of Mr. D. C. Bisset of this Department, who undertook the deposition of the monolayers.

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Intense Gallium X-Rays for Microradiography and Diffraction Investigations

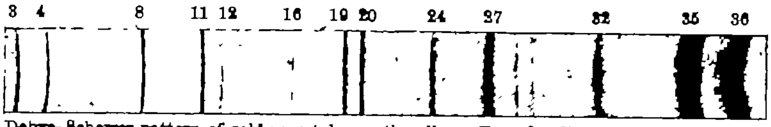
The identification of segregates in ferrous and non-ferrous alloys by the technique of microradiography[1-4] is now established as an extremely valuable complement to the conventional optical micrographic procedures. The contrast between segregate and matrix is independent of the etching characteristics of the metal, but depends, instead, on the relative absorption of the X-ray beam through a finite depth of specimen. Since the linear absorption coefficient μ is $C \, . \, N^4\rho\lambda^3$, where N is the atomic number of the absorbing element, ρ its density, λ the wave-length of X-rays and C a constant between absorption edges, it follows that, provided suitable wave-lengths are available, a segregated element may be positively identified by X-ray methods alone. When it is sought to distinguish between two elements close to each other in atomic number, it is possible to accentuate the contrast in X-ray absorption by choosing a radiation with a wave-length lying between the K-absorption edges of the elements.

For the bulk of alloys normally investigated, the range of wave-lengths available for microradiographic examination is, on the whole, quite adequate, with the exception of the commercially important group which comprises the brasses. As shown in the accompanying table, the only radiation capable of discriminating satisfactorily between copper and zinc-rich segregates is the $K\alpha$-radiation of gallium, and this radiation has hitherto not been available.

On account of its extremely low melting point (29·75° C.), it would be impossible to employ gallium as a target material in the normal types of sealed-off or demountable X-ray tubes, unless the current were kept down to a few micro-amperes. This in its turn, would make exposure periods inordinately long and quite impracticable except for very special purposes. However, the situation is quite different when a rotating anode X-ray tube is employed. By carefully

Target material and wave-length in A.		Linear absorption coefficient μ Cu	Zn
0·559	Ag	236	201
0·585	Pd	265	233
0·613	Rh	303	269
0·708	Mo	448	391
1·339	Ga	3440	426
1·433	Zn	425	350
1·538	Cu	470	421
1·656	Ni	580	514
1·786	Co	720	620
1·933	Fe	882	780
2·100	Mn	1080	970
2·287	Cr	1370	1206

cleaning the cylindrical copper surface of the 4-in. diameter anode of a 'Gyrotron' X-ray tube[5], it was quite a simple matter to cover its slightly warmed surface with a uniform thin layer of gallium, simply by rubbing it on until it adhered. A continuous output of X-rays corresponding to a mean current of 80 m.amp. at 40 kVp. with focal spot dimensions 0·8 mm. × 8·0 mm. could easily be achieved. During the emission of X-rays, the gallium at the focal spot is, of course, liquid, but instantly freezes on moving away from the electron stream. So adherent is the film and so short is the period in which it is liquid, that no gallium is thrown off the anode surface due to centrifugal forces, nor, because of the efficient cooling, is there any intergranular attack which would cause disintegration of the copper base.



Debye–Scherrer pattern of gold wire taken with gallium $K\alpha + \beta$-radiation in 9-cm. diameter camera. Exposure 60 m.amp., 40 kVp., 1¼ min.

Since the focal spot is small, the intense beam of gallium radiation may also be employed for X-ray diffraction work. A typical Debye–Scherrer diffraction pattern of gold wire in the 'as drawn' condition and taken in a 9-cm. diameter camera with gallium $K\alpha + \beta$-radiation is reproduced herewith. The exposure period, with the tube operating at only 60 m.amp. and 40 kVp., was approximately 1¼ min.

The wave-length of gallium $K\alpha$-radiation is appreciably shorter than that of copper $K\alpha$. Thus, in suitable cases, much more information may be obtained from gallium radiation diffraction patterns than copper, since additional reflexions at higher values of $\sin\theta/\lambda$ are possible.

The availability of this new radiation emphasizes the advantages of a rotating anode X-ray tube over the conventional demountable tube fitted with a stationary target. Not only does it make more power available with normal radiations, thereby curtailing exposure times, but also its flexibility enables entirely new techniques to become available.

I should like to express my thanks to the Mond Nickel Co., Ltd., for permission to publish this communication.

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Birmingham. July 24.

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Applications of Multiple-Beam Interferometry

PROF. S. TOLANSKY[1] has made some comments on communications by Bruce[2] and Bruce, Macinante and Kelly[3] on the production and applications of transmission-like reflexion fringes. I am grateful for the reference to the paper by Lummer[4] in which the principle of eliminating beams in a Haidinger fringe system is mentioned.

The first of our communications refers to a Fizeau fringe system, where the relevant beams were eliminated practically, in a very simple manner. The transmission-like reflexion fringes so produced were used with particular success in vibration measurement. No claim is made for the extensive use of such fringes in the topographical study of small areas where high magnification is required. They have been produced in the low-magnification systems so frequently used in the interferometry of length.

It is not suggested that the reflexion fringes shown in the communication are the optimum in contrast, and it is agreed that reflexion fringes may be used in vibration studies; but we have found the transmission-like reflexion fringes a distinct advantage in our work.

The second communication, on vibration measurement, had been submitted for publication before we had seen the papers by Tolansky[5] and Tolansky and Bardsley[6].

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Sonic Layers in the Sea

THE article on 'scattering' layers in the sea by A. C. Burd and A. J. Lee in *Nature* of April 21[1] was read by us with much interest since such layers have been frequently observed in Scottish waters during the past three years.

The increasing use of the echometer as a fish-locating device during the past few years has raised the important problem of the assignment of characteristic echo traces to specific sound-reflecting surfaces. Hodgson[2] has shown that it may be possible at certain seasons and at particular times of the day to distinguish between shoals of several species of fish by the shape, density and texture of the echo traces; but traces are often obtained which cannot so readily be ascribed to particular organisms. Among these is the type, illustrated by Burd and Lee, which appears as a diffuse layer with the lower boundary frequently ill-defined; it is often recorded for long distances as an uninterrupted trace at varying depths from the sea-bed. For example, in our records such traces have extended for distances up to 35 miles on the

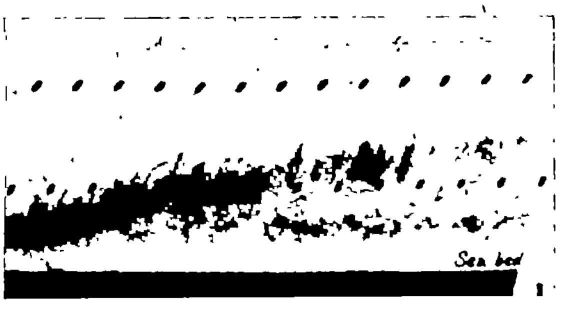

Fig. 1. Specimen of diffuse scattering layer obtained on M/S 12 Kelvin Hughes 14 kc./s. echo-sounder aboard the Scottish Home Department's F.R.S. *Clupea* while operating on Peterhead fishing grounds, August 5, 1948. (Depth marks on echo-trace are at 0, 20, 40 fathoms, etc., and the time interval between marks is 3 min.)

Moray Firth herring grounds. Some of our traces show the vertical migration observed by Burd and Lee, whereas others have been observed in the upper water layers in full daylight. This suggests that the 'scattering' layers may be produced by a variety of pelagic forms which sometimes are associated in the same layer. An interesting example in support of this is shown by the trace in Fig. 1 (supplied by Dr. H. Wood). This was detected near the sea-bed at sunset on August 5, 1948, on the Peterhead fishing grounds. On the approach of darkness the trace split into two parts, one of which rose towards the surface and stopped in the neighbourhood of a sharp thermocline, while the other persisted at a level about 10 fathoms from the sea-bed.

In order to ascertain the nature of this type of trace, we attempted to photograph the organisms with an underwater ciné-camera and a 1,000-watt light source, and to observe their reaction to underwater light stimuli. During 1950 some identifiable photographs (including fish and jellyfish) were obtained. One experiment in particular revealed something of the reactions and the type of the organisms producing traces of this nature. On July 20, 1950, off Fraserburgh, an extensive sonic layer was picked up in darkness at 0100 hr. This trace appeared as a diffuse record at approximately six fathoms from the surface. The vessel was stopped, and the sequence of events was as follows (the results being illustrated in Fig. 2). (1) The lamp was lowered a few feet below the surface of the water, and was switched on and left in this position for 15 min.; the scattering layer descended to a depth of approximately 10 fathoms and gradually increased in density. (2) The lamp was switched off for 3 min.; the layer remained dense and rose rapidly towards its previous level. (3) The lamp was lowered into the middle of the layer and was switched on; the greater part of the trace descended immediately to 20 fathoms; but some organisms remained at the level of the light. (4) The light was hauled to the surface and held there for 10 min. The main part of the scattering layer rose quickly to 10 fathoms; but some organisms rose to the surface. (5) The light was then switched off and the main body of the trace rose to its original level of approximately 6 fathoms.

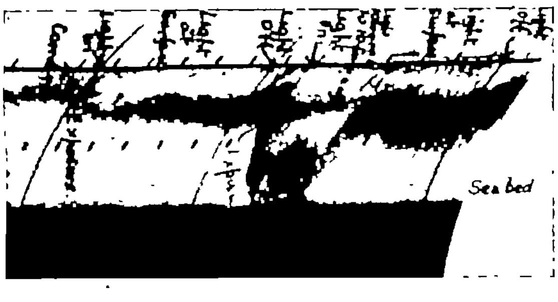

Fig. 2. Echo-trace illustrating experiments referred to in text. Time sequence of events indicated by numbered arrows. (Each tick denotes the passage of 3 min.)

The conclusions which we draw from these observations are: (*a*) Most of the organisms giving rise to this scattering layer were very active swimmers; their descent from 10 to 20 fathoms in a few seconds presumably eliminates from sole consideration such drifting forms as medusæ and the smaller plankton organisms. (*b*) The main body of the trace resulted from organisms showing positive phototaxis to a light intensity corresponding to that at a depth of 10 fathoms below the 1,000-watt lamp. (*c*) A smaller portion of the trace was composed of organisms showing a greater positive phototaxis, being attracted to within a few feet of the lamp; these we were able to identify from samples taken with a small hand-scoop as young scaled three-bearded rockling (*Onos tricirratus*) of 4–8 cm. in length, and sand eels (*Ammodytes spp.*) of 10–15 cm. in length, in the ratio of approximately 20 : 1.

In the absence of identifiable photographs on this occasion, it is not possible to determine to what extent these two species contributed to the main body of the patch which concentrated at approximately 10 fathoms below the light source, and in view of the difference in reaction to the light stimuli it is probable that species other than these fish were also present. Presumably a similar specific difference holds for Fig. 1.

These observations seem to have general interest in relation to the conflicting beliefs held as to the nature of the *deep* 'scattering' layers—whether they are of physical or biological origin. Testing their reactions to lights in their neighbourhood might help to resolve this question with high probability.

The presence of fish as one component of this type of scattering layer provides a possible explanation of our failure to secure more identifiable photographs with the camera-light unit used in these experiments. This particular unit had independent switches for the light and camera, the camera being set in operation before the light. Fig. 2 demonstrates clearly the immediate flight response of part of the scattering layer to light stimuli, which would have taken the organisms responsible rapidly out of the field of focus of the camera. Some species of fish are also known to adopt similar flight reactions to sound stimuli, and it is possible, therefore, that the noise made by the ciné-camera mechanism would have caused a similar flight response. During the present season a single-frame camera with electronic flash is being used. In this way it is hoped that all component organisms will be photographed before any movement away from the field of focus of the camera can be effected.

Further records of the presence of diffuse scattering layers in Scottish waters have come to our notice from a number of herring fishermen. One such record, kindly provided by Skipper G. Leslie of the drifter *Betty Leslie*, and from the Shetland herring grounds in June 1950, is of interest in providing further evidence of the presence of young fish in the scattering layer. In this instance a widespread diffuse trace, similar to those illustrated above, was obtained from the upper water layers, and Skipper Leslie shot his drift-nets at the trace depth. Although the trace persisted during the whole of the time that the nets were in the water, the total catch was only one adult herring; but entangled in the nets were vast numbers of small fish, a sample of which was collected and identified as post-larval unscaled herring of 3–4 cm. in length.

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[1] Burd, A. C., and Lee, A. J., *Nature*, 167, 624 (1951).

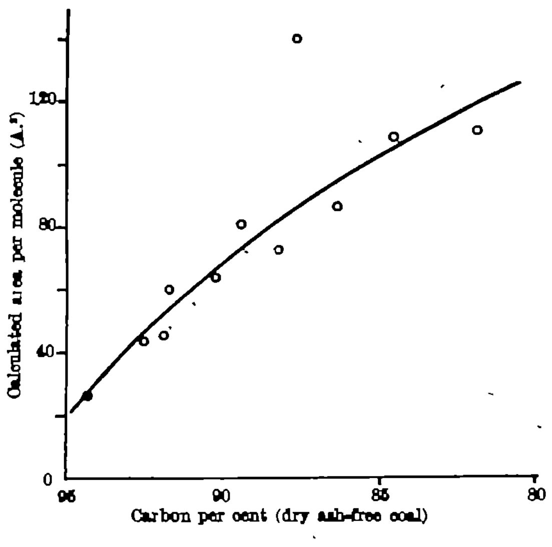
[2] Hodgson, W. C., Min. Agric. Fish., Fish Invest., Ser. 2, 17, No. 4 (1950).

Adsorption on Coal

IN a recent letter in *Nature*[1], Lecky *et al.* have reported that surface areas of coal obtained from low-temperature nitrogen adsorption are considerably smaller than areas determined from water and methanol adsorption, while Malherbe[2] found a similar discrepancy between areas of coal determined from low-temperature argon adsorption and heats of wetting in methanol. The doubts thus cast on the extent of the internal surface area of dry coal samples do not, however, necessarily apply to coal in its wet and swollen state, and it is in this form that coal is encountered in wet processing and also, as dust, in the lungs of coal-miners.

I have studied adsorption of organic molecules from aqueous and alcoholic solutions on coal. Adsorption on high-rank coals (for example, the anthracites) is often very high, even with low molecular weight solutes which give no evidence of multimolecular adsorption, suggesting that for these coals the heat of wetting in methanol does not over-estimate the internal surface. The area per molecule of solute, calculated from the apparent adsorption at final concentrations of 0·100 *N*, decreases as the rank of coal (and percentage carbon) decreases and the oxygen content increases. The accompanying graph gives results for the area per solute molecule in the case of acetic acid, heats of wetting in methanol being used as a measure of specific surface[3].

A similar gradation in the calculated areas is found with other solute molecules in aqueous solution, for example, formic acid, methyl and ethyl alcohol, methyl and ethyl acetate. The slope of the curves is dependent on the particular solute, being least pronounced for methyl alcohol. Adsorption presumably takes place through the non-polar portion of the solute molecule; Traube's law for homologous series is valid for coal except in cases where molecular sieve action is pronounced.



The gradation in calculated area per molecule is probably largely due to a true decrease in adsorption per unit area as the coal becomes more hydrophilic. Dependence of heats of wetting on the composition of the surface may be a contributory factor.

The available results will be more fully reported elsewhere. The observations reported above were obtained on coal samples supplied by the British Coal Utilization Research Association, by whom the heat of wetting determinations were carried out.

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July 26.

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Observation of Cool Flames with Ethylene

IN the course of investigations into the inflammability of ethylene/oxygen/nitrogen mixtures, some interesting observations have been made on the type of flame produced by spontaneous ignition at 300°. Experiments were carried out in a cylindrical steel bomb (explosion cavity 3·8 cm. dia. and 15·3 cm. long) mounted vertically and fitted with a quartz window near the top.

Several mixtures, containing 5–6 per cent of oxygen and 15–68 per cent of ethylene, were fed into the bomb at 300° and pressures up to 40 atm., and found to give rise spontaneously to two quite different types of flame.

(1) At 17–41 atm., a pale blue flame moving downward through the mixture. The flame front was about ⅛ in. thick, nearly planar, and possessed no tail. It travelled at a speed of approximately 1 cm./sec. and was associated with a gentle pressure 'pulse' of 0·5–1·0 atm. Titanic sulphate indicated small quantities of peroxides in samples of the gas taken immediately before or immediately after the passing of the flame. 50–90 per cent of the oxygen was consumed, 20–28 per cent being converted to formaldehyde and 1–2 per cent to acetaldehyde.

(2) At 25–41 atm., normal ignition occurred. The flame was bright red and moved too rapidly for visual perception of the flame front, that is, at least at (and possibly much faster than) 50 cm./sec. Much soot was produced and the gauge registered a sudden kick that sometimes exceeded 30 atm. No peroxides were detected, but all the oxygen was used up, about 16 per cent being converted to formaldehyde and 1–2 per cent to acetaldehyde.

The pressure at which the flame characteristics changed depended on the composition of the gas, and for each gas was located within a range of some 2–3 atm. Within this range, a two-stage ignition could sometimes be observed, the blue flame being followed by a normal ignition in the space of about one second.

The low-pressure flame has the following characteristics of a 'cool' flame: (i) pale blue and non-luminous; (ii) slow speed; (iii) small pressure pulse; (iv) capacity to lead to a two-stage ignition; (v) associated with peroxide and aldehyde formation.

Up to the present, however, attempts to produce similar flames artificially in cold gas mixtures with a feebly glowing platinum spiral have not met with any success.

Townend, in a study of the auto-ignition of ethylene/air mixtures[1], found no evidence of cool flames despite exploration over a wide range of values of temperature, pressure and composition. Since the present study differs only from this work in composition, namely, a greater quantity of nitrogen for all ethylene concentrations, it seems likely that the diluent effect of the nitrogen is a vital factor in the formation of cool flames in ethylene.

These observations were made in the Fuel Department of the University of Leeds, and we wish to express our appreciation of the interest taken by Prof. A. L. Roberts in this work. A detailed account will be published in due course. We wish to thank the directors of the British Oxygen Company, Ltd., for permission to publish this letter.

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Mode of Decomposition of Sulphur Sesquioxide

Wöhler and Wegwitz[1] tentatively assumed the formation of sulphur monoxide as an unstable intermediate compound in the decomposition of sulphur sesquioxide and thus accounted for the formation of thiosulphate and polythionates. Neither Partington and Vogel[2] nor Wöhler and Wegwitz obtained sulphur monoxide during the decomposition.

While studying the properties of sulphur sesquioxide, I heated a sample of the sesquioxide in an all-glass apparatus at 60° C. The volatile products of decomposition, when cooled in a U-tube immersed in liquid air, condensed to a pale yellow solid. On shaking with cold dilute alkali, this yellow residue gave rise to sulphide, sulphite, thiosulphate and sulphur.

When sulphur monoxide prepared by the combustion of sulphur in oxygen at low pressure (Schenk[3]) is cooled at the temperature of liquid air, a similar yellow condensate is obtained. On hydrolysis with cold dilute alkali the condensate gives rise to sulphide, sulphite, thiosulphate and sulphur, as in the case of the products of decomposition of sulphur sesquioxide mentioned above. It is thus concluded that the condensates in the two cases are the same. In other words, this experiment shows that the sulphur monoxide is produced during the decomposition of sulphur sesquioxide. It may be mentioned that the formation of the products of alkali hydrolysis has been explained by B. S. Rao[4] on the basis that disulphur monoxide is produced during the decomposition of sulphur monoxide.

Further support for this observation comes from the following experiment. When sulphur trioxide is led into a solution of sulphur in dry carbon tetrachloride, a dark blue solution of the sesquioxide is obtained. On subjecting this to alkali hydrolysis, it is noticed that sulphide, sulphite, thiosulphate and sulphur are produced. No detectable amounts of polythionates are formed. The production of sulphide during the hydrolysis of sulphur sesquioxide has been observed for the first time, and this is attributed to the production of sulphur monoxide as the primary product during the hydrolysis. The results of a representative experiment are:

Amount of sulphur (mgm.) in carbon tetrachloride (80 gm.)	Sulphur (mgm.) as SO_3 added to carbon tetrachloride	Products of alkali hydrolysis (in mgm.)			
		Sulphur as sulphide	Sulphur as sulphite	Sulphur as thiosulphate	Free sulphur
97·92	97·92	18·2	99·2	36·8	40·9

It is presumed that sulphur sesquioxide can decompose in two ways:

$$\text{(i)}\quad S_2O_3 \longrightarrow S + SO_3$$
$$\text{(ii)}\quad S_2O_3 \longrightarrow SO_2 + SO.$$

The amount of sulphur monoxide produced can be calculated quantitatively from the products of alkali hydrolysis by the method developed by B. S. Rao[4]. It has been found in this case that 82 per cent of the decomposition of sesquioxide goes according to reaction (ii). This value is in good agreement with the percentage (80 per cent) obtained by the German authors. It can therefore be concluded that sulphur monoxide is one of the primary products of decomposition of sulphur sesquioxide.

Further details of the work will be published elsewhere.

I wish to express my thanks to Dr. B. Sanjiva Rao and Dr. M. R. Aswathanarayana Rao for their interest in this work.

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Paper Chromatography of Nicotinic Acid Derivatives

Leifer *et al.*[1] have reported the paper chromatography of nicotinic acid with the use of microbiological assay. While our work was in progress, Huebner[2] described a spot test for detection of some pyridine derivatives. The present work describes sensitive qualitative techniques developed in this Laboratory for the detection of tertiary and quaternary pyridinium compounds. The laborious procedure involved in the microbiological method of Leifer *et al.*[1] is obviated by rapid colour or fluorescent tests. For the colour test, advantage was taken of König's[3] reaction, namely, the formation of coloured compounds when tertiary pyridine derivatives are treated with cyanogen bromide and a primary aromatic amine. The fluorescence test allows the detection of quaternary nicotinamide derivatives. Use is made of the formation of bluish-white fluorescent substances when quaternary pyridine compounds with a side chain CO—NH—*R* in the β position are treated with methyl ethyl ketone and ammonia[4].

From a number of solvent systems, those were chosen which allowed the best separations of the various compounds (Tables 1 and 2). After descending chromatograms had been run on Whatman paper No. 1 overnight, the papers were dried at room temperature and treated in the following way.

(1) *Tertiary pyridine compounds.* The dry paper was placed in a closed glass tank for 1 hr. at room temperature over a cyanogen bromide solution, prepared according to Wang and Kodicek[5]. It was then sprayed with 2 per cent *p*-aminobenzoic acid (2 gm. of *p*-aminobenzoic acid dissolved in 75 ml. 0·75 *N* hydrochloric acid and made up to 100 ml. with 96 per cent ethanol). The positions of the different compounds are revealed by their colours (see diagram). It is possible to detect quantities as small as 0·1 microgram.

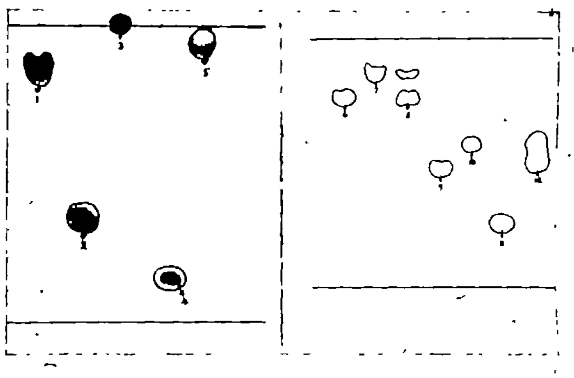
(2) *Quaternary pyridinium compounds.* The dry paper was placed over a mixture of methyl ethyl ketone and ammonia (1 : 1) for 1 hr. in a closed glass tank at room temperature. The relative positions could be detected by their bluish-white fluorescence under ultra-violet (see diagram). Quantities as small as 0·05 μgm. (nicotinic acid equivalents) could be detected.

Table 1. R_F VALUES OF SOME TERTIARY PYRIDINE COMPOUNDS (DESCENDING CHROMATOGRAMS)

Material	Solvent System					Colour
	n-Butanol, water	*n*-Butanol. water + 0·1 per cent ammonia (bottom)	*iso*-Butanol, water	80 per cent acetone	Methyl ethyl ketone . acetic acid : water, 49 · 1 · 50 .	
Nicotinic acid	0·21	0·19	0·17	0·55	0·68	yellow
Nicotinamide	0·69	0·69	0·69	0·78	0·59	deep yellow
Nicotinuric acid	0·11	0·06	0·08	0·44	0·45	orange
Diethyl nicotinamide (coramine)	0·90	0·89	0·91	0·89	0·90	pink

The R_F values of some nicotinic acid derivatives determined by these techniques are listed in Tables 1 and 2. The R_F values of the leading front were taken.

The results show that the R_F values of nicotinamide and coramine were more or less consistent irrespective of the solvent used, whereas those of the more acidic compounds (nicotinic acid, nicotinuric acid) moved slower in neutral or alkaline than in acidic solvents.



(*a*) *n*-butanol – water (*b*) 60 per cent *n*-propanol

Descending chromatograms in (*a*) *n*-butanol, water and (*b*) 60 per cent *n*-propanol

(*a*) Coloured spots from tertiary nicotinyl compounds treated with cyanogen bromide and *p*-aminobenzoic acid (1) nicotinic acid; (2) nicotinamide; (3) bound nicotinic acid preparation; (4) diethylnicotinamide (coramine); (5) nicotinuric acid. (*b*) Fluorescent spots from quaternary nicotinamide compounds treated with methyl ethyl ketone and ammonia (6) diphosphopyridine nucleotide; (7) triphosphopyridine nucleotide; (8) mixture of (6) and (7), (9) N′-methylnicotinamide; (10) N′-methylnicotinuric acid betaine; (11) 3-carbamyl-*tetra*-acetyl-N′-D-glucosidyl pyridinium bromide; (12) 3-carbamyl-N′-2′-hydroxyethyl pyridinium bromide

Thus, for example, the R_F value for nicotinic acid was 0·70 when *n*-butanol–water–1 per cent acetic acid was used, compared to 0·21 in *n*-butanol–water.

The bound nicotinic acid (a purified preparation from wheat bran[6]) did not move with any of the solvents investigated, indicating, in agreement with the findings of Chaudhuri and Kodicek[6], that the nicotinic acid is bound to a moiety which makes it insoluble in the organic solvents tested (see diagram).

The butanol, 80 per cent acetone and methyl ethyl ketone solvent systems were most suitable for the tertiary nicotinyl series. For the quaternary nicotinamide derivatives, with the exception of the diphospho- and triphospho-pyridine nucleotides, 60 or 80 per cent propanol proved to be the most suitable solvents. For diphosphopyridine nucleotide and triphosphopyridine nucleotide, 60 per cent acetone, 60 per cent *n*-propanol or 60 per cent ammonium sulphate in *M*/10 phosphate buffer (*p*H 6·8) with 2 per cent *n*-propanol were the best solvents.

When diphosphopyridine nucleotide was developed in the 60 per cent ammonium sulphate system, two spots were observed with R_F values of 0·38 and 0·86, respectively. The second spot, which is only faintly fluorescent, is most probably due to a split product formed by the action of the solvent system. Its R_F value is identical with that of the quaternary nicotinyl riboside, kindly supplied by Dr. L. J. Haynes.

Table 2. R_F VALUES OF SOME QUATERNARY PYRIDINIUM COMPOUNDS (DESCENDING CHROMATOGRAMS)

Material	Solvent system				Method of detection
	60 per cent acetone	80 per cent acetone	60 per cent *n*-propanol	60 per cent ammon. sulphate in phosphate buffer (*p*H 6·8) with 2 per cent *n*-propanol	
N′-methylnicotinamide	0·71	0·47	0·64	0·83	Bluish-white fluorescence
N′-methylnicotinuric acid betaine	0·57	0·26	0·43	—	,,
Carbamyl-N′-2′-hydroxyethyl pyridinium bromide*	0·74	0·36	0·57	—	,,
Diphosphopyridine nucleotide	0·43	0·10	0·26	0·38	,,
Triphosphopyridine nucleotide	0·30	0	0·15	0·54	,,
3-Carbamyl-*tetra*-acetyl-N′-D-glucosidyl pyridinium bromide*	0·94	0·84	0·81	—	,,
3-Carbamyl-N′-ribosidyl pyridinium bromide*	0·62	0·33	0·48	0·86	,,

* Prepared by Haynes and Todd (ref. 7).

N′-Methylnicotinuric acid betaine could not be traced in the ammonium sulphate solvent system. This may be due to the removal of glycine with ammonium sulphate from the β side-chain, thus leaving a carboxylic group which would not give a fluorescent condensation compound with methyl ethyl ketone and ammonia[4].

Further work is in progress to apply these procedures to biological materials.

We wish to thank Dr. L. J. Haynes for supplying us with some of the quaternary nicotinyl compounds and Dr. E. C. Slater for the gift of diphosphopyridine nucleotide and triphosphopyridine nucleotide.

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Dunn Nutritional Laboratory,
University of Cambridge
and Medical Research Council. May 8.

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New Lateral Line Sensory Organs in *Xenopus lævis* Daudin

During an investigation of a trematode infestation in *Xenopus lævis* a median ventral row of 'lateral' sensory organs was observed, which has not previously been described[1]. The observation was due to the nature of the infestation, and Fig. 1 is a photograph of a parasitized adult female toad. The parasites (*Strigeid metacercariæ*) encyst in all layers of the dermis beneath the lateral sense organs, and the position of these is emphasized by numerous large melanophores close to the cysts, while the rest of the skin remains paler than usual.

The median ventral row runs forward from the junction of the two ventral rows just anterior to the anus, and consists of three to six 'plaques'. It is an anterior continuation of the row that joins the anus to the lateral ventral rows, which Paterson[2] suggests are derived from the paired rows on the ventral fin of the tadpole. The median ventral row can sometimes be seen in normal animals, but is very inconspicuous. Its presence in these has been confirmed histologically (Fig. 2).

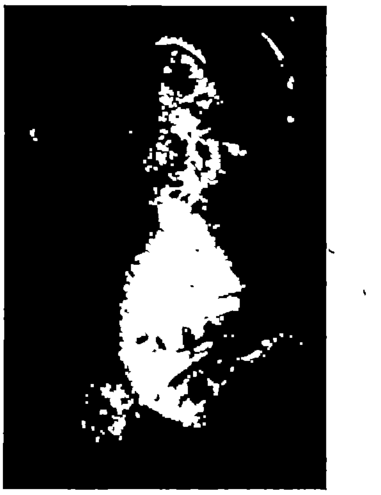

Fig. 1. *Xenopus lævis* D. Adult female with metacercarial infestation of the lateral line system. The melanosis provoked by the parasites discloses the presence of a hitherto unsuspected median ventral line

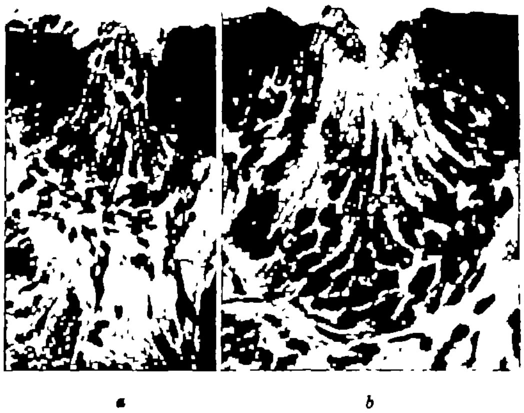

Fig. 2. (*a*) Sensory epidermal bud from the median ventral 'lateral' line of *Xenopus lævis* D. Some nerve fibres, supplying the organ, are visible. × 180. Holmes silver impregnation. (*b*) Sensory epidermal bud from the upper lateral line of *Xenopus lævis*. × 270. Masson's trichrome. Note the presence of the central depression on the surface which is absent in (*a*)

The median ventral row differs from the other rows in that the plaques are short (less than 2 mm.) and are not raised above the surrounding skin; tactile organs, which usually alternate with the lateral line neuromasts along the plaque, are often absent, and the latter are smaller than usual, scarcely extending down into the dermis. The innervation appears normal.

Fuller accounts of these observations, of the infestation and of an investigation into the electrophysiology of the lateral sensory organs of *Xenopus* by one of us (R. W. M.), will be published elsewhere.

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The So-called Chromosome-Races of *Cardamine pratensis* and *Nasturtium officinale*

In his recent article on "Plant Chromosome-Races and their Ecology in Great Britain"[1], Dr. G. Haskell devotes a paragraph each to lady's smock (*Cardamine pratensis*) and to watercress (*Nasturtium officinale* agg.). So far as *Cardamine pratensis* is concerned, he omits to mention the work of Hussein[2,3], who has made by far the largest study of the distribution of the two chromosome-races of this plant in Great Britain. Haskell states that in Great Britain, as in Sweden, the form with the lower chromosome number ($2n = 30$) is characteristic of drier conditions than the form with the higher chromosome number ($2n = 56$). This was found by Hussein, who says: "The ecological difference found by Lövkvist holds good in most of the cases recorded; for example, Prof. R. D'O. Good, who kindly provided material from Dorset, noted particularly that the large plant, now found to have the low chromosome number, occurred in quantity on the damp roadside banks characteristic of Marshwood Vale, whereas the smaller darker-leaved one ($2n = 56$) grew in wet meadows". It should also be noted that the chromosome number of *Cardamine pratensis* from Merton was found by Lawrence[4] to be $2n = 30$ (thus agreeing with counts made by Lövkvist[5] and Hussein[2,3] and with unpublished counts by myself for the lower chromosome number form) and not $2n = 32$ as stated by Haskell, although Lawrence did suggest that it may have arisen from $2n = 32$ by chromosome fusion.

Watercress should surely not have been included as an example of chromosome-races since, although Manton[6] suggested that the forms with $2n = 32$, 48 and 64 were diploid, triploid and tetraploid races of the same species, later work by Howard and Manton[7,8] showed conclusively that there are two quite distinct species of watercress, *Nasturtium officinale sensu stricto* with a chromosome number of $2n = 32$ and *N. microphyllum* (or *N. uniseriatum* as Howard and Manton called it) with $2n = 64$. The form with $2n = 48$ is the interspecific hybrid *N. microphyllum* × *officinale*. Moreover, it was shown quite conclusively that *N. microphyllum* was an allotetraploid and therefore that any differences between it and *N. officinale* were most likely to be due not to polyploidy but to the influence of other, unfortunately still unknown, parent species of *N. microphyllum*. Further, as Airy Shaw[9] has pointed out, the tetraploid species of watercress, namely, *N. microphyllum*, had been distinguished for many years by several European botanists as a distinct species.

It should also be noted that diploid watercress, namely *N. officinale sensu stricto*, is a perennial and not an annual as Haskell states and that Haskell's description of *N. microphyllum* as perennial winter watercress is misleading in another respect. The brown or so-called winter cress of the commercial grower is the hybrid *N. microphyllum* × *officinale* and not *N. microphyllum*, which is not cultivated[10]. Also, green or so called summer cress, *N. officinale*, is cultivated for winter use at the present time on a very large scale and the terms 'winter' and 'summer' cress are therefore to a large extent misnomers. It may be, as Haskell suggests, that *N. officinale* occurs in areas with a higher mean rainfall and *N. microphyllum* in areas with a lower mean rainfall; but when we mapped our records[11] for the distribution of the two species, it was not apparent to either Mr. A. G. Lyon or me. The suggested distribution is, moreover, an exception to the general rule proposed by Haskell in his last paragraph that tetraploids, not diploids, occur in the wetter places; but, if correct, it is easily understandable when we remember, as has been pointed out earlier, that *N. microphyllum* is an allotetraploid and not an autotetraploid. There is, however, further evidence about the distribution of the two watercress species which Haskell has omitted. Both Airy Shaw[12] and Howard and Lyon[11] give reasons for suggesting that *N. microphyllum* can tolerate lower *p*H values and calcium concentrations than *N. officinale*. It is hoped that further observations on this point will be published soon in *Biological Flora* accounts for the two species. Lastly, in discussing the distribution of watercress, it must always be remembered that, in addition to being a wild plant, watercress is cultivated in the south of England and that for many centuries prior to its cultivation it was eaten as a salad plant by man.

H. W. Howard

Plant Breeding Institute,
School of Agriculture,
Cambridge.

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[1] Haskell, G., *Nature*, 167, 628 (1951).
[2] Hussein, F., *Nature*, 161, 1015 (1948).
[3] Hussein, F., Rep. Bot. Soc. Brit. Isl. Conference of 1948, p. 77.
[4] Lawrence, W. J. C., *Genetica*, 13, 183 (1931).
[5] Lövkvist, B., *Hereditas*, 33, 421 (1947).
[6] Manton, I., *Z. indukt. Abstamm. Vererb.*, 69, 132 (1935).
[7] Howard, H. W., and Manton, I., *Nature*, 146, 303 (1940).
[8] Howard, H. W., and Manton, I., *Ann. Bot.*, N.S., 10, 1 (1946).
[9] Airy Shaw, H. K., *Kew Bull.*, No. 1, 39 (1947).
[10] Howard, H. W., *J. Min. Agric.*, 54, 453 (1947).
[11] Howard, H. W., and Lyon, A. G., *Watsonia*, 1, 228 (1950).
[12] Airy Shaw, H. K., Rep. Bot. Soc. Brit. Isl. Conference of 1948, p. 75.

I am indebted to Dr. H. W. Howard for criticisms and comments on my survey of the ecology of British chromosome-races[1]. The following points may also be added.

(1) I am pleased to learn of Miss Hussein's studies on the distribution of *Cardamine pratensis* in Britain. However, in her map[2] she did not relate the widespread distribution of the higher chromosome-race and the restricted southerly distribution of the lower race to colonization following retreat of the ice.

(2) Lawrence[3] gave $2n = 30$ for the Merton *C. pratensis* and interpreted this as reduction from 32 through chromosome fusion. I put $2n = 32$ to avoid confusion with genuine aneuploidy due to actual loss of chromosomes.

(3) Dr. Howard's criticism of my using the term 'chromosome-race' with regard to *Nasturtium* species and their hybrid is of much wider significance. Darlington[4] has pertinently asked recently whether the chromosomes fit the species, and the problem of polyploid races within and between species has now been discussed at length by Löve[5]. He believes that all chromosome-races should be recognized as distinct species (even if morphological differences are slight), except asexually reproducing higher, uneven hybrids. Löve maintains that all chromosome-races show morphological differences when carefully examined and uses the term 'polyplotype' to refer to a polyploid regardless of whether it is an auto- or allo-polyploid. This is useful, as Stebbins[6] has already indicated that many so-called auto-polyploids could be interpreted as allo-polyploids.

(4) Manton[7] referred to the summer watercress crop as being diploid and the winter crop as triploid. She said there was a marked tendency for diploids to behave as annuals unless conditions were especially favourable in the autumn, and ease of perennation was in part at least responsible for the use of the higher polyploid in winter. Dr. Howard's more recent observations will therefore clarify this point.

G. Haskell

John Innes Horticultural Institution,
Bayfordbury,
Hertford.

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[1] Haskell, G., *Nature*, 167, 628 (1951).
[2] Hussein, F., Rep. Bot. Soc. Brit. Isl. Conf. of 1948, p. 77
[3] Lawrence, W. J. C., *Genetica*, 13, 183 (1931).
[4] Darlington, C. D., *Nature*, 167, 662 (1951).
[5] Löve, A., *Caryologia*, 3, 263 (1951).
[6] Stebbins, G. L., "Adv. in Genet.", 1, 403 (1947).
[7] Manton, I., *Z. indukt. Abstamm. Vererb.*, 69, 132 (1935).

FORTHCOMING EVENTS

Wednesday, September 19

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. Morris Muskat: "Our Unproduced Reserves—What are They ?"

Friday, September 21

Television Society, Engineering Group (at C.E.A., 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. H. Page: "Slot Aerials".

Saturday, September 22

Biochemical Society (at the Rowett Research Institute, Bucksburn, Aberdeenshire), at 11 a.m.—Scientific Papers.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Analyst (with associateship of the R.I.C and, preferably, experience in the analysis of foods and drugs) in the Department of the Public Analyst—The Registrar and Secretary, The University, Bristol (September 22).

Assistant Lecturer (Grade III) and a **Lecturer** (Grade II) **in the Department of Botany**—The Secretary, The University, Edmund Street, Birmingham 3 (September 22).

Senior Lecturer in Advanced Non-Ferrous Metallurgy to Honours B.Sc. (metallurgy) standard—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (September 22).

Director of the City Art Gallery and Museum—The Town Clerk, Town Hall, Wakefield (September 24).

Scientific Technologist (with a good general training in chemistry, preferably up to degree standard) in the Coal Survey Laboratory at Leeds—The National Coal Board, Establishments (Personnel). Hobart House, Grosvenor Place, London, S.W.1, quoting TT/368 (September 24).

Biochemist (non-medical) **in the Pathological Department**—The Secretary, Nottingham No. 1 Hospital Management Committee, General Hospital, Nottingham (September 29)

Lecturer in Chemistry—The Principal, Norwood Technical College, West Norwood, London, S.E.27 (September 29).

Lecturer to teach Metallurgy to engineering students preparing for the London University degree in engineering, and other examinations—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (September 29).

Lecturer in Experimental Pharmacology—The Secretary of University Court, The University, Glasgow (September 29).

Lecturer or an **Assistant Lecturer in the Zoology Department**, University College, Ibadan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 29).

Assistant Plant Pathologist (with an honours degree in botany, and with special training in mycology)—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (September 30).

Educational Psychologist (with Bachelor of Education degree or honours degree in Psychology)—The Secretary, Scottish Education Department, 14 Queen Street, Edinburgh 2 (September 30).

Lecturer (with a first- or second-class honours degree in mechanical engineering) **in the Department of Applied Mechanics**—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10 (September 30).

Professor of Anatomy—The Registrar, University College of South Wales, Cathays Park, Cardiff (September 30).

Chemists (Experimental Officer grade) at a Ministry of Supply research establishment in Berkshire. (Ref. F.626/51A) with experience of gas analysis (Ref. F.627/51A) experienced in factory development work; (Ref F.628/51A) inorganic or physical chemist with knowledge of analytical procedure—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (October 8).

Engineers I at a Ministry of Supply establishment in London: (Ref. C.509/51A) to be responsible for production, conversion and repair of aircraft, turbine engines and accessories, planning programmes and progressing, (Ref. C.510/51A) to be responsible for planning and progressing of specialized sub-contract supplies, vetting proposals for capital expenditure, and statistical analysis; (Ref. C.511/51A) to be responsible for planning and progressing the supply of engine accessories, including magnetos and ignition systems, also gun-turrets and tool kits—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (October 8).

Principal Scientific Officer (with a first- or second-class honours degree in a science subject or in mathematics, or an equivalent qualification and, preferably, experience of fundamental research in chemistry) at the Norfolk Flax Establishment, King's Lynn—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4072/51 (October 11)

Lecturer in Zoology at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 13).

Physics Graduate for a research appointment in Microwave Spectroscopy—The Secretary, University College, Southampton (October 15)

Scientific Assistant (with a university degree in electrical or mechanical engineering or physics) **in the Department of Science and Industry**—The Director, City Museum and Art Gallery, Birmingham 3 (October 15).

Examiners (male, with a University degree in either physics or chemistry; some postgraduate research experience an advantage) **in the Gas Standards Branch**, Ministry of Fuel and Power—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4073/51 (October 18).

Forest Entomologist at the Forest Research Station, Alice Holt, Farnham, Surrey—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting 4071/51 (October 18).

Lecturer in the Department of Botany (with special qualifications to lecture (through the medium of the Afrikaans language), guide and conduct research in cytogenetics, or systematic botany of lower plants)—The Registrar, University of Pretoria, Pretoria, South Africa (October 30).

Research Assistant (with at least two years research experience and, preferably, a Ph.D.) **in the Department of Chemistry**, to carry out experimental work on Friedel-Crafts polymerization and related problems—Dr. P. H. Plesch, Chemistry Department, University College of North Staffordshire, Keele, Staffs (October 30).

Research Plant Biochemist—The Head, Plant Physiological Institute, University of Pretoria, Pretoria, South Africa (October 30).

Director (with a scientific training, preferably in zoology or anthropology) **of the Otago Museum**, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

Senior Lecturer in Inorganic Chemistry at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

Holbrook Gaskell Chair of Botany—The Registrar, The University, Liverpool (November 17).

Engineer and **Ship Surveyors** and **Nautical Surveyors** in the Marine Survey Service of the Ministry of Transport—The Principal Establishment and Organization Officer, Ministry of Transport, Room 6029, Berkeley Square House, London, W.1 (December 1).

Agricultural Economist (with a degree in agriculture, horticulture or economics, and experience of investigational work), and an **Assistant Agricultural Economist** (with a degree in agriculture, horticulture or economics)—The Registrar, Wye College, Wye, Ashford, Kent.

Assistant Chief Engineer (Development) by the Division of Atomic Energy (Production), Capenhurst, Chester, to take charge of a development team engaged on the construction and operation of prototype plants, involving both mechanical and chemical engineering—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

Assistant Chief Engineers (Design), to take charge of teams of engineers and draughtsmen engaged on the design and detailing of special mechanical and chemical plant for manufacture on a production basis, and **Engineers** (Design), to undertake the duties of project engineers, including the design of special plant and equipment and the layout required for efficient manufacturing processes—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for.

Chemist III at a Ministry of Supply establishment at Chislehurst, to be responsible for metallurgical analysis section and deputy to the Officer-in-Charge of laboratories—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.634/51A.

Chemists (Experimental Officer grade) at Ministry of Supply research and development establishments mainly in the vicinity of Waltham Abbey, Sevenoaks, South-East London and Staffordshire—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.607/51A.

Chemists (2, honours degree in chemistry essential, and textile experience an advantage) for research on problems relating to the dyeing and finishing of knitted products—The Secretary, Hosiery and Allied Trades Research Association, Thorneywood House, 4 First Avenue, Sherwood Rise, Nottingham.

Circuit Engineer (with experience of radar pulse techniques) for work on digital electronic computing machines—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

Development Engineers by the Division of Atomic Energy (Production), Capenhurst, Chester, to assist in the construction and operation of prototype plants, involving mechanical and chemical engineering—The Ministry of Supply, Division of Atomic Energy (Production). Risley, Warrington, Lancs.

Electrical Engineer to design electrical equipment, including H. T. and L. T. switchgear, substations, and internal installations for large chemical factories, and an **Instrument Engineer** to undertake the design, provision and maintenance of instruments for the measurement of radioactivity and for the control and recording of pressures, temperatures and the flow of liquids and gases in pipes—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for.

Electrical Engineers and **Physicists** at a Ministry of Supply research and development establishment near London: (Ref. D.390/51A) **Electrical Engineers** (Senior Scientific Officer grade) with special qualifications in radio communications and experience in the engineering of development prototypes, (Ref. A.245/51A) **Physicist** (Senior Scientific Officer grade) with experience in electronic circuitry for research into the measurement of high speed transients; (Ref. A.246/51A) **Physicist** (Senior Scientific Officer grade) with experience of optical and electronic techniques, and with an interest in fluid mechanics, for work on aerodynamics problems including wind tunnel investigations; (Ref. D.392/51A) **Electrical Engineer** or **Physicist** (Scientific Officer grade) with interest in the application of electronic methods to optical instrumentation techniques; (Ref. D.391/51A) **Electrical Engineer** or **Physicist** (Scientific Officer grade) for work on high speed electronic calculating machine—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

Engineers and **Physicists** (Experimental Officer grade) at the Royal Aircraft Establishment, Farnborough, and an out-station in Bucks: (Ref. D.396/51A) capable of development of electronic techniques and equipment, and special experience of miniaturization, or V.H.F. and U.H.F. radio and radar techniques an advantage; (Ref. D.397/51A) with experience in light mechanical and electrical mechanisms and equipment, and capable of research and development work in electronics, aircraft instrumentation, servo mechanisms, or analogue computing and automatic pilots—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

EXECUTIVE ENGINEER IN THE PUBLIC WORKS DEPARTMENT, Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27322/4.

GRADUATE (with a knowledge of chemistry or physics up to a degree standard, and a good knowledge of French and/or German) IN THE LIBRARY AND INFORMATION DEPARTMENT—The Director of Research, British Leather Manufacturers' Research Association, Milton Park, Egham, Surrey.

HEAD OF THE DEPARTMENT OF RADIO AND MUSICAL INSTRUMENT TECHNOLOGY—The Clerk, Northern Polytechnic, Holloway, London, N.7.

HYDROBIOLOGIST in the Sudan Government Fisheries Section, to work on freshwater hydrobiological problems in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Hydrobiologist 4/312'.

JUNIOR ASSISTANT PHYSICIST—The Secretary, Royal Infirmary, Bradford.

LECTURER IN GEOLOGY—The Registrar, The University, Nottingham.

LECTURER IN MATHEMATICS—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

MECHANICAL AND ELECTRICAL ENGINEERS (New Construction) for service in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Mechanical and Electrical Engineer, 4/320'.

METALLURGIST (with a good university degree in metallurgy and a sound knowledge of physical chemistry) for a new important research in connexion with electrical sheet steel—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

PHYSICAL CHEMISTS (Scientific Officer grade) at Ministry of Supply experimental establishments mainly in the vicinity of Waltham Abbey, Sevenoaks and South-East London, for research and development work in the field of physical chemistry—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.603/51A.

PHYSICIST or PHYSICAL CHEMIST (with a good honours degree and preferably an interest in the physical properties of materials) for work on fundamental problems associated with the hardening of Portland Cement—The Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1.

PROFESSIONAL CIVIL ENGINEERS at the London office of the Crown Agents, in conjunction with the location, design and construction of a major bridge in East Africa—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.27777.A.

RESEARCH ASSISTANT (with a science degree and preferably some postgraduate research experience in chemistry) to take part in a programme of research in physical chemistry (reaction kinetics)—The Registrar, University College, Exeter.

RESEARCH and DEVELOPMENT CHEMISTS and PHYSICISTS by the Division of Atomic Energy (Production), Capenhurst, Chester, to take charge of small teams of technical staff engaged on research and development work for a new factory—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for.

RESEARCH OFFICER (Forest Chemist) IN THE FORESTRY DEPARTMENT, Federation of Malaya—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27106/45.

SCIENCE OR ENGINEERING GRADUATES to do research on either the flow of fluids through porous substances, or the theory of atomization of liquids—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7.

SCIENTIFIC ASSISTANT (Analyst) for the East African Agriculture and Forestry Research Organization—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.27761.G.

SENIOR ELECTRICAL AND MECHANICAL ENGINEER for service in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Senior Electrical and Mechanical Engineer, 4/320'.

SENIOR LECTURER (with high academic or professional qualifications, qualified to teach a main branch of chemistry to honours degree, and to direct research) IN CHEMISTRY—The Principal, Royal Technical College, Salford 5.

SENIOR LECTURER IN MATHEMATICS (to teach pure and applied mathematics up to general degree standard, and certain sections up to honours standard)—The Clerk, Northern Polytechnic, Holloway, London, N.7.

SENIOR LECTURER IN PHYSICS—The Principal, Sir John Cass College, Jewry Street, London, E.C.3.

SENIOR LECTURER IN RAYON TECHNOLOGY at Bradford Technical College—The Director of Education, Town Hall, Bradford.

SENIOR LECTURER, and an ASSISTANT LECTURER, IN PHARMACEUTICAL CHEMISTRY—The Secretary, Royal Technical College, Glasgow.

SENIOR SCIENTIST, a BOTANIST, an AGRONOMIST, and a SOIL SCIENTIST, in the Research Division of the Sudan Ministry of Agriculture, for work at a new station for agricultural research on rain grown crops—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Senior Scientist 4/316a', 'Botanist 4/316b', 'Agronomist 4/316c', or 'Soil Scientist 4/316d', as applicable.

SOIL SURVEY OFFICER in the Department of Soil and Land-Use Survey, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27059/162.

TUTOR (with an honours degree in science or mathematics, with physics as primary interest) in Berks, Bucks and Oxon—The Secretary, Services Education Committee, 7 Wellington Square, Oxford.

WOOL TEXTILE RESEARCH COUNCIL SCHOLARSHIPS for research on (a) woollen yarn manufacture, (b) cloth finishing, (c) for an investigation of the quantitative absorption of mordants—The Principal, Technical College, Queen Street South, Huddersfield.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Colonial Office. Colonial Research Studies, No. 4: Nandi Work and Culture. By G. W. B. Huntingford. Pp. iv+126. (London: H.M. Stationery Office, 1950.) 8s. 6d. net. [127

29th Report of Gresham's School Natural History Society. Pp. 32+2 plates. (Holt: Gresham's School, 1951.) 2s. 6d. [127

Empire Cotton Growing Corporation. Annual Report for the Year ending 31st March 1951. Pp. ii+22. (London: Empire Cotton Growing Corporation, 1951.) [127

A Statistical Survey of 56,122 Case Records of Employees in Royal Ordnance Factories examined by Ophthalmic Opticians, 1943–46. A Report by the Visual Welfare and Research Committee of the Association of Optical Practitioners. Compiled by S. Black. Pp. 40. (London: Association of Optical Practitioners, 1951.) 2s. 6d. [127

Broadcasting: Memorandum on the Report of the Broadcasting Committee, 1949. (Cmd. 8291.) Pp. 12. (London: H.M. Stationery Office, 1951.) 6d. net. [127

Colonial Office. The Colonial Territories (1950–51). (Cmd. 8243.) Pp. ix+184. (London: H.M. Stationery Office, 1951.) 4s. 6d. net. [177

General Register Office. Census 1951, England and Wales: Preliminary Report. Pp. xxiii+52. (London: H.M. Stationery Office, 1951.) 5s. net. [177

Alkali &c. Works Regulation Act, 1906, and Alkali &c. Works Orders 1928–1950. Eighty-seventh Annual Report on Alkali &c. Works covering the Year 1950. By the Chief Inspector. Pp. 56. (London: H.M. Stationery Office, 1951.) 1s. 6d. net. [177

British Standard 1736: 1951, Filling Ratios for Liquefiable Gases. Pp. 9. (London: British Standards Institution, 1951.) 2s. net. [177

Grassland Research Institute: Grassland Research Station. Experiments in Progress, No. 4, 1951. Pp. vii+104. (Stratford-on-Avon and Hurley: Grassland Research Institute, 1951.) 2s. 6d. [177

British Trust for Ornithology. Seventeenth Annual Report, 1950. Pp. 40. (Oxford: British Trust for Ornithology, 1951.) 1s. 6d. [177

British Museum (Natural History). Economic Series No. 14: Clothes Moths and House Moths; their Life-History, Habits and Control. Fifth edition. Pp. ii+28. (London: British Museum (Natural History), 1951.) 9d. [187

Other Countries

East Africa High Commission: Filariasis Research Unit. Annual Report, 1950. Pp. ii+61. (Nairobi: East Africa High Commission, 1951.) [107

Bulletin of the American Museum of Natural History. Vol. 97, Article 1: Shoal-Water Geology and Environments, Eastern Andros Island, Bahamas. By Norman D. Newell, J. Keith Rigby, Arthur J. Whiteman and John S. Bradley. Pp. 30+8 plates. 75 cents. Vol. 97, Article 2: The Arachnid Order Solpugida in the United States. By Martin H. Muma. Pp. 31–142. 1.25 dollars. (New York: American Museum of Natural History, 1951.) [107

Rayon Revue. 1: Selection of articles from the 1947 volume of 'Rayon Revue'. Pp. 64. 2: Selection of articles from the 1948 volume of 'Rayon Revue'. Pp. 60. 3: Selection of articles from the 1949 volume of 'Rayon Revue'. Pp. 76. (Arnhem: International Rayon Trading Co., n.d.) [127

Field Museum of Natural History. Anthropological Series, Vol. 24, No. 2: The Medora Site, West Baton Rouge Parish, Louisiana. By George I. Quimby. (Publication 664.) Pp. 79–136. (Chicago: Chicago Natural History Museum, 1951.) 1.25 dollars. [127

Fieldiana. Zoology, Vol. 31, No. 45: On the Clausiliidae of Palestine. By Georg Haas. Pp. 479–502. 40 cents. Zoology, Vol. 32, No. 8: The Carotid Arteries in the Procyonidae. By H. Elizabeth Story. Pp. 475–558. 1 dollar. Zoology, Vol. 33, No. 1: Philippine Zoological Expedition, 1946–1947; Narrative and Itinerary. By Harry Hoogstraal. Pp. 86+7 plates. 1.50 dollars. (Chicago: Chicago Natural History Museum, 1951.) [127

Bulletin of the American Museum of Natural History. Vol. 97, Article 3: The Ancestral Crocodilian *Protosuchus*. By Edwin Harris Colbert and Charles Craig Mook. Pp. 143–182+plates 9–10. (New York: American Museum of Natural History, 1951.) 75 cents. [127

Institut Royal des Sciences naturelles de Belgique. Mémoire No. 118: Les représentations de l'homme et des animaux quaternaires découvertes en Belgique; revision des documents déjà connus et description de documents inédits. Par Prof. François Twiesselmann. Pp. 28+10 plates. Mémoires, Deuxième Série, Fasc. 37: The Free-living Marine Nemas of the Mediterranean, 1: The Bay of Villefranche. By Prof. Jacobus Hermanus Schuurmans Stekhoven, Jr. Pp. 220. Mémoires, Deuxième Série, Fasc. 38: Revision du genre *Atractaspis* A. Smith. Par Raymond Laurent. Pp. 50. (Bruxelles: Institut Royal des Sciences naturelles de Belgique, 1950–1951.) [177

Department of Commerce: Bureau of the Census. State Economic Areas: a Description of the Procedure used in making a Functional Grouping of the Counties of the United States. By Donald J. Bogue. Pp. iv+96. (Washington, D.C.: Government Printing Office, 1951.) 1 dollar. [177

Bibliography of Scientific Publications of South Asia (India, Burma, Ceylon). No. 4, July–December 1950. Pp. v+86. (Delhi: Unesco South Asia Science Co-operation Office, 1951.) [177

Indian Council of Medical Research. Report of the Scientific Advisory Board for the Year 1950. Pp. xiii+346. (New Delhi: Indian Council of Medical Research, 1951.) 1 rupee. [177

Annual Report of the Indian Central Jute Committee for the Year 1949–50. Pp. iv+212. (Calcutta: Indian Central Jute Committee, 1951.) [177

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GOVERNMENT RESPONSIBILITY IN CIVILIAN SCIENTIFIC RESEARCH

IN January 1947, the Advisory Council on Scientific Policy was appointed "to advise the Lord President of the Council in the exercise of his responsibility for the formulation and execution of Government scientific policy". Its appointment has been amply justified, for not merely in the field of scientific man-power but also over the whole range of national economy it has become increasingly important to have a permanent means for ensuring that the scientific resources of Great Britain are effectively utilized in the national interest. The rearmament programme and the demands on scientific man-power and resources likely to result from the implementation of the Colombo Plan and other schemes for the economic development of backward territories in various parts of the world emphasize further the need for an overall survey, in order to ensure that resources are wisely distributed, and also to keep in balance the civil and defence aspects of research policy, as is done by the appointment of a common chairman for the Advisory Council on Scientific Policy and the Defence Research Policy Committee.

Already the work of the Advisory Council during the past four years has shown that opportunities exist for it to watch over and improve the arrangements for securing an adequate supply of scientific workers to meet the needs of the Government and industry, including the provision of adequate facilities for their training, and for the dissemination of information resulting from scientific research; and it is encouraging to note from the fourth annual report surveyed elsewhere in this issue (p. 491) that the Advisory Council appears to have overcome the diffidence with which it approached the man-power situation a year ago, for it has appointed, after consultation with the Ministry of Labour and National Service and the University Grants Committee, a standing Committee on Scientific Man-power. However, apart from special questions, such as those arising out of the use of potentially toxic substances in consumer goods, where the Advisory Council can assist in formulating a common and agreed interdepartmental policy, it is clear from the present report alone that there are other problems in which all the authority and prestige of the Council will be continuously required to avoid distortion of the country's scientific and technical effort and of the use of its resources in directions that may seriously hinder the meeting of other and more important commitments.

This is pointed out by the Advisory Council specifically in regard to demands which may be made upon our resources of scientific man-power in connexion with projects under the Colombo Plan or like schemes. It makes a similar reference in commenting on a report from the Committee on Atomic Energy. The proportion of scientific resources which is now being devoted to atomic energy and nuclear physics in general is a matter of considerable concern, and may well be out of balance. This particular question is one of priorities, and possibly cannot be resolved even by the Advisory Council on Scientific Policy without some reference to the Defence Research Policy Committee. That may equally apply to some other aspects of national expenditure on civilian research and development which the Advisory Council has at present under review, bearing in mind the restriction on the use of man-power and resources caused by the diversion, in the present economic situation, of so much of the nation's effort to re-armament. The Advisory Council is considering, in particular, the scientific responsibilities which the Government has rightly assumed, and the extent to which government expenditure on civilian research could safely be restricted.

That review is not complete; but in the meantime scientific workers and industrialists will welcome one point made in the present report. Government organizations, like other research institutions, cannot be built up quickly in a stable and effective form. The Advisory Council is convinced that experienced research teams should be kept together in civilian establishments, and that urgent defence work should be assigned to them, rather than that attempts should be made to transfer individuals to defence establishments; in this view the Defence Research Policy Committee and the defence departments have concurred.

Whether or not the review now proceeding foreshadows a considerable curtailment of the research and other scientific services which government establishments are able to offer to industry, the rising costs of equipment, materials and labour are likely to have that effect, even if the establishments of the Department of Scientific and Industrial Research are not diverted to defence work to any considerable extent. Any appreciable increase in the appropriation for civilian research and development must be regarded as unlikely, although the Advisory Council considers it important to maintain a normal rate of recruitment in scientific establishments. Such recruitment will compete with what may be an increasing demand from industry, at least on its rearmament side; but there is no suggestion in this report of what the demand may be from the defence establishments.

These circumstances give special interest to the recently issued memorandum on "Government Scientific Organization in the Civilian Field"*, which embodies the results of a survey which has been conducted by the Council during the past six months. This memorandum traces the growth over the past fifty years, describes the existing organization in Great Britain, and shows the government expenditure on scientific research in the civilian field from 1900 to 1950, together with summarized estimates for 1950–51. While the role of the universities in fundamental research is indicated, no account is taken of appropriations to the universities in the estimate of some sixteen million pounds for government expenditure on scientific research in the civilian field for 1950–51, nor is any attempt made to assess what proportion of the government grants of £11,000,000 for recurrent and £4,000,000 for capital expenditure to the universities in this period could be regarded as for scientific purposes.

The figure cited in this memorandum must therefore be regarded as a minimum, and not as representing the full expenditure by the central Government on scientific work in the civilian field. Nor is account taken of some expenditure by the Ministry of Supply and the Admiralty on scientific research which is preponderantly in the field of defence, but which has a significant application to the needs of civil industry. That by the Ministry of Supply covers the work on atomic energy at Harwell, and probably represents the largest item which could arguably be charged under the civilian head rather than entirely under defence.

The question of the work at Harwell was discussed in a debate in the House of Lords on July 5 on Lord Cherwell's motion to transfer responsibility for work on the development of atomic energy from the Ministry of Supply to a special organization more flexible than the normal Civil Service system and under the direct control of the head of the Government. Lord Alexander's reply was not altogether convincing, and the motion was carried against the Government. Without going into the arguments advanced in that debate, the picture presented in the present memorandum affords some support for the suggestion that the Department of Atomic Energy might well be turned into a separate directorate responsible to Parliament, like other official scientific bodies, through the Lord President of the Council.

The memorandum gives a very clear picture of the organization of government scientific effort in Great Britain and should considerably facilitate the asking of the right questions if any policy of restriction of expenditure becomes necessary. It owes something, indeed, to the earlier statement "Scientific Research and Development" issued in April 1944, to which there is no reference in the bibliography, and it shows how complex is the problem of keeping the Government's research programme in balance. Particularly at a time of financial stringency is it essential to keep in mind two of those aspects which were stressed by the Select Committee on Estimates in its Third Report for the Session 1946–47.

It should lie well within the field of the Advisory Council for Scientific Policy to consider whether the sum appropriated for fundamental research is reasonably related to that allocated to the conduct of applied research and development, though it would require the assistance of other bodies, such as the University Grants Committee, to make such a survey. To determine whether the expenditure on fundamental and applied research is distributed in the best proportion between the several main lines of civil and military research is a task which can scarcely be undertaken except jointly with the Defence Research Policy Committee. Nevertheless, the attempt should be made, and both surveys should take full account of what is being done outside government establishments. So far as applied or industrial research is concerned, government effort should be ancillary and should be in balance with the main effort which is being made in industry itself. Resources of man-power or equipment allocated to government establishments must have regard to what is required in the industries those establishments exist to serve.

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* Government Scientific Organization in the Civilian Field. Pp. 47. (London: H.M. Stationery Office, 1951.) 1s. 6d. net.

While, therefore, the opportunity for the Advisory Council on Scientific Policy has been amply demonstrated, it may be suggested that the Council has been over-conscious of its advisory capacity. On the question of man-power, a year ago it appeared strangely diffident in pressing for the figures required as a basis for concrete recommendations, and it is not clear from the present report that the new standing Committee on Scientific Man-power has received firm instructions. It is difficult to believe that a proposal to which the Council lends the weight of its authority would not have reasonable prospect of early acceptance, and it is to be hoped that no lack of confidence will in future deter the Council from making the firm recommendations in such matters which it is fully competent to make and which the scientific world is entitled to expect of it.

KEPLER THE MAN

Johannes Kepler

Life and Letters. By Carola Baumgardt. Pp. 209+3 plates. (New York: Philosophical Library, Inc., 1951.) 3.75 dollars.

THE main interest of this book lies in the numerous letters of Kepler which are made available for the first time in English translation. They have been selected from his very extensive correspondence so as to depict Kepler as a man rather than as one of the outstanding astronomers of all times. They reveal a very human person who suffered from indifferent health and, as a result of an early attack of small-pox, from permanently impaired eyesight; who was almost always in financial embarrassment, because his salary as imperial mathematician was constantly in arrears (which by 1627 had accumulated to 12,000 florins); who was continually persecuted because of his Protestant convictions; whose work was often interrupted by the disturbed conditions of the time; who suffered from frequent bereavements (only two of his twelve children reached maturity) and from family troubles—including the long persecution of his mother on the grounds of sorcery and witchcraft. The letter he wrote to Scultetus after the death of his wife and of his six-year-old son is a deeply moving document. In very different vein is the amusing letter to Baron Strahlendorf, after he had decided to marry again, describing how difficult it was for him to make a final choice, even with advice from various friends, from among eleven candidates.

In the preface of the book it is stated that this biography of Kepler is the most detailed yet presented to the English-reading public. There is indeed a great need for a comprehensive biography of Kepler in English; this book does not meet that need. The biographical portions are very sketchy; the account of Kepler's scientific work is quite inadequate, and no attempt is made to assess its value. With Kepler a mystical conception of the universe was combined with real scientific insight. Thus, on one hand, in his "Mysterium Cosmographicum" he sought for a relationship between the number and distances of the planets and the five regular solids, convinced in his own mind that there must be an abstract intelligible connexion; on the other hand, he produced works of the greatest importance, such as his "Astronomia nova", in which the first two of his famous laws were formulated, and the "Epitome astronomiae Copernicanae", in which emphasis was placed on physical causes and not on arbitrary hypotheses. His third law was enunciated in the "Harmonica Mundi", the main theme of which was to establish an elaborate system of celestial harmonies. Nor is any indication given of how Kepler patiently tried and discarded one hypothesis after another in the attempt to find one that would accord with Tycho Brahe's observations of Mars, until at last he made the momentous discovery that its orbit was an ellipse, so for the first time breaking away from the old Aristotelian conception that the movements of the planets must be compounded of circular motions.

Kepler's interest in astrology was no doubt bound up with his mystical ideas of the universe; he believed that there was an element of truth in it, although it needed to be purged of gross errors. But his 'prognostics' were prepared with his tongue in his cheek; shrewd common sense often enabled him to guess what was likely to happen, so that he gained considerable credit with the vulgar. He was thus able to alleviate to some extent his financial difficulties. In a letter to Mästlin he wrote: "Forgive me, my best teacher. There is much I must apologize for or it would damage my reputation in your eyes. The matter is this: in this calendar I do not write for the large crowd nor for scholars (with a few exceptions) but for noblemen and the prelates, who pretend to have a knowledge about things which they do not understand . . . thus hoping that the readers may be tempted to approve a raise in my salary, which has not yet been increased, just as my expenses have not yet been refunded." Many years later, when writing to Matthias Bernegger about Jakob Bartsch, who was a suitor for the hand of his daughter Susanna, Kepler remarked, "One thing I do not like, he anchors his studies in astrology".

Kepler was in Linz in 1626 when it was besieged, and a sidelight on the conditions during the siege is given in another letter to Bernegger: "With the help of God and his angels, I have survived the siege for fourteen days safely. I did not starve either, even without tasting horse-meat. Only a few had the same good luck." In these more civilized days there are queues often to be seen waiting to obtain horse-meat for human consumption!

Desperate as Kepler's financial straits often were, he repulsed the repeated efforts to induce him to become a convert to Catholicism, although that would have been of great material advantage to him at the Imperial Court in Prague. In a letter to the Jesuit Guldin he wrote that, rather than become a Catholic, "I am prepared to renounce the reward offered to me at present, to which his Imperial Majesty has graciously consented, and to relinquish even the Austrian countries, the whole Empire, and what weighs so much more than all this, astronomy itself. I would add, also, life itself."

It was to the rigours of a journey on horseback from Sagan to Regensburg in stormy wintry weather that Kepler succumbed. The journey was made in an effort to obtain from the Reichstag in Regensburg the salary which had been repeatedly promised to him and which was so long overdue. His last days were described by an unknown scholar named Fischer: "During the recent meeting of the Reichstag Kepler arrived here on a skinny mare (which he sold later for two gulden). He had been here for just three days when a fever befell him. . . . Soon it increased so that he lost consciousness. As long as the illness lasted, he did not talk like one in possession of his mind. . . . On the 19th [November, 1630] he was buried in the cemetery of St. Peter's, outside the town. For it is not the custom to bury Lutherans inside the walls."

His friends erected a tombstone over his grave with an epitaph he had himself composed:

Mensus Eram Coelos Nunc
Terrae Metior Umbras
Mens Coelestis Erat
Corporis Umbra Iacet.

But within three years the stone was destroyed when Regensburg was conquered by the Duke Bernhard of Weimar in the course of the Thirty Years' War.

This picture of Kepler the man is a valuable contribution to astronomical literature and is of absorbing interest. H. Spencer Jones

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RECENT RESEARCHES IN PHYSICS

Physical Society

Reports on Progress in Physics. Vol. 13 (1950). Pp. iv+424. (London: Physical Society, 1950.) 50*s*. net; to Fellows, 25*s*. net.

"Reports on Progress in Physics", the series of annual reports on recent advances in physics, inaugurated in 1934 and published by the Physical Society, is now an established part of our scientific literature and needs no special introduction or recommendation. It is sufficient to say that Volume 13 is of similar high standard, both in subject-matter and in production, to that of previous volumes in the series. Nine separate topics, covering mainly the experimental field, are chosen for individual treatment in Volume 13. They range from the very border-line subject of physiological optics to the fundamental physics of magnetism.

Three articles deal with various aspects of astronomy. Recent advances in infra-red solar spectroscopy are reviewed by L. Goldberg of the McMath–Hulbert Observatory of the University of Michigan. The way in which the infra-red spectrum between 0·8 and 3·6 μ has been recently mapped, at the Observatory and at Mount Wilson, with a resolution comparable with that which can be obtained photographically, is described. Lead sulphide photoconductive cells and a high-dispersion grating spectrometer were used. It is stated that an atlas of the spectrum, consisting of approximately 250 of the Mount Wilson tracings, each about 70 A. in length, and covering the wave-length region 0·8–2·5 μ, is being published. The post-war developments in radio-wave spectroscopy in the range of wave-lengths of 1 cm.–15 m., particularly the work carried out at the Cavendish Laboratory, Cambridge, are admirably described by M. Ryle of that Laboratory in an article entitled "Radio Astronomy". A shortened and slightly modified version of this report appeared under the same title in the February 1950 issue of *Physics Today*. The report is complementary to the recent excellent surveys of J. S. Hey (*Mon. Not. Roy. Astro. Soc.*, 109, 179; 1949) and J. L. Pawsey (*J. Inst. Elec. Eng.*, Pt. 1, 97, 290; 1950), and therefore more emphasis has been placed on the limitations of the experimental techniques and of the theoretical implications of the observations. Spectroscopic, visual and photographic observations of planetary atmospheres are discussed by G. P. Kuiper, of the Yerkes Observatory, University of Chicago. This article is illustrated by some very fine photographs, taken at the Lowell Observatory, of the planets Mars, Jupiter and Saturn.

Electrostatic generators and linear accelerators were the subjects of separate reports in Volumes 11 and 12 respectively of the Reports. To complete the series, in Volume 13 there is a clearly written and well-illustrated article by J. H. Fremlin and the late J. S. Gooden on particle accelerators, such as the cyclotron, betatron, etc., in which magnetic fields are used for controlling the particle orbits. It is natural to turn from this article with its description of what the new, extraordinarily costly and extraordinarily powerful synchrotrons and synchro-cyclotrons are capable of doing, to the last report in Volume 13, where Prof. C. F. Powell gives an account of the production of mesons in the atmosphere as a result of cosmic radiation, for, as Powell remarks, "even when the new machines have been brought successfully into operation it will still be necessary to turn to natural sources in order to study the nuclear transmutations produced by particles of the greatest energy". The nuclear physicist will regard Powell's and Fremlin and Gooden's reports as of paramount importance.

The longest report, a hundred pages, in Volume 13 is by Prof. E. C. Stoner and is the second half of his survey on ferromagnetism, the first half of which appeared in Volume 11. Under the composite title of "Magnetization Curves", the magnetic properties of single crystals, domain structure, the analysis of magnetization curves, and magnetic materials are treated. The theoretical and experimental work of the past sixteen years is adequately and exceptionally clearly described. There is no need to stress that where magnetism is concerned Prof. Stoner is a master of his subject; but it is worth while commenting that every physicist ought to read this article if only to study the elegant and exemplary manner in which Prof. Stoner collects and marshals his material and writes a technical paper.

Relaxation effects in paramagnetic crystals is the subject of the other report on magnetism in the volume. Experimental methods, namely, absorption measurements at radio frequencies, dispersion measurements and measurements at liquid helium temperatures, and their application to the measurement of magnetic specific heats, are briefly described. In the remaining two articles border-line subjects are dealt with. "Shock Waves and the Propagation of Finite Pulses in Fluids", by W. G. Penney and H. H. M. Pike, is based on work done during the Second World War and contained in papers only recently declassified or still unpublished, and should be extremely useful to workers in this field. "The Investigation of Eye Movements", by M. P. Lord and W. D. Wright, will be of interest to ophthalmologists, psychologists and physiologists as well as physicists.

Attention must be directed to certain changes which have been made for Volume 13. The Reports have been placed under the general supervision of the Papers Committee of the Physical Society, with Dr. A. C. Stickland as executive editor; the detailed name index has been discontinued, and a contents list has been provided at the commencement of each Report. The reviewer regrets the absence of abstracts, but welcomes the announcement that it is proposed to supplement the cumulative name index for Volumes 1–7, already published, by a cumulative index for authors and subject-matter for all the volumes up to date.

S. Weintroub

AMERICAN RESOURCES

Conservation of Natural Resources

Edited by Guy-Harold Smith. Pp. xii+552. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 48s. net.

"RESEARCH Conservation" now appears in the curricula of many American universities. It is an indication of the increasing realization that the natural resources of the world in general, and the United States in particular, are far from being inexhaustible, and that serious attention should be paid to their conservation.

The subject as taught in the universities is, in fact, economic geography, dealing in turn with each of the main products required by man, but to which is now added an assessment of reserves and an account of the steps which are taken or should be taken to maintain supplies, so leading into the field of State and local planning.

The book under review deals exclusively with the United States and is the co-operative effort of twenty authors under the general editorship of Prof. Guy-Harold Smith, professor of geography in the Ohio State University. It is divided into eight parts, comprising twenty-three chapters. The first chapter, by A. J. Wright (Ohio State University), deals appropriately with the development of conservation in America, and is followed by Chapter 2, "The Public Domain and its Disposal", by S. S. Visher (Indiana University).

Nearly every visitor from the Old World to the New is struck at once by evidences almost everywhere of profligate waste of land and resources. In Britain where the total area of land of all sorts is only a little more than one acre per head of population, conservation has been automatically a part of the British way of life for many centuries. It is difficult to appreciate what has happened in the United States over the past hundred years, where the exposure of vast tracts of former forest and grassland to the evils of soil erosion by indiscriminate clearing and ploughing has led to the abandonment of millions of acres. It is greatly to be hoped that the evils of the present position there will be fully appreciated before the same forces of destruction are let loose in the so-called under-developed lands of Africa and South America.

Part 2, occupying a major part of the book, deals with soils, soil conservation, tree crops, irrigation, grassland, marsh-reclamation and the agricultural prospect. Part 3 deals with forests, Part 4 with water in its different aspects, Part 5 with minerals, including fuel, Part 6 with wild life and fisheries. Part 7 comprises a chapter on recreational resources and a chapter by the late Ellsworth Huntingdon on the conservation of man and what he called the "geography of the human crop". He draws the conclusion that at present the quality of the American people is declining and that little attention is being paid to the decline. Finally Loyal Durand (Tennessee) deals with State and local planning, and the editor with national planning and the conservation of resources. He rightly stresses the continuing need for research and refers to the United States as a country of diminishing material resources, but where there are still new frontiers to be explored. The United States is passing from the phase of extensive, carefree use of land, to an intensive, careful one.

This volume is a scholarly, objective and timely survey of the whole field; it is fully illustrated by maps and diagrams and adequately documented.

L. Dudley Stamp

SCIENTIFIC PHOTOGRAPHY

Wissenschaftliche Photographie

Eine Einführung in Theorie und Praxis. Von Prof. Dr. E. v. Angerer. Vierte Auflage. Pp. vii+226. (Leipzig: Akademische Verlagsgesellschaft Geest und Portig K.-G., 1950.) 13.80 D. marks.

Photography in Astronomy

By Dr. E. W. H. Selwyn. Pp. 112. (Rochester, N.Y.: Eastman Kodak Company, 1950.) 2.75 dollars.

CONSIDERING the wealth of fundamental physical and chemical problems underlying photographic practice, and the many diverse fields of research in which photography is such a valuable—sometimes an indispensable—tool, it is remarkable that there is such a dearth of good general texts on the subject in the English language. In the opinion of the reviewer this is closely connected with the neglect of photography as a subject of study, whether from the scientific interest of its underlying theory or as a branch of technology deserving of scientific analysis, in British universities and higher technical colleges. Certain it is that the position has long been different in Germany and Austria, as the mere mention of such names as Eder, Luppo-Cramer and Luther will serve to remind us.

The author of "Wissenschaftliche Photographie" is an associate professor at the Technische Hochschule at Munich, and his well-known book (first published in 1939) is a good example of the sort of text we need. Its virtues lie especially in its method of approach to the subject—an approach calculated to appeal to the serious student, and to the research worker who wants something more than a 'cookery book' to guide him in his use of photography as a tool. Yet it is not an exhaustive text by any means, but only an introduction to the subject; and for this reason, perhaps, this fourth edition does not differ very markedly from earlier editions. It is excellently produced and moderately priced.

In the absence of academic texts in English, the photographic industry itself has sought in recent years to fill the gap: Dr. C. E. K. Mees's "Theory of the Photographic Process" and Dr. Walter Clark's "Photography by Infra-Red" will come to mind in this connexion. Dr. Selwyn's book on astronomical photography is another excellent, though slender, text from the same source. It is essentially readable, superbly illustrated, and very well produced; and the fact that it comes from one particular industrial company is not obtrusive. The astronomer may find it a useful summary, the student in other fields will certainly learn much from it; but both will no doubt regret its omission of references to original work.

L. V. Chilton

Statistics

An Intermediate Text Book. By Dr. N. L. Johnson and H. Tetley. (Published for the Institute of Actuaries and the Faculty of Actuaries.) Vol. 2. Pp. xi+318. (Cambridge: At the University Press, 1950.) 20*s*. net.

STATISTICS is now an important part of the course of training for actuaries. The Institute of Actuaries and the Faculty of Actuaries have consequently arranged for the preparation of this book for the use of their students.

This second volume, which completes the work, has three chapters on the general theory of distribution functions, their application to particular types of sampling and the multinomial distribution (leading to χ^2). There follow chapters on the general theory of statistical tests and estimation, stratified population and variance analysis, correlation analysis and curve fitting, and graduation. The exercises at the end of each chapter and the end of the volume are numerous and well chosen. That the book emanates from the Cambridge University Press is sufficient guarantee of the quality of the printing; and the price, in present circumstances, is quite reasonable.

The defects of the book—it is perhaps scarcely fair to describe them as such—are inevitable in any attempt to compress statistical theory into a comparatively brief compass at the University Intermediate level. There is only space, for example, for two and a half pages on least squares estimation, and less than that for maximum likelihood. On the other hand, there are sections on topics which have not yet found their way into standard texts, such as the supplementation of the χ^2 test by tests of changes of sign. Notwithstanding the limited objective of the book, it should also form a useful Intermediate text for non-actuarial students.

Trace Elements in Plants and Animals

By Prof. Walter Stiles. Second edition. Pp. xi+189+8 plates. (Cambridge: At the University Press, 1951.) 15*s*. net.

THE demand for a concise and reliable account of the part played by trace elements in the nutrition of plants and animals is shown by the issue of a second edition of Prof. W. Stiles's useful book on the subject. The text remains for the most part unchanged, though a number of supplementary references and a photograph illustrating molybdenum deficiency in cauliflower have been included. In view of the rapid progress that has been made in this field it seems a pity that the opportunity was not taken to extend the section on molybdenum deficiency in plants a little further, and that no references later than 1948 have been quoted. K. W.

Flora of Egypt

Vol. 2: Angiospermæ, part Monocotyledons; Cyperaceæ–Juncaceæ. By Vivi Tackholm and Mohammed Drar. (Fouad I University: Bulletin of the Faculty of Science, No. 28.) Pp. xii+547. (Cairo: Fouad I University Press, 1950.)

NINE years have elapsed since the publication of the first part of this work. The second volume covers the sedges, palms, aroids, rushes and some related families. The Flora is considerably more comprehensive in scope than most works of its kind, for, in addition to the systematic account of indigenous plants, cultivated species and many garden plants are included. All plants of importance in Egypt, either because of the uses to which they are—or used to be—put, or because of their connexion with ancient cultures, receive an unusually detailed treatment which embodies much historical, archæological and other information of interest and value. There are also copious references to literature relating to all the aspects discussed. Particularly detailed accounts are given of papyrus and date palm, in which the importance of these plants is described in relation to art, literature, religion and ancient industries. It is therefore not surprising to find that, in this volume of more than 500 pages, only seventy native species are included. The account of the palm family, for example, runs to nearly 200 pages, though only the date, dom and argoun palms are extensively grown and are important species, and only one of these is indigenous. The many other exotic species included are all cultivated plants. It is greatly to be hoped that future parts will appear at more frequent intervals, and that it will be possible to complete the work on the scale and with the thoroughness foreshadowed by the first two volumes. W. A. S.

Die naturwissenschaftliche Illustration

Ein geschichtlicher Überblick. Von Claus Nissen. Pp. 64. (Bad Munster am Stein: Lothar Hempe Verlag, 1950.) n.p.

THIS little book surveys a very large subject—the history of animal and plant illustration from classical to modern times. Such a work must deal with questions of art, illuminated MSS., the evolution of the printed illustration, the woodcut, line engraving and etching on copper, lithography, and finally the numerous processes based on photography by which illustrations in black and colour can be produced. It is obvious that a small octavo booklet of only fifty-six pages can only explore so vast a field in the merest outline. Dr. C. Nissen's contribution, however, will be very useful to the beginner in setting him on the road to more detailed information. Skeleton bibliographies are added. F. J. C.

The Subject Index to Periodicals, 1949

Issued by the Library Association. Pp. xi+296. (London: Library Association, 1951.) 105*s*.

SINCE the outbreak of war in 1939, the "Subject Index to Periodicals", of which the 1949 volume has now been published, has dealt only with periodicals in the English language, which are published in Great Britain, the Dominions and the Colonies, excluding Canadian periodicals, which with American periodicals are adequately covered by the H. W. Wilson Company's indexes. Highly specialized periodicals in science or technology are also omitted and the "Subject Index" thus caters chiefly for the general reader, offering him a key to the contents of many periodicals which are not indexed elsewhere. Among these are some devoted to subjects of limited appeal such as stained glass or mountaineering, and also the proceedings and transactions of local societies concerned with antiquities, natural history, etc. The "Subject Index" is compiled on the plan of the 'dictionary catalogue', all entries being in simple alphabetical order. Articles relating to people, places, institutions, etc., are placed under the proper names in question, while 'subject' articles are entered under simple, practical headings, which describe, as specifically as possible, the material in question. Cross-references are freely used for linking up related subjects, and where necessary titles are elucidated by admirable explanatory annotations. The production and layout maintain the high standard set by previous volumes of the "Subject Index".

AURORAS AND LUMINOUS NIGHT CLOUDS*

By J. PATON

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Auroras

SCOTLAND is well situated for observing auroras for they may be seen there on the average on about forty nights in the year, compared with seven to ten nights in the south of England. Since 1946, four stations—at Abernethy and Blairgowrie in Perthshire, Newton Stewart in Wigtownshire and Roseneath in Dumbartonshire—equipped with specially designed cameras ($f/1\cdot25$ and focal length 5 cm.) and linked by telephone, have been used to record the forms and to determine the positions and heights of auroras that have occurred in association with the last sunspot maximum of 1947.

It is impossible to predict precisely the course of a great aurora, but what usually happens is as follows. At first, a glow, much like dawn (hence the name aurora borealis, northern dawn, which was first used by the French philosopher, Gassendi, in 1621), appears on the northern horizon, often with a warning by day 24–36 hours beforehand of a solar flare. The glow then ascends from the horizon to form an arc, the lower border of which is at a height of about 100–110 km. Of all the auroral forms, the quiet arc is the only one of which the lower border appears always at about the same height; there is no significant variation either with latitude or with local time. This fact, together with the tendency of the arc to remain quiescent for a long time, allows the determination of its geographical position by photographs from a *single* station. In fact, when such an arc appears, there is an arrangement at the Scottish stations to photograph simultaneously according to a prearranged time scheme with Prof. Carl Størmer's Scandinavian network. The geographical position of the arc may then be plotted from mid-Atlantic to western Russia, thus providing information that may be of value to the theoretical worker.

The true colour of most arcs is probably green, for a predominant line in the spectrum is the green forbidden line 5577 A. of atomic oxygen, and this happens to be in the region of maximum sensitivity of the retina. But, except in the case of very bright arcs, it appears to the eye to be grey-white, since the light intensity is below the threshold of colour perception. The arc may then brighten suddenly to an intensity above the threshold such that patches of vivid greens and reds can be seen here and there along its length. Simultaneously the lower border becomes extraordinarily sharply defined and is appreciably lower, all of which are signs that the arc is about to lose its regular shape and to show ray structure. It may then undulate to appear like the folds of a huge waving curtain, or it may take the form of a wide band, stretching irregularly across the sky. The base of these draperies may come as low as 90 km.; the minimum height tends to occur at about 0300 hr. local time, so that the particles which cause auroras appear to penetrate most deeply into the atmosphere about this time. There is some evidence, too, that the bases of curtains and bands are lower in lower latitudes. Indeed, one of the aims of low-latitude stations, such as those in Scotland, is to investigate these latitude variations.

When the rays pass overhead into the southern sky, they then form what is undoubtedly the most spectacular of auroral forms—the corona. The rays appear to converge to a point, approximately the point in the sky to which the south pole of a magnetic dip needle would point—in Scotland it is about 20° south of the zenith. Thus the direction of the auroral streamers coincides approximately with the lines of force of the earth's magnetic field. This is what would be expected if the aurora is caused by charged particles emitted from the sun at the time of the flare, for, when they eventually enter the earth's magnetic field after their journey of a day or so through space, the particles would be deflected to travel ultimately either directly down the lines of force or in close spirals round and down them. The auroral light is produced along their path by the excitation of atmospheric atoms and molecules, probably mainly by collisions with secondary electrons ejected by the primary auroral corpuscles. The light streamers are therefore closely parallel and their apparent convergence in the corona is merely the effect of perspective.

When the display is at its height, the total illumination may be greater than that of full moon. During the great display of January 25, 1949, it was possible to pick out trees and fields on a hillside three miles away. At one point during this display the illumination suddenly ceased as if the lights had been switched off; but a great display usually fades out in what is called 'flaming'—waves of light, generally of low intensity, surge upwards, one after the other, towards the zenith. Sometimes this whole sequence may be repeated. There is a fairly well-marked diurnal variation with a main maximum at 2200 hr. and a secondary one at 0400 hr. Usually, luminosity is greatest and the auroral forms are most active and well defined at the time of the main maximum, and it is then that the display is likely to reach its most southerly limit. At the time of the secondary maximum, the forms are often diffuse and weak.

The method of determining the height and position of aurora is due to Prof. Størmer, who, besides making important contributions to the theory of aurora, has, during the past forty years, made a very thorough investigation of auroral forms seen from Norway. A certain part of the aurora is photographed simultaneously by the observing stations, and then, on comparing the plates, the relative parallax of the star background is measured and the location of the aurora computed. During the great aurora of January 25, 1949, a base line of 169·8 km. was used between Abernethy and Newton Stewart to measure the height and position of red diffuse surfaces, which were found to be situated at heights of 500–700 km. over northern Germany. As might be expected, the main difficulty has been cloud and fog, which have completely obscured at least two great auroras, and often obscure an aurora at one of the stations when the others are able to make an exposure.

Luminous Night Clouds

The auroral cameras and plates are suitable for the photography of the rare noctilucent or luminous night clouds, so that when the brilliantly blue clouds were observed on July 10–11, 1949, parallactic photography was immediately begun and continued until the clouds slowly vanished in the growing light before dawn. Measurements showed that the whole mass of cloud was situated at heights between 84 and 89 km. and was confined within the twilight circle. (The greatest height at which ordinary clouds appear is about 12 km.)

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* Substance of a paper read on August 9 before Section A (Physics and Mathematics) at the Edinburgh meeting of the British Association.

It is most surprising that the first records of these remarkably lovely blue clouds appeared as late as 1885. Their spectrum is similar to that of the day sky and shows Fraunhofer lines; the particles constituting the cloud then are so high that those within the twilight circle are in sunlight, revealing their presence by the sunlight they scatter. Their blue colour indicates that the diameter of their particles is small compared with the wave-length of light.

The conditions necessary for observation of the clouds are as follows: the sun must be at least 10° below the horizon in order that the sky background may be sufficiently dark; it must not be more than 18° below the horizon, for an appreciable part of the atmosphere above 80 km. must be in sunlight; normal clouds must be sparse or absent and visibility excellent. Thus they can be seen only in the summer months and only within latitudes 45°–62°.

The first accurate measurements were made in Germany by Jesse about 1890. He found their height to be about 79–90 km., and on one occasion recorded the remarkable velocity of 177 m. per sec. or 400 m.p.h. He observed that they travelled from the north-east before midnight and from east-north-east after midnight. They occurred frequently and in brilliant forms during 1885–88. Omond saw them from Ben Nevis Observatory on every clear night from June 4 to July 2, 1888. From then until 1932 they were seen only occasionally. During 1932–34 the clouds again appeared in brilliant forms to give Prof. Störmer the opportunity of applying the technique that he had used so successfully in studying auroras. He confirmed Jesse's measurements, finding the mean value of their height to be 82 km. and their velocities to lie in the range 48–83 m. per sec. The clouds were rarely seen between 1934 and 1949, but during and since 1949 several fine displays have been photographed and measured both in Norway and Scotland. On July 24–25, 1950, the rare coincidence occurred of luminous night clouds in association with an aurora. On this occasion the clouds soon became so brilliant that they extinguished the aurora. By 0100 hr. they extended along the horizon between azimuths 345° and 85° and reached an elevation of 25°; at this time, so brilliant were they, that it was possible to make notes and observe the stop watch by cloud light.

The nature and origin of the clouds is still uncertain. Jesse thought them to consist of the products of condensation of matter projected into the high atmosphere at volcanic eruptions; the magnificent displays of 1885–86 were ascribed to residual dust from the Krakatoa eruption of 1883. But Vestine has pointed out that just at this time there occurred a remarkable number of meteor appearances, showers and great comets. Moreover, no marked increase in the frequency of the clouds succeeded the eruption in 1912 of Katmai, Alaska, whereas the great Siberian meteor of 1908 was followed immediately by a brilliant display. So he concludes, and Prof. Störmer agrees, that the clouds consist of material of cosmic origin.

On the other hand, Vegard believes that the clouds may be formed by the condensation of water vapour on sodium oxide nuclei formed by the combination of sodium and atmospheric oxygen. He suggests that the presence at this great height of water vapour, in the concentration necessary to account for such extensive clouds, may result from the combination of atmospheric oxygen, perhaps in the form of ozone, and hydrogen, projected into the atmosphere from the sun. There is evidence that a temperature minimum of the order of 200° K. exists at a height of 80 km., and, as the pressure there is of the same order of magnitude as the vapour pressure of water, conditions may be favourable for condensation. During the display of July 24–25, 1950, portions of the clouds were observed to change colour from vivid blue to white, suggesting growth of the particles.

Now that Whipple's meteor observations and the theoretical work of others on atmospheric tides indicate that temperature falls rapidly from a maximum at 60 km. to a minimum at 80 km., the problem of explaining the occurrence of the clouds always at about 80 km. is resolved. Meteoric dust, for example, would tend to drift to and remain below the base of the inversion at 80 km., and if these are water clouds, then condensation is most likely at the temperature minimum at 80 km. Indeed, the presence of the clouds always at this fixed level is itself evidence of the existence there of a temperature minimum.

Wave formation is a characteristic of the clouds, and measurements show that the distance between the wave crests is about 9 km. Recalling the great speeds with which these clouds may travel, the wave formation is no doubt generated in the wind shear at the inversion, as in ordinary billow clouds.

These clouds are naturally of great interest to the meteorologist for, with meteor trains and now the new radio methods, they provide a direct means of measuring air movement at these high levels.

STORAGE OF FARM PRODUCTS

It is often not realized that an increase in the yield of a farm crop which has taken many years of selection and improved culture to achieve may be much less than the losses during storage of the crop. For example, it has been estimated that a fifth of the total production of potatoes in France is lost during storage because of respiration, water-loss, disease and sprouting. There seems no reason for believing that the overall loss in Great Britain is much less, in which case the weight lost during storage would be sufficient to supply the whole human population of the United Kingdom for nearly four months. Admittedly potatoes are one of the more impermanent farm crops; but for most products the development of more efficient means of storage is a matter of great importance, and clearly merited the discussion devoted to it at Edinburgh by Section M (Agriculture) of the British Association during the morning of August 10 under the chairmanship of Dr. E. M. Crowther, president of the Section.

Prof. S. J. Watson, of the Department of Agriculture and Rural Economy, University of Edinburgh, speaking first, discussed the storage of grass. The traditional method—by making hay—is extremely wasteful of the feeding potential of the grass. In a wet year as much as half the feeding value may be lost by various means—as by respiration during the comparatively slow drying process and by leaching. Even in an exceptionally fine year about a quarter of the nutrients originally present is lost. The average loss is about a third. The use of appliances, such as stakes, wires, and tripods, on which the grass is placed after cutting reduces these losses but only by about 5 per cent. On the average, ensiling without any addition is as wasteful as haymaking in an average year, though it must be remembered that silage and hay are not comparable, the former being made from younger and more leafy material. The various forms of fermentative losses during ensiling may be reduced if the *p*H is low, preferably below *p*H 4, and it has been claimed that the losses are very slight if silage is made with the addition of acid. The beneficial effect of the acid tends, however, to be local. Possibly the best practical method is to use a roofed and lined pit silo and achieve a certain degree of acidity—say *p*H 4–4·5—by the addition of molasses and the consequent lactic acid fermentation. This acidity is sufficient to suppress butyric acid fermentation.

By far the most efficient means of conserving the feeding value of grass, Prof. Watson said, is to dry it artificially. The net feeding value may be of the order of 7 per cent less than that of grass, due mainly to the greater loss of energy in the mastication of dried, as compared with fresh, grass. The disadvantages of grass drying are economic; but Prof. Watson agreed in the course of subsequent discussion that such disadvantages might not be important if the drying were undertaken on a large scale by a competent factory manager. Broadly speaking, he recommended drying for the large-scale preservation of grass and, on the small scale, ensiling in either pit silos or good tower silos. Hay would still be made, and every care should be taken to keep the losses to a minimum.

Following Prof. Watson, Mr. J. H. Leycester, of Wheatfield, Hilton, Huntingdon, described the method which he has developed for storing grain, explaining that it had been planned to meet his own requirements for the storage of about four hundred tons of wheat and barley. The system followed is not to harvest the grain moist and then dry it, but to wait for dry weather and harvest twenty tons a day using combines with a total cutter-bar length of twenty feet. The grain is delivered in bulk by pneumatic tipping lorries to the store, which consists of a receiving bin (with a floor sloping to the outlet and feeding by gravity into a pneumatic conveyor), a cleaning unit and eight 40-ton storage bins. No dryer is installed—this being a useful selling-point when disposing of the barley for malting. In years when the grain has necessarily been harvested wetter than advisable, drying down to 16·5 per cent moisture has been achieved by repeatedly passing the grain from one bin to another through the pneumatic conveyor. Passage once through the conveyor has been found to remove 0·25–0·5 per cent of moisture at a cost of 2·2d. per ton. (In answer to questions, Mr. Leycester stated that this is the cost of electricity only.) He agreed that a moisture content of 16·5 per cent is higher than normally regarded as advisable, and only exceptionally does he store grain at a moisture content as high as this. The stored grain is shifted from one bin to another during storage at intervals of 6–7 weeks, one bin being kept empty to enable this. Asked whether, in the light of experience, he could suggest improvements to his store, Mr. Leycester replied that it would be better if it were excavated to a depth sufficient to avoid the necessity for a loading ramp from which the receiving bin is now filled. Higher storage bins and a conveyor of greater capacity would be preferable.

The further proceedings of the meeting were devoted to the storage of potatoes. Mr. W. G. Burton, of the Ditton Laboratory, East Malling, of the Department of Scientific and Industrial Research, outlined the ideal conditions for the storage of potatoes but stated that these were attainable only in heavily insulated cool stores with continuous air circulation. These are not at present thought economically justifiable. Potatoes stored at normal temperatures generate sufficient metabolic heat to raise their temperature 0·6–0·8 deg. F. per day. In a stored mass of potatoes a state of dynamic equilibrium is set up in which heat removed by convective air circulation and conduction, both of which result from the difference in temperature between the potatoes and the surrounding atmosphere, just balances the heat produced by respiration. At normal storage temperatures of 40–50° F. and for unsprouted tubers it is approximately true to say that, if the width and length of an unventilated potato stack exceed twice the height, increasing them has little effect upon the average and maximum temperatures, that the average temperature of the potatoes will exceed that of the store air by ⅔ deg. F. for every foot of height; and that the maximum temperature among the potatoes will exceed the average temperature of the store air by 1 deg. F. for every foot of height. The provision of ventilating ducts beneath the potatoes lowers both the average and maximum temperatures, and further cooling is possible if forced ventilation with a power-driven fan is employed. Continuous forced ventilation at a rate of 2,300 cu. ft./ton hour will remove about 110 B.Th.U./hr. deg. F. difference in average temperature between the potatoes and the ventilating air, and with air at a steady temperature will maintain stored potatoes at an average temperature exceeding the inlet temperature of the ventilating air by about 1 deg. F. and with a maximum temperature less than 1 deg. F. higher than the average temperature. Continuous ventilation causes excessive wilting. In addition, the temperature of the outside air fluctuates widely, and is often such that ventilation serves only to warm the potatoes. By forced ventilation with cold night air it has proved possible to maintain a stack of potatoes at an average temperature fluctuating within approximately ±2 deg. F. about an average rather below the average weekly air temperature. In answer to a question, Mr. Burton stated that potatoes harvested immature will at first produce more heat than mature ones; but after storage for some weeks the heat production of immature and mature potatoes is approximately the same.

Dr. A. R. Wilson, of the Agricultural Research Council Potato Storage Unit at Sutton Bonington, described the practical advantages to be derived from the indoor storage of potatoes. He stated that a single-story building in which the potatoes are stored to a depth not exceeding twelve feet is most useful under British conditions. The potatoes should be stored in one large mass, not sub-divided into bins. Sub-division by straw bales can be used if necessary to avoid mixing varieties. Storage to a depth of about six feet in existing farm buildings is satisfactorily practised in many parts of the country, and although this method is wasteful of floor space, this need not be a disadvantage if the space is required for other purposes, such as machinery storage during the summer. Excluding such alternative uses, there is no doubt that storage to a depth of twelve feet is cheaper per ton than is shallow storage. The store should not be less than twenty-four feet wide if machinery is to be manœuvred without difficulty, nor more than thirty feet wide because of difficulties in air distribution if deep storage with bottom ventilation is practised. For storage until March sufficient insulation is provided if the walls have a transmittance value of 0·2 B.Th.U./sq. ft. hr. deg. F. difference, and, if with such walls the roof is insulated to give a transmittance value of 0·15, condensation and drip are prevented. The most efficient means of ventilation is by a thermostatically controlled power-driven fan delivering to ducts under the potatoes. Manual control usually results in less cooling and more ventilation, which latter is to be avoided because of the wilting caused. Bulk harvesting has proved more efficient than other methods, and an elevator-loader has been designed to handle potatoes in bulk. It has a hopper to receive bulk loads from standard tipping trailers and has an outreach of twelve feet when loading to a height of twelve feet. A loading-rate of twelve tons per hour has been reached over short periods, and the turn-round of vehicles with two-ton loads has been achieved in less than seven minutes. Preliminary studies on the comparative costs of clamping and indoor storage indicate that a capital expenditure of £5 per ton on storage accommodation is justifiable, even leaving out of consideration such important advantages of indoor storage as independence of weather conditions during grading. In reply to a question Dr. Wilson stated that the ventilating unit of a grain dryer can probably be used to ventilate a potato store, and, in fact, some farmers are experimenting with such dual-purpose installations using the platform-type sack dryer.

If food is produced far in excess of the need for it, its storage or wastage is a matter of indifference. At the other extreme we may have conditions such that the conservation of farm products to the greatest possible extent is an overriding necessity. For each product mentioned during the discussion, methods of storage are known which will preserve a very high proportion of the value for much longer than is normally necessary; but such methods are regarded as uneconomic under present conditions. It was clear from the discussion that the methods adopted and being sought in practice are therefore compromise attempts to preserve as much as possible within the framework of the present relative values of farm products and the apparatus necessary to preserve them.

LIMITS TO INTENSIVE PRODUCTION IN ANIMALS

On August 14 at the Edinburgh meeting of the British Association, Section M (Agriculture) held a symposium on "Limits to Intensive Production in Animals". Prof. R. A. Fisher, Balfour professor of genetics, University of Cambridge, read the first paper, taking for his subject "Genetical Limits to Intensive Production in Animals". He referred to farm animals as part of a farmer's machinery for turning material from a less valuable into more valuable form, and said that in the designing of such material the geneticist can make an important contribution. He commented on the separation of genetics and biometry as university subjects dealt with in different departments and taught to different sets of students, thus creating a difference of outlook and preventing progress: he felt that because of this unnatural separation it would be difficult in the future to find personnel with the necessary outlook, although they may be well trained in one or other of the subjects. Prof. Fisher's view is that the work on the breeding of farm animals is so technical and the precision of the biometrical determinations involved are so important that it is necessary to set up biometrical laboratories for the purpose. The genetics of farm livestock have been neglected in the development of the general subject of genetics. This Prof. Fisher attributed to several causes: the two World Wars have shaken the national economy of Great Britain, and there is also to be considered the economic revolution, which has interfered to some extent with the prospects of the older methods employed for livestock improvement. Livestock breeding is slow and expensive, and therefore has not been given its rightful place in research work; in fact, the whole subject of genetics has been left to amateurs and teachers and, therefore, it is but natural that such workers should prefer mice or birds for their work, rather than farm animals. He remarked on the work during the past forty years on *Drosophila* and claimed that these studies have done more towards an understanding of genetic improvement in livestock than have all the efforts made up to date with livestock themselves. He agreed that some beginnings have now been made on serious research work; but he wondered if public officials really think or imagine that a centre for the study of pure genetics of each of the larger species of animals could be of any importance for livestock improvement. Prof. Fisher's final remarks were: "As a last optimistic consideration, let me point out that land long fallowed is sometimes very productive; that unworked gold mines are the best gold mines. Because nothing effectual has been done, we may at least feel sure that the law of diminishing returns has not yet set in, as seems to be the case in some fields of plant improvement, and the ceiling of genetic potentiality is still a long way off."

In the discussion on Prof. Fisher's paper, Dr. H. P. Donald, of the Animal Breeding and Genetics Research Organization of the Agricultural Research Council, directed attention to the recent establishment of the Organization, the object of which is to study the genetics of livestock. The work is long-term, and results will not be available for some time to come. Dr. Donald pointed out that little publicity has been given to the setting up of this Organization, and it may be that this is the best procedure because it will be a long time before any results will be produced for application to the industry.

Further discussion centred around the efforts of practical farmers for livestock improvement, and it was claimed that, by the use of sires selected for specific qualities, improvements have been obtained in some breeds of cattle.

Dr. John Hammond, University of Cambridge, who spoke on "Physiological Limits to Intensive Production in Animals", referred to the British Friesian cow which recently attained a new world record in milk production, yielding in its lifetime nearly 120 tons of milk. He also referred to other high milk-yielding cows as illustrating that the limits of production have not yet been reached; in fact, he considered that there are no physiological limits to intensive production, provided that suitable nutrition and other environmental conditions are applied. Dr. Hammond showed by diagrams how a system of priorities operates whereby nutrition is supplied from the blood stream for the various body tissues and how the animal adjusts itself to the nutritional requirements. A balance is obtained according to the needs of the different tissues and the extent to which they are developed in the make-up of the animal; in cows in which high milk yields are being developed, the requirements for udder development are greater than those in the poorer milk yielders. He also dealt with pigs, in which he showed that, after feeding at a high nutritional level, better growth and development results if the high level is maintained.

Sir Thomas Dalling, chief veterinary officer, Ministry of Agriculture and Fisheries, took as his subject "Relationship of Animal Health to Production". He pointed out that in the absence of a healthy animal the results of attempted improvement in production may fail. He pleaded for a better understanding of the physiology of some of the important systems in the animal body, the study of which has been long neglected but is now being taken up largely through the efforts of the Agricultural Research Council. Infectious diseases must always limit increased production, and therefore a better understanding of their nature and how they spread is necessary; much attention has been given to their control throughout the world, and measures are being successfully practised. Sir Thomas referred at some length to bovine tuberculosis and the limits its presence in cattle places upon production. Research work has resulted in the application of schemes for its control, and eradication from Great Britain is now being undertaken. Venereally transmitted diseases and the value of artificial insemination in their control were also referred to. Dealing with increased yields of milk, special attention must be given to the health of the udder and the prevention of mastitis. In addition to the knowledge that certain micro-organisms play a part in the causation of mastitis, Sir Thomas referred to the necessity for adopting satisfactory husbandry and hygiene procedures to prevent injury to the udder tissues. He mentioned the necessity for regard for the health of an animal from the time it is conceived and throughout its young life; he stressed the importance of feeding colostrum to the newly-born animal. His remarks also covered the health of pigs and the need for close attention to nutrition whereby a sudden change in the bacterial flora of the digestive tract may be prevented. He gave as an example the finding of large numbers of micro-organisms of the salmonella group in the intestine, following the use of unsuitable diets. Sheep and poultry were also dealt with—the susceptibility of the former to infections with anaerobic micro-organisms, especially when in a thriving condition, and the high incidence of disease in the latter associated with high egg production.

Dr. A. S. Parkes, National Institute for Medical Research, discussed the "Preservation of Spermatozoa at Low Temperature". He showed a film which illustrated the freezing and thawing of red blood cells and spermatozoa in the presence of 15 per cent glycerol, the thawed cells being unimpaired. In the absence of glycerol the spermatozoa do not resume motility. Fowl spermatozoa so treated have been shown to retain their fertilizing capacity. Dr. Parkes thought that, with further refinements of technique, it would be only a matter of time before semen from bulls and other animals could be kept in a frozen condition and used long after it was obtained from the animal: in fact, he foresaw that an animal would be used as a sire long after its death. The results of this work have an important practical application. In artificial insemination as a method of breeding there is a heavy loss of semen, for it is not always possible to adjust supply to demand. When Dr. Parkes and his colleagues have progressed further in their studies, it is to be hoped that they will be able to show that semen from livestock can be preserved with results similar to those they have obtained in poultry; this will be an important forward step in improving livestock production by the greater use of selected sires.

ADVISORY COUNCIL FOR SCIENTIFIC POLICY

The fourth annual report of the Advisory Council on Scientific Policy[*] covers the period April 1950–March 1951 and, apart from the discussion of the implications of the Colombo Plan for the employment of scientific workers, technologists and other experts from Great Britain and of the recommendations of the Committee on Toxic Substances in Consumer Goods, which occupy the greater part of the report, covers much the same ground as the third report. In regard to scientific man-power the report notes that the rearmament programme will make particularly heavy demands for physicists, chemists and engineers. The Advisory Council admits that the views expressed in its last report regarding the supply of scientific men under-estimate the difficulty and that over a wide field the demand exceeds the available supply. It has set up a standing Committee on Scientific Man-power, on which the Ministry of Labour and National Service and the University Grants Committee are represented, to deal with the position. The membership of this and of other standing committees set up by the Advisory Council is detailed in an appendix. A particular question of scientific man-power, that relating to biologists, has been remitted to another of these committees, that on Biology and Allied Sciences, and this committee reported that while more general botanists and zoologists than can find employment as such may be graduating, there is a continuing shortage of most kinds of biological specialists, particularly of those suitable for employment by the Agricultural and Medical Research Councils and for posts overseas. It is unlikely that this shortage will be made good for several years, and it may be accentuated if the plans for economic development of under-developed areas, whether under the Colombo Plan or in other parts of the world, come to fruition and the biological work of the Colonial Service increases.

The Advisory Council recognizes the great scope for expansion of Colonial research, and that such expansion is likely to be limited by a shortage of scientific workers trained in the necessary disciplines as well as by financial stringency. It is equally concerned that the demands which the numerous agencies concerned with the development of backward areas may make upon British resources of scientific man-power cannot be met, if all the plans discussed come to fruition, without serious damage to other commitments. It emphasizes that the situation will only become more difficult if suitable undergraduates are now deterred from taking up careers in one of those fields of biology in which there continues to be an unsatisfied demand. It suggests that, where requests for scientific assistance under the Colombo Plan are referred to the United Kingdom, they should be examined, where appropriate, by the Research Councils, to see whether they could be fitted into their current programme of work, and that the men sent abroad should retain a connexion with one of the research councils or some other research organization at home so as to prevent isolation impairing the value of their work. Moreover, although facilities for training in British universities and other institutions are severely taxed and the financial provision may be curtailed, the Advisory Council thinks it important that places should be found for people sent to Great Britain under the Colombo Plan. In this way we could play an important part in the development of South and South-East Asia, and the effect of such assistance would be to cement and strengthen the relations already existing between the United Kingdom and the under-developed countries.

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[*] Fourth Annual Report of the Advisory Council on Scientific Policy (1950–1951). Pp. 18. (London: H.M. Stationery Office, 1951.) 9d. net.

The Advisory Council's discussions on the Colombo Plan brought out three further points which are relevant to any major schemes of development in under-developed territories. First, experience has shown the value of initiating pilot schemes in the first instance, rather than full-scale work. Second, it emphasizes the importance of a historical study of the sociological and ecological effects of similar economic developments in the past, and of attempting to apply sound sociological principles simultaneously with promoting economic development. Third, although the extensive application of science could greatly improve the economic standards of these countries, so long as the population of the world continues to increase at its present rate the hoped-for improvements in the standards of life may not, in fact, occur.

On higher technological education, the present report adds very little to what was contained in last year's report. It notes that the proposal in the report of the National Advisory Council on Education for Industry and Commerce for a "Royal College of Technologists" does not meet the need for an expansion of the facilities for higher technological education. The Advisory Council reiterates the view that expansion of these facilities is essential if we are to develop a balanced supply of applied scientists of adequate calibre and training to achieve the broader and more vigorous applications of scientific methods and advances upon which our industrial prosperity so closely depends. While it rightly points out that the necessary development of technological education is a long-term process which must take more than a decade to achieve, something more might well have been expected of the Advisory Council in this important matter than a hope that an early decision will be announced.

The Advisory Council has received from its Scientific Library and Technical Information Committee a report on the needs of the national library of science and invention which is to form part of the new Science Centre in London. It is understood that the President of the Board of Trade has agreed that the Patent Office Library should be expanded to form the national reference library of science and invention, and that it will continue to serve the needs of the Patent Office. The library will cover the whole field of science and will be supported by the specialized libraries of the learned societies. The areas of its responsibility have been agreed with the Agricultural and Medical Research Councils and with the government departments principally concerned. A novel feature of the library is that it is not proposed that it should contain any scientific literature more than about fifty years old. In conformity with this plan, material which has ceased to have value for current work will be pruned in consultation with the British Museum. The library will serve working scientific men in industry and all those concerned with research and development; but it will not provide for other users, such as undergraduate students, for whom other facilities exist. The Committee's report has been approved by the Lord President of the Council and it has been passed to the Ministry of Works for preliminary planning in connexion with the Science Centre.

The Panel on Technical Information Services has now been dissolved and its responsibilities have passed to the Scientific Library and Technical Information Committee, which is now examining the recommendations in the Panel's report on technical information services in the United Kingdom. This report has since been published in the *Journal of Documentation* (June 1951).

The Advisory Council has considered the comments of the Medical Research Council and of the government departments concerned on the recommendations of the Committee on Toxic Substances in Consumer Goods. While it believes that the risk to life and health is probably small, the rapid growth of the chemical industry and needs of the food-processing industries for substitutes to replace scarce materials or for new chemicals for improving the appearance, palatability or texture of manufactured foods are accelerating the pace at which new chemical substances are being introduced into consumer products, and existing machinery for testing the possible harmful effects of these substances is inadequate. Adequate and fully effective arrangements should therefore be made by government departments for the acquisition of information about possibly noxious substances or processes which industry may contemplate using, before these are allowed to find their way into the composition or treatment of the articles concerned; but the Advisory Council agrees with the view that new legislation is not required at present, and recommends that manufacturers should be informed that they are expected to take all reasonable care to ensure that no new substances should be offered for sale if toxic effects are suspected. It also recommends the establishment of a standing committee of representatives of the departments mainly concerned, and that the Medical Research Council should retain the general responsibility of keeping the whole problem under review and of initiating research and should receive adequate financial provision for the purpose, including the development of information services. Information over the whole field of toxic substances should be interchanged with the appropriate authorities in other countries, and particularly with the Food and Drug Administration and other government agencies in the United States. The Advisory Council also thinks that it would be appropriate for the cost of a central toxicological laboratory to be borne by industry, either through subscriptions or out of fees paid by trade associations.

A Committee on Atomic Energy considered the possible industrial uses of atomic energy and their economic value. In the view of this Committee, there is a reasonable prospect that atomic power can be developed on a large scale and that the cost would not ultimately differ widely from that of coal. Successful development of an experimental atomic power plant depends largely on metallurgical development which is now proceeding, and the capital cost of an early type of atomic power station would be substantially greater than that of a coal station, although its fuel costs might be less. Development of such stations to a point when they can contribute substantially to the power resources of the country is likely to take at least a generation, and the Advisory Council emphasizes that work on the civil applications of atomic energy should not be allowed to retard inquiries into the better utilization of existing sources of heat and power.

BIOPHYSICAL STUDIES OF RHEUMATOID CONNECTIVE TISSUE

By Dr. J. H. KELLGREN and Dr. J. BALL
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AND

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Department of Biomolecular Structure, University of Leeds

Introductory

IN rheumatoid arthritis and related syndromes, characteristic changes may be found in the connective tissue for which the term 'fibrinoid' is usually employed. This fibrinoid change occurs in minute spots scattered sparsely throughout the affected tissues; but on the elbows and elsewhere, sizeable aggregates may form which with their surrounding zones of fibrous and inflammatory tissue constitute the classical rheumatoid subcutaneous nodules.

Fibrinoid areas can often be seen with the naked eye as yellowish opaque spots in the semi-translucent connective tissue; but they can be recognized with certainty only by histological examination, when they are distinguished by the following characteristics.

Within a fibrinoid area connective tissue cells are either few or absent altogether, and the regular fibre pattern of normal connective tissue is replaced by a disorderly mesh of swollen, indistinct bundles or clumps of amorphous material. With eosin the fibrinoid area stains a more intense red than the surrounding connective tissue. Deposits of fibrin in the tissues may give rise to a somewhat similar appearance, hence the term 'fibrinoid'.

In frozen sections stained by Lillie's reticulin method and Van Gieson's stain, a fibrinoid area may show three different effects: fine silver-staining fibrils which histologists call reticulin; occasional clumps of material staining reddish-brown like normal collagen; and an indistinct refractile material which takes a yellow colour with the Van Gieson stain. In sections treated by the periodic acid – Schiff technique, the fibrinoid areas stain more strongly than normal connective tissue with the pink or magenta colour which is considered by many histologists to indicate the presence of polysaccharides. Histological evidence, therefore, suggests that a fibrinoid focus is not necessarily homogeneous but corresponds to alterations in both the collagen and polysaccharides of connective tissue.

It would be a substantial advance if these histological appearances could be correlated directly with observations at or near the molecular level, and the purpose of this communication is to present a preliminary account of such a comparison with the findings of X-ray diffraction and electron microscopy.

Methods

Owing to the random distribution and minute size of most fibrinoid lesions, the first requirement was an accurate sampling technique. To this end we obtained biopsy specimens of recently formed subcutaneous nodules from patients with active rheumatoid arthritis, and each specimen was fixed in 5 per cent formol saline and trimmed to a firm rectangular block which was then embedded in ice and cut in such a way that 10 μ–15 μ sections immediately preceded and followed a slice 1 mm. thick. The sections preceding and following the slice were stained in various ways and examined under the optical microscope, and, if they showed suitable areas of histologically well-defined fibrinoid, photomicrographs (× 8) were made. The corresponding thick slice was then washed in water and enclosed (wet) in a carrier specially adapted to the needs of a point-by-point

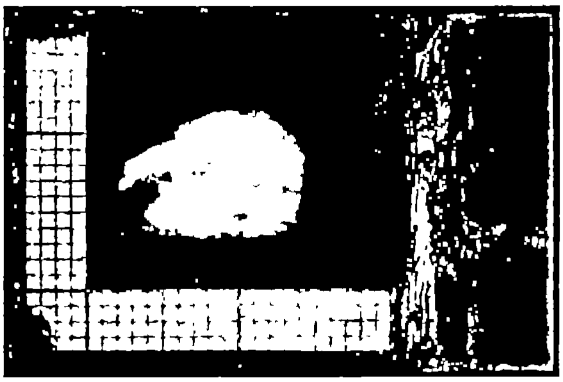


Fig. 1a. Slice of rheumatoid subcutaneous nodule mounted in carrier for exploration by X-ray diffraction

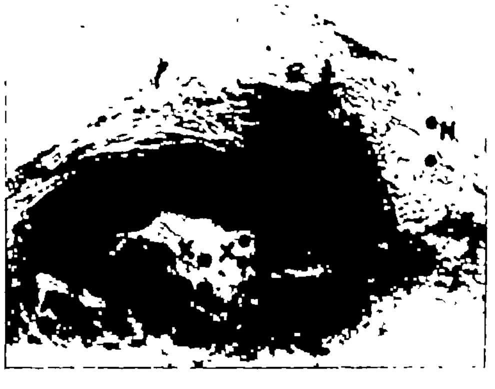


Fig. 1b. Photomicrograph of immediately adjacent section showing topographical relation between histological and X-ray examination. *N*, probably normal collagen; *I*, incipient abnormality; *X*, fibrinoid sites common to slice and adjacent sections. ●, sites of X-ray photographs

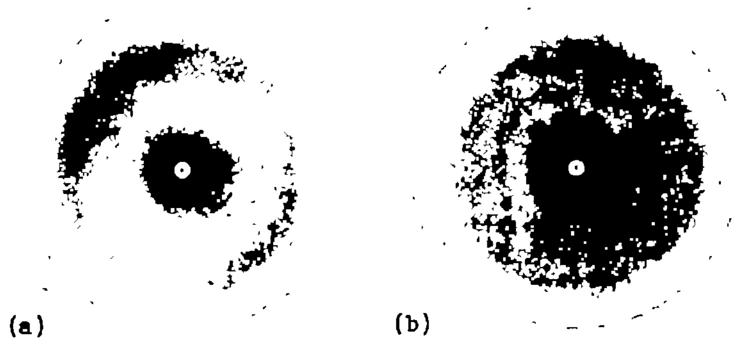


Fig. 2. X-ray diagrams of (*a*) a normal site, (*b*) a fibrinoid site in a rheumatoid subcutaneous nodule

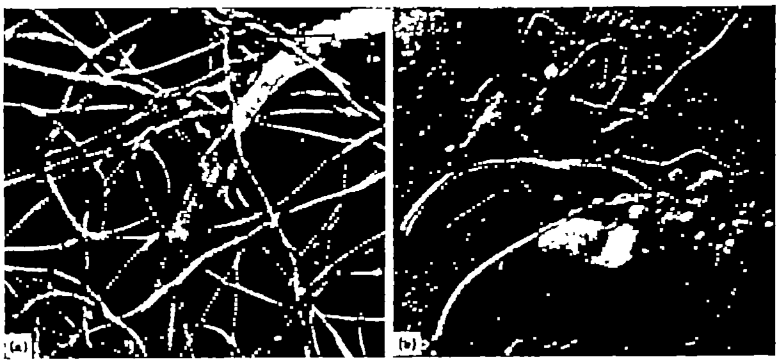


Fig. 3. Electron micrographs of (*a*) a normal site, (*b*) a fibrinoid site in a rheumatoid subcutaneous nodule. × 9,050

exploration by X-rays: it had collodion windows, and it was graduated vertically and horizontally in millimetres, so that when fitted into slides on the spectrometer the co-ordinates of the X-ray beam with respect to the slice could be read off directly for every photograph taken.

For the purpose of relating the X-ray co-ordinates to the topography of the adjacent fore-and-aft histological sections, a negative photographic plate was made of the slice in its carrier (Fig. 1*a*), and this was projected on to enlarged prints of the photomicrographs of the sections. When the best superposition of the two images had been obtained, the co-ordinates inscribed on the carrier were marked also on the prints (Fig. 1*b*).

The slice was explored with an X-ray beam ½ mm. in diameter, photographs being taken of up to as many as thirty different spots. After the X-ray study was complete, tiny fragments were dissected out from each of the same spots and examined in the electron microscope.

Results

Detailed findings will be published at a more advanced stage of the investigation, which is being planned to include an inquiry into whether there is any detectable change in the pathological collagenous tissues corresponding to the dramatic alleviation of symptoms brought about by treatments with adrenocorticotropic hormone (ACTH) and cortisone. It will suffice here to state that the sampling technique just described has proved very satisfactory indeed, and that we have found excellent correlation between the indications of histology, X-ray diffraction and electron microscopy. We have obtained two limiting X-ray diagrams: one (Fig. 2*a*) of normal collagen (often oriented and with, of course, the liquid halo in addition), corresponding to regions which histology also would specify as normal; and the other (Fig. 2*b*) consisting of little more than a diffuse ring of spacing about 4·8 A. This latter diagram we definitely associate with the histological fibrinoid regions—a poor name, by the way, since there is no recognizable X-ray evidence so far of the presence of true fibrin, for which we should expect either an α- or a β-diagram. For many of the spots examined the X-ray photographs showed both diagrams present at the same time, in general one or the other predominating in correspondence with the histological indications. In one region of a slice we found that it sufficed for the X-ray beam to be moved through only ½ mm. for the normal collagen diagram to disappear entirely and be replaced by the pure fibrinoid diagram.

The electron micrographs also revealed two limiting conditions: one of apparently normal collagen fibrils (Fig. 3*a*), and the other of amorphous material. Mostly, however, there was seen a mixture of the two, though again, in general, one or the other predominated in correspondence with the histological and X-ray indications. Fig. 3*b* is a typical picture of an intermediate state.

Concurrently with this special investigation on rheumatoid arthritis, we at Leeds have been collaborating with Prof. R. E. Tunbridge and other colleagues at the Medical School in a wider survey of pathological collagenous and related tissues. From this work it is clear that the real problem in the end is to characterize the degenerate fibrils and amorphous materials that are found so frequently in all sorts of clinically different conditions. Though they look so alike in the electron microscope, they can scarcely be the same every time, and the next step must obviously include comparative chemical analyses. We have already made a beginning along such lines in the rheumatoid arthritis problem, and we hope soon to be able to supplement our correlated histological, X-ray and electron microscope findings on slices of subcutaneous nodules with a corresponding set of micro-biochemical results.

We should like to thank Mr. G. Eaves for assistance in the electron microscopy and Mr. A. Millard for the photographic reproductions.

OBITUARIES

Prof. W. E. Agar, C.B.E., F.R.S.

Wilfred Eade Agar, emeritus professor of zoology in the University of Melbourne, died on August 14, aged sixty-nine. His health had been precarious through cardiac trouble since 1943, and he had to lead a more and more sedentary life; but he continued to work quietly in his little home laboratory up to the day before he died.

Born on April 27, 1882, at Wimbledon, Agar passed from his preparatory school to Sedbergh and then to King's College, Cambridge, where his tutor was S. F. Harmer. He went through the regular courses of instruction for the Natural Sciences Tripos, Parts I and II, in both of which he obtained a first class. Of all his teachers he looked back with special gratitude to Harmer, for his inculcation of precise and orderly method, and to Bateson, then in the flood tide of Mendelism, for turning his mind in the direction of his future research in genetics.

I had been impressed by Agar as the most outstanding member of the Tripos class in zoology during my last year as demonstrator; so when he had completed his Tripos, I invited him to join the staff of the Zoology Department in the University of Glasgow, on which he remained until 1920, holding latterly the position of senior lecturer.

During his Glasgow years, Agar showed himself to be an admirable teacher, and he also achieved a large proportion of his most valuable research work. During his first two years this was devoted to vertebrate morphology, and he produced valuable papers upon the skull and visceral arches, and upon the anterior mesoderm, of *Lepidosiren* and *Protopterus*. In 1907 he made an expedition to the Gran Chaco to supplement my work on *Lepidosiren*; but above all to obtain full material for investigating the gametogenesis of that fish—outstandingly suitable for such a research on account of the relatively enormous size of the chromosomes and their strongly marked individuality. Agar made a splendid success of his expedition and brought back a large amount of perfectly preserved material which he proceeded to investigate in detail. His skill and accuracy as an observer, in conjunction with his admirable technique, enabled him to achieve what is still probably the most reliable account of the gametogenesis of a male vertebrate. In his work he made full use of the Glasgow technique, which enjoined that all microscopic work under high-power oil-immersion objectives be done with stereoscopic eyepieces—the technique which enabled Ballantyne in 1925 to establish with certainty the passage of neurofibrils across the generally accepted discontinuity between the neurones of the vertebrate nervous system. Agar's Chaco expedition achieved other results than those of his main quest, the most important being the discovery of the 'neonychium'—the cushion-like structure which in the embryo of the Amniota fills up the concavity of the claw and safeguards the amniotic membranes against injury.

Agar's work on the chromosomes of *Lepidosiren* may be said to inaugurate the second phase of his research career, devoted to genetics. Next after it came the breeding through long series of generations of Daphnid crustaceans and having as their main object the testing of Lamarckian inheritance of environmental or 'acquired' characters. The Daphnids in question were chosen as specially advantageous for such investigations in view of their parthenogenetic reproduction, their short life-cycle, and the fact that all members of a clone are genetically identical so as to exclude the disturbing effects of Mendelian segregation. The results of Agar's work on the whole, including one particularly precise set of experiments extending over a hundred generations, was to show the complete absence of any evidence of such inheritance.

Both by his own original work and by his critical examination, and in some cases repetition, of the work of others, Agar played an important part in substantiating the view that environmental or 'acquired' characters are not inherited and are therefore not available for the process of racial evolution.

In its third phase, Agar's work diverged from the realm of pure science, in which things are observed, accurately recorded and when possible seriated into a general expression, into the realm of 'philosophy', which deals rather with ideas or opinions, and is free from the constraints to which purely scientific research is subject. In this phase Agar was, above all, influenced by the philosophy of A. N. Whitehead—primarily a mathematician, not a biologist—as expounded in his "Process and Reality". According to this philosophy, reality consists not in substance but in process, and the difference between living and non-living 'organisms' is merely one of degree—"Biology is the study of the larger organisms; whereas physics is the study of the smaller organisms." Whether or not Whitehead's philosophy is destined to have any influence upon the advancement of biological science, it is clearly of advantage to have an account of it and its implications from the pen of one who not only accepts the general principles of that philosophy but also holds a distinguished position in the realm of biological science. Such an account with further developments in detail is provided by Agar in his last book, "A Contribution to the Theory of the Living Organism" (Melbourne University Press, 1943), a revised edition of which he had just completed at the time of his death.

It would be wrong to conclude this notice without mention of Agar's activities outside laboratory and lecture-room. At Glasgow he held a commission in the Officers' Training Corps, and during the First World War he was captain in the 5th Highland Light Infantry, until invalided home from Gallipoli. Later he acted as adjutant to the 1st Volunteer Battalion of the same regiment. Then in 1920 came his appointment to the professorship of zoology at Melbourne. There he served as dean of the Faculty of Science (twice), president of the Professorial Board, in which he played an important part in the deliberations preceding the appointment of a full-time vice-chancellor, and as member of the University Council (twice).

As a Melbourne colleague writes, "Wilfred Eade Agar will be remembered by all as a thoughtful and kindly man, reserved, yet with a delightful sense of humour, slow to assert himself, yet vehement when the need arose. With his death the University of Melbourne has lost one of its great men."

JOHN GRAHAM KERR

Brigadier E. M. Jack, C.B., C.M.G.

BRIGADIER EVAN MACLEAN JACK, who died on August 10, was born in Edinburgh in 1873. Commissioned in the Royal Engineers in 1893, he served first at Gibraltar and St. Helena; and in 1903 joined the Ordnance Survey, on the staff of which he served for four years.

In 1907 he was selected for duty with the Uganda-Congo Boundary Commission under Major Bright and four years later became chief commissioner of another Central African Boundary Commission, which, in the course of its work, measured a section of the arc of the 30th meridian. In 1913, Jack, now promoted major, was posted to the Geographical Section of the General Staff at the War Office; and on the outbreak of war, in 1914, went to France with the B.E.F. as officer in charge of maps at G.H.Q. In this post, which he held throughout the War, he was responsible for directing and controlling a great variety of survey developments, including the mapping of the trench lines, German as well as British; sound-ranging and flash-spotting (for the location of enemy batteries); and, last but far from least, the 'Artillery survey' procedure, which made possible the sudden accurate bombardments of 1918 by massed artillery—a development which, from the battle of Cambrai onwards, contributed so much to the Allied victory.

For his services in the First World War Jack was awarded the C.M.G. and the D.S.O. and was several times mentioned in dispatches. The Royal Geographical Society, which in 1916 had given him its Gill Memorial Award for his work in Africa, awarded him its Founder's Medal for his geographical work on the Western Front. In 1920 he became head of the Geographical Section, and two years later succeeded Sir Charles Close as director-general of the Ordnance Survey. In 1924 he was promoted to the rank of brigadier, and in 1928 was made a C.B.

Jack retired from the Service in 1930, but this 'official' retirement was only the beginning of another career of unpaid service to many charitable and other causes, scarcely less distinguished than the one he had just completed, and which lasted for twenty years more. The kindliest and most modest of men, Brigadier Jack has left a record which any man might envy; and a memory which all his many friends will cherish.

M. N. MacLeod

Prof. E. Baldi

Prof. Edgardo Baldi died on August 10 at the age of fifty-two very much regretted by all his friends and colleagues. He was director of the Istituto Italiano di Idrobiologia at Pallanza on the Lago Maggiore, a research institute founded in 1939 which has become one of the world's leading limnological laboratories.

Baldi's research career began with work on insect neurophysiology which has left important traces in the literature. He soon turned, however, to hydrobiology, beginning with systematic work, especially on diaptomid copepods. He made a study of the distribution of the various races of *Eudiaptomus vulgaris* in Italian lakes. One of his favourite fields of research was the biology of alpine lakes, the chief object of which was to define the communities and discover their degree of temporal constancy. Rivers were also studied, the main thread of the research being the seasonal variation and survival in rivers of plankton derived from lakes.

In the last period of his life, Baldi's particular interest was in the biometrical study of form differences between planktonic Crustacea of certain species belonging to populations of varying density living in different parts of a lake. General accounts of this important part of his work are to be found in *Experientia*, 2, 476 (1946) and *Vierteljahrschrift Naturf. Ges. Zürich*, 95, 89 (1950), while details are in the *Memorie Ist. Ital. Idrobiol.* His was always the spirit of pure scientific research for its own sake. To British and other foreign biologists who had the pleasure of visiting or working in his Institute, Baldi always extended a most generous welcome.

H. Munro Fox

Dr. G. A. Shakespear

Dr. Gilbert Arden Shakespear, who died as a result of a road accident within a few days of his seventy-eighth birthday, was a prominent member of the University of Birmingham for more than half a century. Educated at Wyggeston School, Leicester, and Mason College, Birmingham, he was one of J. J. Thomson's research students at Cambridge before returning to Birmingham as lecturer under Poynting. He was acting professor during 1914–19 and, though he retired in 1938, he continued active research work in the Department of Physics.

Dr. Shakespear was distinguished for his ingenuity and skill in making precise measurements by simple methods. Much of his early work was inspired by Poynting, whom he greatly admired, and was concerned with thermal radiation. His most important contribution to science, however, arose from a practical need and was made with characteristic speed and perfection. During the First World War his attention was directed to the need for measuring the purity of hydrogen in connexion with airships and observation balloons; he quickly produced his 'katharometer', a sensitive and robust apparatus for gas analysis by thermal conductivity, and then applied it in many different directions, the principal one at that time being the permeability of rubberized fabrics.

Although the instrument has now been extensively used in measuring mixtures of many gases and in all kinds of applications, it still remains in the essentially simple form which Shakespear originally devised. The katharometer, in the hands of many workers, has been the means of making substantial contributions to many branches of science—physics, biology, physiology, medicine and chemical engineering. It is ideally suitable for measuring diffusion and thermal diffusion: it is used for measuring the respiration of plants and animals, for the control of anaesthetic gas mixtures, for the analysis of flue gases and the exhaust gases from internal combustion engines, and in ammonia plants. An indication of Shakespear's ingenuity and breadth of interest is given by the fact that with only a slight modification he was able to convert the katharometer into a very sensitive extensometer.

Shakespear was always most generous in freely giving his ideas to others. He delighted in having problems brought to him and in assisting in their solution. For this he wanted no recognition or reward; his pleasure lay in sharing in the enthusiasm for any subject and in sowing the seed of progress. His influence has thus been much greater than can be measured by the volume of his published work.

In his teaching, Shakespear was remarkable for his originality and freshness of approach on the experimental side of his subject. A student's measurement of the acceleration due to gravity in the elementary laboratory was to him a matter of importance and excitement, in which the result really mattered.

Shakespear was a man of extraordinary activity, both mental and physical, and an uncommonly keen observer of everything that lives and moves, as well as of the inanimate things. His wife, the late Dame Ethel Shakespear, was a geologist and a notable figure in the public life of the Midlands. Their farm, garden and laboratory at Caldwell Hall, near Bromsgrove, formed an ideal centre for a rare breadth of interests.

NEWS and VIEWS

Botany at Birmingham: Prof. W. Stiles, F.R.S.

Prof. W. Stiles has retired from the Mason professorship of botany in the University of Birmingham, which he has held since 1929. He moved to Birmingham after occupying the chair of botany at Reading for ten years. He has brought renown to his Department, both by his own published papers, reviews and books, and by the direction or stimulation given to the physiological researches of his colleagues and students, especially in the fields of permeability, the salt relations of plant tissues, and respiration. The way was prepared in the first field by early work done in the University of Leeds, where he collaborated, first with Mr. I. Jørgensen and, later, with Dr. Franklin Kidd. They developed the method of placing representative samples of disks of storage tissue under selected and controlled conditions. This technique for obtaining reproducible results is now widely used in many types of investigation.

Throughout his career, Prof. Stiles has favoured the use of physical instruments for measuring plant performance. In more recent times, skilled work has been performed in his research school with the katharometer in studies on respiration, and with the spectrograph, polarograph and absorptiometer in measuring small amounts of ionic absorption. Exact quantitative data have been obtained for physiological performances, controlled in the light of existing knowledge. Certain passages in his presidential address delivered in 1938 to Section K (Botany) of the British Association make it clear that no one knows better than Prof. Stiles that this knowledge is incomplete. However, he has helped to make it more ample than it was forty years ago. Moreover, no one in Great Britain has ever done more in bringing together scattered literature and making widely known major advances in knowledge of plant physiology as these occurred. We may note his review articles which have appeared regularly in *Science Progress* since 1927, and his books on "Carbon Assimilation" (1917, with I. Jørgensen), "Permeability" (1924), "Photosynthesis" (1925), "Respiration" (1932, with W. Leach), "An Introduction to the Principles of Plant Physiology" (1936, second edition 1950), and "Trace Elements in Plants and Animals" (1946, second edition 1951).

Prof. E. J. Maskell, F.R.S.

Dr. E. J. Maskell, reader in plant physiology in the University of Cambridge and Fellow of Emmanuel College, has been appointed to succeed Prof. W. Stiles in the Mason chair of botany from October 1. After a distinguished academic career at Cambridge, interrupted by service in the Friends' Ambulance Unit, 1915–19, Dr. Maskell, as Frank Smart student, carried out researches under the late Dr. F. F. Blackman on carbon assimilation with particular reference to stomatal control. In 1922, Dr. Maskell was appointed plant physiologist at the Cambridge Horticultural Station. Two years later he moved to Rothamsted Experimental Station in the same capacity, where he worked on problems of crop growth and methods of field experimentation. In 1926 he went to Trinidad as plant physiologist at the Cotton Research Station, where, in association with Dr. T. G. Mason and Dr. E. Phillis, he carried out notable investigations on the transport of carbohydrates and other solutes in the cotton plant. In 1930 he was recalled to Cambridge as lecturer in plant physiology, afterwards becoming reader and head of the sub-department in this subject in the Botany School. Since his return he has taken a prominent part in teaching and research, chiefly on the metabolic aspects of plant physiology, and many students have carried out investigations under his direction. He was elected a Fellow of the Royal Society in 1939. He returned to Trinidad for the summer of 1950 and assisted in the researches proceeding at the Imperial College of Tropical Agriculture on the mineral nutrition of the cocoa plant. Dr. Maskell has had much experience of university and college administration, and served for a considerable period on the General Board of the Faculties. Birmingham is fortunate in securing the services of Dr. Maskell, and he will be greatly missed by his colleagues in the Cambridge Botany School.

Scientific Civil Service: Promotion of Individual Research Workers

It is announced that further special posts are being created for individual research workers of exceptional merit. The promotions will be effective from January 1, 1952.

Deputy Chief Scientific Officers:

Dr. E. Glueckauf

Dr. E. Glueckauf, an outstanding physical chemist who during the pre-war period made notable contributions in surface phenomena, radiochemistry and in the measurement of the constituents of the atmosphere. Since joining the Atomic Energy Research Establishment his researches have included solution chemistry and the study of chromatography and ion exchange.

Mr. N. W. Pirie, F.R.S.

Mr. N. W. Pirie, of Rothamsted Experimental Station, is well known for his work on the separation and biochemical properties of substances of diverse biological origin and high molecular weight. The group includes antigens from *Brucella melitensis* and *B. abortus*, agar, several plant viruses, hyaluronic acid and proteins from the normal leaf. The last has been studied both on the laboratory and on the industrial scale. Most of these substances have been shown to be heterogeneous, and he has emphasized the importance of looking on macromolecules, even when they have a defined biological activity, as categories rather than as chemical individuals.

Dr. H. G. Thornton, F.R.S.

Dr. H. G. Thornton, of Rothamsted Experimental Station, has investigated many aspects of the life of the nodule bacteria and their symbiosis with their host legume, including their behaviour in soil, the process of the root infection, the growth and decay of the nodule and the structure of nodules ineffective in fixing nitrogen. With P. S. Nutman and J. H. Quastel he took part in the early experiments on the selective toxicity to plants of 2,4-dichlorophenoxyacetic acid. He has made quantitative studies of the soil microflora, and in this field he has devised improved counting methods.

Senior Principal Scientific Officers:

Mr. J. E. Gordon

Mr. J. E. Gordon, a research engineer at the Royal Aircraft Establishment, whose work has been directed towards the use of plastic structural materials for aircraft. This has involved fundamental work on structural plastics and the development of suitable plastic materials and manufacturing techniques. As a result of this work it has been demonstrated that large aircraft structures can be made cheaply and easily from reinforced plastics, and that such structures will compete successfully with the more conventional metal structures.

Dr. C. C. Hall

Dr. C. C. Hall, of the Department of Scientific and Industrial Research (Fuel Research Station), a chemist who has specialized on problems concerned with the production of oils and chemicals from coal, and is a recognized authority on the subject. He has made notable contributions to knowledge of the mechanism of the reactions in the hydrogenation of coals and tars and in the synthesis of hydrocarbon oils and waxes from carbon monoxide and hydrogen. He has played a leading part in the C.I.O.S. investigations of German researches in this field, and of the commercial plants in Germany for the production of oils and chemicals from coal; and he has been in close touch with the work of the U.S. Bureau of Mines on synthetic liquid fuels.

Dr. L. Pincherle

Dr. L. Pincherle, who joined the Telecommunications Research Establishment, Malvern, in 1948, after a distinguished academic career. Since this date he has been engaged in a study of the electronic properties of semiconductors using the methods of quantum mechanics. He has been largely responsible for initiating an extensive calculation of the electronic wave functions in ionic crystals having cubic symmetry, and has been responsible for the development of powerful mathematical methods to enable this to be achieved.

Dr. D. G. Tucker

Dr. D. G. Tucker, of the Royal Naval Scientific Service, who has had wide experience in telecommunications. For many years he was at the Post Office Research Station, Dollis Hill, before joining the Admiralty. His many valuable publications on important electronic problems give some indication of his ability as a research engineer, and the theoretical and practical work he is now doing on underwater problems is of particular concern to the Royal Navy.

Royal Aeronautical Society: Awards

The following medals and prizes have been awarded by the Council of the Royal Aeronautical Society: *Society's Gold Medal:* W. G. A. Perring (posthumously), in recognition of his distinguished service to aeronautical science; *Society's Silver Medal:* S. B. Gates, for outstanding work on the stability and control of aircraft; *Society's Bronze Medal:* H. J. Pollard, for his many contributions to the development of aircraft construction; *British Gold Medal:* A. E. Russell, for practical achievement in aircraft design; *British Silver Medal:* Group Capt. J. Cunningham, for his outstanding achievements as a test pilot; *R. P. Alston Memorial Prize:* R. J. Falk, for his outstanding work in the testing of British delta-wing aircraft; *George Taylor (of Australia) Gold Medal:* R. E. Bishop, for his paper on "Design for Maintenance"; *Simms Gold Medal:* Dr. G. S. Hislop, for his paper on "Investigation of Gusts"; *Herbert Ackroyd Stuart Memorial Prize:* A. V. Cleaver, for his paper on "Rockets and Assisted Take-off"; *Eduard Busk Memorial Prize:* R. Hills, for his paper on "The Use of Wind Tunnel Model Data in Aerodynamic Design"; *Orville Wright Prize:* Dr. Neumark, for his paper on swept-back wings, published in the *Aeronautical Quarterly*, August 1950.

National Institute of Sciences of India: Research Fellowships

The National Institute of Sciences of India has recently awarded the following research fellowships (normally tenable for two years) for work in particular fields at the places shown. *National Institute of Sciences Senior Research Fellowships:* Dr. A. M. Naqvi (solar problems), University of Delhi; Dr. S. C. Shome (corrosion of metals), National Metallurgical Laboratory, Jamshedpur; Dr. B. G. L. Swamy (comparative plant morphology), University of Madras. *National Institute of Sciences Junior Research Fellowships:* D. Basu (statistics), Indian Statistical Institute, Calcutta; Dr. M. Datta (statistical physics), University of Calcutta; Dr. A. M. Mehta (biochemistry), Haffkine Institute, Bombay; Dr. A. K. Mukherjee (bacteriology), Indian Institute for Medical Research, Calcutta; Dr. (Mrs.) T. S. Sarojini (mycology), University of Madras; E. G. Silas (zoogeography), University of Madras; T. B. Sinha (entomology), University of Allahabad. *Imperial Chemical Industries (India) Research Fellowships:* Dr. B. K. Banerjee (physical chemistry), Indian Association for the Cultivation of Science, Calcutta; Dr. A. Ganguli (plant pathology), Bose Research Institute, Calcutta; Dr. P. T. Rao (spectroscopy), Andhra University.

Graduateship of the Institute of Physics: A New Grade

A booklet recently issued by the Institute of Physics, and which may be obtained free, on request, sets out the regulations and syllabuses for the examination for the graduateship grade of membership of the Institute. This new grade was formed in September 1949 and is for those who hold a recognized degree or other qualification in physics but who do not possess the necessary period of professional experience required for the associateship of the Institute. By July of this year more than four hundred applicants had been elected to graduateship. At the moment, such applicants are only admitted if they possess an honours degree of a British university; but for those who are without this qualification an examination, starting in 1952, is being arranged. Candidates for this examination will normally be required to have followed a suitable course of study at a college or other place of learning recognized for this purpose by the Institute, those already approved including all the universities and university colleges in Great Britain, a number of Commonwealth and foreign universities, and thirty-six technical colleges in Great Britain. The subjects of the examination are physics (three papers and a practical examination), mathematics (two papers), and a third subject (one paper) chosen from applied physics, more advanced physics, mathematical physics and statistics; those choosing applied physics will be required to offer only one of the sections, electronics, high-vacuum technology, acoustics, spectroscopy, X-rays or temperature measurement. Those who already have certain qualifications may be exempted from various parts of the examination. Graduates of the Institute, who must have reached the age of twenty-one, are entitled to use the abbreviation Grad.Inst.P. The grade is non-corporate and is intended to be the normal step to associateship of the Institute.

Soil and Climatic Factors in Plant and Animal Nutrition

THE first of the specialist conferences, recommended by the British Commonwealth Scientific Official Conference of 1946, was held in Australia in 1949 to consider "Plant and Animal Nutrition in Relation to Soil and Climatic Factors". A general report of the proceedings appeared in 1950; but the papers presented, together with the recommendations and resolutions passed, have now been published in full (pp. 490. London: H.M. Stationery Office, 1951; 20*s*. net). The various aspects considered cover a wide field, and some idea of their scope may be obtained from the titles of the five sessions held: review of present knowledge of the climatic and soil factors affecting nutrition of plants and animals; effects of specific soil and climatic factors on the nutrition of plants; nutritional problems of the animal as determined by plant and soil; pasture management; and influence of plant and animal on soil fertility. From the papers presented, it is evident that a wealth of information has already been obtained in each field; but in its recommendations the conference stresses the necessity for closer co-ordination of research if full use is to be made of the knowledge acquired and the gaps in that knowledge filled. In particular, the need for co-operation is urged between, on one hand, specialists in soil science, agronomy, plant physiology and biochemistry and, on the other, animal research workers. As a practical outcome of the deliberations, a number of specific lines of work which call for immediate investigation are suggested, together with outlines of the type of experiment which could be usefully conducted on a long-term basis.

Fall in World Malaria

WHEN the effectiveness of DDT against mosquitoes was realized, and particularly when the value of residual films of this insecticide was discovered, hopes were raised that at last a method had been found which would make possible the control of rural malaria at a practicable cost. A recent article by E. J. Pampana (*Bull. Org. Mondiale de la Santé*, 3, 557; 1951), written at the suggestion of the Executive Board of the World Health Organization, summarizes the results of a number of large-scale campaigns in Africa, America, Asia and Europe in which the use of residual insecticides figured prominently. It makes encouraging reading. In treated regions of Brazil, notified cases of malaria fell from 18,297 in 1945 to 976 in 1949; in one typical village in British Guiana, the spleen index fell from 71·6 per cent in 1945 to 4 per cent in 1948; in Ceylon, infant mortality in 1949 was only 62 per cent of what it was in 1946; in Greece, the most malarious country in Europe, where morbidity varied from 1 to 2 millions a year between 1930 and 1940, malaria has now "ceased to constitute a serious public health problem". A conspicuous gap in the reports is left by tropical Africa where, as yet, very little seems to have been done. Two problems loom ahead: a possible breakdown in the method if the mosquito becomes tolerant to the insecticide, and a great upswing in human populations if these measures continue to prosper.

Antihistaminic Agents in Allergy

A VALUABLE publication, "Antihistaminic Agents in Allergy" (*Ann. New York Acad. Sci.*, 50, Art. 9, 1013; 1950; 3 dollars) records the papers given at a conference on this subject held in October 1947. Although about half the papers deal with antihistaminic agents, the remainder deal with histamine itself; and among these a paper by Sir Henry Dale, entitled "The Pharmacology of Histamine", includes a brief survey of evidence for the occurrence of histamine and its liberation and participation in natural reactions. The volume as a whole records the results of a great deal of research, and the bibliographies appended to each paper indicate how extensive the study of histamine and antihistaminic agents has been.

A Royal Head from Ancient Egypt

THE Freer Gallery of Art, which forms part of the Smithsonian Institution, Washington, D.C., possesses an interesting royal Egyptian head, and the late Dr. George Steindorff was asked to describe it. His findings have been published by the Gallery in a little booklet, under the title of "A Royal Head from Ancient Egypt", which runs to thirty pages of text and twenty-nine full-page illustrations and is a commendable little study (Occasional Papers, 1, No. 5; Pub. 4022; 1951). Dr. Steindorff has taken the opportunity not only to make a study of the particular sculpture in question, but also to illustrate for purposes of comparison the various styles in sculpture that appear at different times in Egyptian history. The result is a very useful little brochure for those interested in portrait sculpture who do not happen to be specialists in Egyptian archæology.

Ancient Polynesians as Navigators

AN article by T. G. F. Mann (*Irish Astro. J.*, 1, No. 4; 1950), with the title "The Polynesian, Master Mariner and Astronomer", outlines the extraordinary navigational ability of the early Polynesians in their voyages through the central and eastern Pacific, the islands of which are peopled by a race which displays very remarkable similarities in appearance, character, language and traditions. It appears that they used the stars as compass, chart and chronometer, and the Pleiades and Antares were especially utilized. It is remarkable that they fixed the northern solstice about June 25, and this was determined by the appearance of the Pleiades at about 5 a.m. 22° above the horizon. A description of their method for determining degrees is given and, crude as it may seem, it was sufficiently accurate to enable the navigators to find their directions for thousands of miles across unknown seas. It is believed that the people in the Hawaiian group were able to measure the altitude of Polaris by means of a gourd filled with water. It is very remarkable, as the author points out, that when the Western mariner was largely confined to the Mediterranean, creeping cautiously along its seaboard, the Polynesians regularly covered thousands of miles of open sea.

Properties and Uses of Photoelectric Cells

AN illustrated booklet, "Electric Eyes", by A. J. Fawcett and published by the Tintometer, Ltd., Salisbury, contains an elementary and somewhat entertaining account, suitable for the non-technical reader, of the properties, use, advantages and disadvantages of the photoelectric cell. Part 1 deals with the use of the photoelectric cell on the underground railways where the interruption of a beam of light by the train sets the signals; as a burglar alarm, a counting or safety device; to grade manufactured articles according as they are light or dark; for smoke detection and to measure the turbidity or pollution in canals and rivers. Part 2 is concerned with colorimetry. It is emphasized that the photoelectric cell is colour-blind and that it is a robot device. "Its failures in the field of colorimetry are not the shortcomings of the photoelectric cell, but of the operator who is making unreasonable demands upon it." The constructions of the photoemissive and the barrier-layer or photovoltaic cells are described in an appendix, the way in which the latter type of cell works being illustrated pictorially by rabbits in a field near their burrows. For the benefit of those on unfamiliar ground, the booklet is completed by a glossary of terms used.

Municipal Library System of London and the Home Counties

The sixth report of a quinquennial series issued by the Library Association (London and Home Counties Branch) summarizes information regarding the rate-supported municipal library system of London and the Home Counties as existing on March 31, 1949 (pp. 32; general editor, James D. Stewart; London: Central Public Library of Hampstead, 1951). The report covers 119 separate library authorities in the counties of London, Bedford, Berkshire, Buckinghamshire, Essex, Hertford, Kent, Middlesex, Surrey and Sussex, and the information analysed includes all grades of the public library service. The development of the library service in the area over a quarter of a century is traced, and the report is essentially factual: conclusions as to the value and tendencies of details of policy are sparingly drawn. Generally, the service of the area reaches twice as many people as in 1924; issues of books are more than four and a quarter times more numerous; its stock of books has increased more than fourfold; and there are nearly five times as many registered readers as in 1924.

Certificates and Diplomas in Management Studies

The British Institute of Management was established in September 1947 and, early in 1949, undertook to administer jointly with the Ministry of Education a national scheme of management studies, the Institute acting as the co-ordinating authority for the various professional bodies concerned. Regulations covering the national scheme agreed to jointly by the Ministry and the British Institute of Management, and the Scottish Education Department and the British Institute of Management, were published in 1949 and 1950 and, since that time, technical colleges have been changing over to the new scheme. The majority of professional management bodies agreed to accept a common intermediate certificate in place of their own examinations, while the professional technical institutions which include management studies in their requirements are prepared to grant certain exemptions. Now it may be said that the intermediate certificate stage has been successfully launched, and the second stage, the preparation of suitable diplomas for various specialized management organizations, is under consideration. To clarify the present position and to collate existing information, the British Institute of Management has prepared a handbook giving full details of the examinations, a list of institutions accepting the common intermediate examination, and the proposals for the development of diplomas in management studies. The handbook may be obtained from the British Institute of Management, Management House, 8 Hill Street, London, W.1, price 6*s*. 3*d*.

Announcements

Dr. C. W. Allen, of the Commonwealth Observatory, Mount Stromlo, Canberra, has been appointed to the Perren chair of astronomy tenable at University College, London, from October 1, or as soon thereafter as possible.

Prof. J. Brontë Gatenby, professor of zoology and comparative anatomy in Trinity College, Dublin, has been appointed visiting professor of zoology in the Faculty of Science, King Farouk University, Alexandria, from October 1.

The Exhibition on the "Human Factor in Industry", at the Safety, Health and Welfare Museum, Horseferry Road, Westminster, London, S.W.1 (admission free; 10 a.m.–6 p.m.), which was to have closed on September 29, will remain open until October 19.

Sir George Beilby Memorial Fund awards, which are considered by administrators representing the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals, are made at intervals to British scientific research workers, preference being given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy. In general, the awards are granted to younger men and women for original work done over a period of years. Awards may be made early next year, and the administrators request that their attention be directed to outstanding work of the nature indicated, not later than December 31. All communications should be addressed to the Convener of the Administrators, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

The eighteenth Christmas Chemical Engineering Symposium, arranged by the Division of Industrial and Engineering Chemistry of the American Chemical Society, will be on the subject of "Nucleation" and will be held at Northwestern University, Chicago, during December 27–28. The programme will be divided into the following four sections: theoretical aspects, and nucleation from the gas, liquid and solid phase respectively. Attendance is open to all; but papers must be sponsored by a member of the American Chemical Society. Communications should be addressed to the chairman of the Papers Committee, C. M. Cooper, Engineering Research Laboratory, Du Pont Experimental Station, Wilmington, Del. Local arrangements are in the hands of Dr. L. F. Stutzman, of Northwestern University, Evanston, Chicago, Ill.

Erratum. In the article entitled "The Development of Taxonomic Theory since 1851" by J. S. L. Gilmour in *Nature* of September 8, on p. 402, column 1, a line of type following line 16 has been omitted. The sentence should read: "It can be called phylogenetic only in a secondary sense, namely, that the reason why a particularly natural biological classification can be made at all is the paramount influence of heredity on the characters of living things. . . ."

INTERNATIONAL UNION OF CRYSTALLOGRAPHY

CONGRESS AT STOCKHOLM

THE Second Congress of the International Union of Crystallography, which was held at the University of Stockholm during June 27–July 5, was attended by more than three hundred members from different parts of the world. Although Britain and the United States provided the largest foreign contingents, the diversity of other nationalities was such that the English-speaking people were in the minority; nevertheless, English was used as the main medium of communication, although some papers were given in French and German. Tribute must be paid to those who forsook their native language to speak English, and to others who, having no English, took particular pains to make themselves clear; unfortunately, the speed of delivery of some of the English papers must have made it difficult for them to receive much in return.

As in the first Congress (see *Nature*, 162, 838; 1948) so many papers were presented that it was found necessary to hold simultaneous sessions, this time in triplicate. Thus it was impossible for a single observer to hear all the papers, and the present account must be regarded as representing mainly the particular interests of the writer; it is mainly concerned with X-ray diffraction, and for the section on electron diffraction he is largely indebted to Dr. L. E. Sutton, of Oxford, who kindly allowed access to some of his notes.

Instruments for X-ray diffraction. It is interesting to compare the state of the subject of X-ray diffraction with that existing at the time of the first conference, in 1948. There would seem to have been a period of stabilization, as no discoveries of major importance have arisen; but we can now see much more clearly how some of those made just after the War fit into the general scheme.

For example, consider instruments. In 1948, we were only beginning to see the application of Geiger–Müller counters to single-crystal work, although their use for powder work had been fairly thorough. We can now see extremely important developments. The results are more accurate than those obtained photographically, but only if a great deal of trouble is taken in obtaining them. Consequently, at present, the method would be employed only if extreme accuracy is required, and it is likely that, for most structure investigations, photographic equipment will continue to be used. There is, however, no reason why improvements in instrumentation should not change this state of affairs, and we may find that ultimately photographic methods will be relegated to quite a minor part in structure determination.

Neutron diffraction is also developing rapidly; with the introduction of the neutron spectrometer at Harwell, practical work is no longer confined to America. For obvious reasons, it is unlikely that neutron spectrometers will ever become very numerous, and hence it is important to see that they are used for those problems for which they are particularly suitable. We cannot, therefore, expect that they will make great contributions to orthodox crystal-structure studies, but nevertheless they are opening up a new field of their own. A particularly fascinating subject is that of the antiferromagnetics, in which neutrons are able to differentiate between isotopes of which the magnetic moments are opposed; superlattice effects are found which are quite undetectable by X-rays.

Crystal-structure determination. Methods of crystal-structure determination figured largely in the Congress, and were the subject of a detailed symposium held after the Congress had ended. Many interesting new ideas were described; but none could be considered as likely to revolutionize the subject. They are more likely to simplify the determination of structures of which the unit cells contain relatively few atoms, but of which the chemistry is uncertain; for structures with large numbers of parameters, the well-established methods which make use of isomorphous replacement and heavy atoms still stand supreme.

The new methods attempt to make use of certain general properties that crystals must possess—that is, that they are composed of atoms of known electron densities. The Harker–Kasper inequalities, for example, make use of the fact that electron densities are always positive. Attempts are now being made to make use of the known interatomic distances, and some success has been obtained with the resulting methods on crystals that have one small cell dimension. Attempts to make use of other facts—for example, that the electron density must be zero at a centre of symmetry if all the atoms are in general positions—do not seem to be fruitful.

Considerable help to the application of these methods has been given by the Fourier machine at Pennsylvania State College. This machine, which produces two-dimensional electron-density maps almost instantaneously, was not yet finished in 1948; but reports now show that it fully justifies the claims made for it. Not only is it helpful in greatly speeding up routine work, but it also seems to be inspiring the application of some of the theoretical methods mentioned in the previous paragraph.

The 'steepest descents' method has not proved to be capable of deriving structures *ab initio*, as was hoped on its first introduction, and it now appears to be settling down as a method for the refinement of approximate structures. Other methods, such as 'least squares' and the 'difference synthesis', also exist for this process, and there would seem to have been distinct advances both in the accuracy and the assessment of accuracy of structure determination in the past three years.

Perhaps the greatest advances in crystal-structure determination, however, are taking place in the application of the Patterson synthesis; this method, which is now fifteen years old, still seems to be capable of providing fresh approaches, and closely similar lines are being followed in France, Spain, the United States and Great Britain. It will be interesting to see, at the next Congress, whether these approaches will prove to be as fruitful as their supporters claim.

Electron diffraction. Considerable technical progress was described in dealing with the diffraction of electrons by gases. The main difficulty in this subject is the extreme variation of the intensity of scattering with angle; if the lower part of the pattern is adequately exposed, the higher parts, which govern the accuracy of the conclusions, cannot be observed.

The main method of overcoming this difficulty is to place a rotating sector over the film during the exposure, so that the observed intensity is reduced according to a known function of scattering angle. With such methods it is possible to observe diffraction patterns down to spacings of about 1·5 A., and thence to derive interatomic distances to an accuracy of about 0·01 A. Many examples of the application of this method were described by workers from Norway, Japan, the United States and Great Britain.

Some extremely interesting photographs of diffraction effects from single crystals were also shown. The possibilities of using electron-diffraction photographs in crystal-structure determination had been pointed out in 1939; but no great progress seems to have been made in this subject. Possibly, considerable difficulties are involved in eliminating the secondary diffraction effects, such as Kikuchi lines, which are given by perfect crystals; but if these could be eliminated or allowed for, the electron-diffraction method might prove to be an extremely useful tool.

To summarize, it may be said that the field covered by the diffraction of X-rays and electrons continues both to expand and to knit itself more closely together. An increasing range of materials has come within the scope of the methods, and connexions are being found between the different methods and techniques that are used. Relationships have been discovered between what were thought to be isolated subjects, and the degree of strength given to these methods of studying matter augurs well for future advances.

H. Lipson

CHEMICAL INDUSTRY IN GREAT BRITAIN

The discussion on August 10 on "The Changing Face of Chemical Industry" before Section B (Chemistry) at the British Association meeting at Edinburgh was opened by Mr. J. Davidson Pratt. As general manager of the Association of British Chemical Manufacturers, it was natural that Mr. Pratt should make some reference to the report on the British chemical industry which the Association prepared two years ago. That report fully displayed not only the scientific character of chemical industry but also its essentially dynamic nature; and beyond quoting the figures given in that report for the industry's estimated expenditure on research to illustrate his point that for chemical industry research is a necessity—and a costly one—Mr. Pratt did not attempt to recapitulate. He made a second point regarding the number of small units still operating, and that success here demands the same qualities of individuality and initiative which have in the past century been responsible for so many remarkable developments and the rise of many of the best-known firms in the industry.

The complexities of both the scientific and technical sides of the industry were indicated in the paper by Dr. F. Roffey on petroleum chemicals, and in that by Dr. J. C. Swallow on synthetic polymers. Dr. Roffey pointed out that, in very general terms, the petroleum chemical industry, which derives its raw material from petroleum or natural gas, has its main influence on the large-scale production of aliphatic rather than aromatic products. In this it is complementary to the older coal-tar industry, although highly important developments have been based on the use of intermediates derived from both. Since the middle 'twenties, the growth of the industry has been remarkable. Dr. Roffey indicated some of the developments and inter-relations on the chemical side, which, as distinct from the breakdown of any given feed-stock into its component hydrocarbons or closely related groups of hydrocarbons—essentially the responsibility of the oil industry—is the task of the petroleum chemical industry.

Dr. Roffey's review of some of these products which are provided for the field of synthetic plastics, fibres and rubbers linked naturally with Dr. Swallow's review, which aimed at giving a picture both of the overlapping relations of these three types of synthetic polymer and of the possibilities of synthesizing a polymer with the properties required for a specific application. There are, however, limiting factors which prevent the production of these new materials in sufficient quantity for all our needs. The lag of seven to ten years between discovery in the laboratory and successful industrial production has still to be faced, and there have been further economic difficulties since the War. Some of these were indicated in the report on chemical industry, and the orderly introduction of new materials into modern economy represents one of the more difficult tasks facing chemical industry, and the industries which use these products for obtaining new technical effects.

In general, the symposium had an economic or even sociological trend that would have made it almost equally appropriate to Section F. What Mr. Davidson Pratt had observed about concentration on quality and efficiency rather than on quantity and output, as in the earlier chemical industry, appeared to be supported by both the following papers. The economic and social background of the industry was even more prominent in a most interesting paper contributed to the symposium, namely, that in which Mr. H. W. Cremer, following the chairman's opening remarks, dealt with some general considerations, mainly from the point of view of the chemical engineer; but he also directed attention to the need for an informed and alert public opinion to prevent some of the undesirable features of the early development of chemical industry, such as atmospheric and water pollution. He insisted frankly that failure of the general public to make active protest was at least partly responsible for such defects.

Mr. Cremer pointed to a number of factors which are giving rise to a different outlook and to better conditions both inside and outside the industry. The increasing competition from industrially minded countries, by necessitating higher process efficiencies, has in consequence diminished waste of materials in effluents and in atmospheric pollution. Stringency of supplies of raw material, including water, can operate in the same way, while the extension of the industry to include a much wider range of products such as textiles, foods and pharmaceutical preparations, requiring manufacturing techniques of a very different character from those employed in the so-called 'heavy' chemical industry, is giving organic chemical industry the character of a fine-chemical industry. Developments in insecticides and in fertilizers have aligned chemical industry closely with agriculture, and he regarded the prospect opened up by the utilization of plastics as almost limitless. He attached much importance to the disappearance of the old differentiation between pure and applied science, and to the unification of outlook to be seen in the approach to problems in modern chemical industry. This finds expression in the team-work in which mathematicians, physicists, chemists, biologists, geologists and metallurgists may all participate, and Mr. Cremer thought that, in thus furthering the idea of the unity of science, that co-operation and interchange between universities and industry which is so essential and fruitful may also be stimulated.

Other factors changing the face of chemical industry to which Mr. Cremer referred were the introduction of new constructional materials, with all their implications for the design of plant to operate under more and more exacting conditions of pressure or temperature, the remarkable developments in scientific instruments which are not only increasing the accuracy of control but also making it possible for such control to be automatic or remote, and the contribution of the chemical engineer in the study of selected categories of process operations, based on the same physical principles although their method of application may differ with the properties of the individual product to be manufactured. Besides this, the attention now being given to the safety and welfare of the workers in chemical industry is also affecting its character as well as the design of its plant. The study of occupational diseases has sometimes stimulated research on disease in wider fields, and the industry in its work on toxicology and like matters is concerned with the health and safety of users of its products as well as of those making them. Mr. Cremer believed that the industry is now fully conscious of all its direct and indirect obligations to the public, and that there is now much better prospect of science being properly wedded to industry and, in turn, of industry to civilization.

But it seems equally clear from this symposium that the future of chemical industry will not depend solely on internal factors, but also on whether Government policy and the general social or political climate are favourable. There was implicit concern that fiscal policy may place fresh difficulties in the way of development when obsolescence is so large a consideration and research and development so costly, and whether there will continue to be forthcoming the initiative and individuality, the enterprise and imagination which are required to create and to seize these opportunities.

STUDENT HEALTH IN GREAT BRITAIN

INTRODUCING a symposium on student health before a crowded session at Edinburgh of Section I (Physiology) of the British Association, Sir Andrew Davidson, chief medical officer, Department of Health for Scotland, claimed that no better nor more appropriate recognition of the importance of student health has been recorded than its inclusion in the discussions this year of the British Association. We have been guilty hitherto of neglecting an important group of the community from which not only our men of science but also other leaders of the nation are most likely to come.

Eighty-five thousand full-time students attend universities and colleges under the ægis of the University Grants Committee, and probably as many more attend other central institutions for higher education. In Scotland there are about thirty-one thousand students in all. This very substantial occupational group is subjected to stresses and strains —both physical and mental—which demand special understanding.

The promotion of full health and the prevention of ill-health, with measures for the early diagnosis and treatment of disease, should be the aim of all student health services. Curative medicine must have its place but should, wherever possible, be arranged within the National Health Service. The best features of our school health services and our industrial health service should be incorporated—the personal health programme and the health education work of the former, and the environmental effort of the latter. The approach to student health work should be through physiology rather than pathology.

Stressing the importance of health education, Sir Andrew quoted the Goodenough Committee Report. "A student health service would be one of the means of inspiring the community to a sensible interest in the promotion of health. . . . the service would be a special education for them [students] as providing a practical demonstration of medical practitioners in the role of health officers. Such a demonstration related to a student's own health and problems is likely to make a much more lasting impression than much exhortation."

Of particular interest were Sir Andrew's remarks on research in student health services. In no other section of the community do such excellent opportunities exist for research in health. The combination of an intelligent, young, apparently healthy person and a doctor with reasonably adequate time is unique. There is, too, an almost unexplored field of investigation of a group living through one of life's most critical stages. Inquiries into environmental, social and personal factors, physical exercise, nutrition and so forth can provide invaluable information, which may perhaps indicate routes of development in our health services. There is the added advantage that the student can be closely observed for three to five years, while his later history may even be followed up for a longer period. Where can intelligent co-operation be more readily forthcoming, asked Sir Andrew ?

During the limited time available for eye testing in the medical examination of large numbers of students, anything more elaborate than the monocular Snellen test is usually considered to be impossible. This test, however, fails to reveal many instances of binocular defects, anisometropia suppression, and so on. Dr. R. H. Bolton, of the University of Birmingham, described in an impressively lucid paper how he has adapted the Turville infinity balance to provide a 'screening' test, which, though not yet completely infallible, nevertheless provides a simple test markedly superior to any other screening test in his experience. The Turville infinity balance is essentially an extension of the well-known binocular reading test in which a pencil or narrow strip of paper is held between the eyes and the test type. The pencil is replaced by a sand-blasted septum in the centre of a mirror in which back-to-front letters are reflected and read, different letters being read by each eye. This "gives a satisfactory indication of how the student is using his eyes as a pair and saves a lot of time". By applying a surface-silvered mirror immediately behind a clear-glass septum, but slightly out of alignment, a virtual image of the test letters is seen binocularly immediately above the separated or monocularly seen types, providing a standard for detecting even minor degrees of 'phoria' or faulty alignment. At a second testing 'station' each student undergoes a colour vision test, a binocular reading test, and near-point phoria test using a Maddox convergeometer. From the subsequent histories of those examined by him, Dr. Bolton confirms the usual view that 'esophores' are more likely to have eye troubles than 'exophores' or 'orthophores'.

As part of a wider study of the socio-medical and environmental background of 2,539 students of all faculties at the University of Edinburgh, Dr. J. G. Thomson has considered the association of these factors with the academic results achieved by 592 medical students from all years except the first, and by a second group of 137 first-year medical students.

Three-quarters of all students and 83 per cent of medicals were from social classes I and II (the upper social classes). Family size does not show the normal variation between the social classes, and students from lower classes obtain academic results as good as those from other classes.

Students entering the medical faculty at ages between twenty-six and thirty showed the best academic results, followed by those who started at less than eighteen years of age. Of the year-group 18–25, those entering between the ages of twenty and twenty-two gave the poorest results of all. There was no evidence in this group that national servicemen did better or worse than non-servicemen, and, of the physical and environmental factors considered, only myopia showed a slight suggestive association with superior academic performance.

In the first-year group, students living at home did less well than those in lodgings approved by the university welfare superintendent. Room-sharing, longer hours of daily travel-time, and differences in recreational habits did not account for this, and the solution was found in a group of twenty-three students from English secondary schools who were very much more successful than any other group. What appeared to be an interesting environmental difference was, therefore, probably the result of pre-university educational factors, or of varying selection criteria.

Presenting a provocative and enjoyable paper on the relationship between physique and physical attainments, habits and behaviour, including delinquency, Dr. R. Parnell, of the University of Oxford, created a stir with a formula based on physical measurements and radiographic heart-size, which not only differentiated sprinters from long-distance runners, but also graded them according to potential performance. He confidently predicted that a particular athlete at the top of his table would win the 1,500-m. race at the Olympic Games at Helsinki next year.

A comparison of heights and weights in the University of Oxford revealed once again that students from the lower social classes are smaller than those from the other social classes. Since, however, students from government grant-aided schools are "taller and heavier than the highest level reached in the general population", Dr. Parnell argues "that the great difference between undergraduates and the general population is probably due to selection" and not to nutritional advantages. Is it not more probable that working-class parents who are ambitious for their children do, as demonstrated in Dr. Thomson's paper, limit the size of their families in order to give them both educational and nutritional advantages?

The classification of physique by methods of standard photography based on the Sheldon technique, and standardized by the work of Tanner in Great Britain and Dupertuis in the United States, has produced evidence in support of those who propound a relationship between physique and behaviour. Dr. Parnell demonstrated the use of the 'fat clock', a graphic method of recording physical measurements and the thickness of the subcutaneous fat, which will be a useful technique for all those who are interested in this work.

In a powerful plea for a deeper appreciation of the problems of the tuberculous student, Sir Alan Rook, of the University of Cambridge, estimated that there are probably close on five hundred undergraduates in sanatoria in Great Britain and more than two thousand in need of medical care or observation for pulmonary tuberculosis. After discussing the problems of adjustment and career selection which face those students who are able to continue their studies while under observation, Sir Alan went on to paint a graphic picture of the frustration, the loss of initiative and desire to work, or the fretfulness and restless anxiety of these young people, progressing all too often to a profound psychological maladjustment, which not only retards recovery but also impedes resettlement after cure.

After referring to the success of Continental students' sanatoria, which he reluctantly classed as impracticable in Great Britain at present, Sir Alan asked that, at least, we should establish something corresponding to the Continental post-cure hostels for tuberculous students.

This must not be thought of as preferential treatment any more than rehabilitation units for industrial workers and 'Remploy' factories can be considered 'preferential'. The correct treatment should be available to all, and Continental experience has shown that the correct treatment for university students includes the mental stimulus of continued teaching and study under medical supervision. It is scarcely creditable to British universities to have lagged so far behind Continental practice in this matter. Now, however, the students of Great Britain are pressing strongly for action, and have collected a large sum of money towards this project. It is to be hoped that Sir Alan's plea will bring them the influential support for which they look so hopefully.

As the speakers freely admitted, much of their work is exploratory and open to criticism or even correction. The important thing is that a start has been made. A regular stocktaking of the health, well-being and occupational efficiency of those on whom the advancement of science will depend in the future will be of great interest to members of the British Association, especially if the approach continues to be "through physiology rather than pathology".

ARMAGH OBSERVATORY

REPORT FOR 1950

THE March issue of the *Irish Astronomical Journal* (1, No. 5; 1951) contains the report on Armagh Observatory for the year 1950, in which Dr. E. M. Lindsay, the director, gives the main items of interest and development for the year. The Armagh–Dunsink–Harvard telescope is now in operation at the Boyden Station of the Harvard Observatory at Mazelspoort, Bloemfontein, where it arrived on October 26, 1950, and was erected under the supervision of Dr. J. S. Paraskevopoulos and Dr. Bok shortly before the death of the former. The primary mirror has a diameter of 36 in., the secondary mirror 16 in., and the correcting plate 32 in. The photographic plate covers an area of about 18 square degrees, and the scale is 1 mm. = 68″. An exposure print of 61 min. is reproduced and shows the excellent performance of the instrument and its efficiency in the photography of diffuse nebulæ. A member of the staff of Armagh Observatory spends four months of the year on the observational programmes on the Southern Milky Way with the telescope. The report includes a photograph of the instrument. The completion of the objective prism for the telescope is well under way; it will be 33 in. in diameter—the largest in the world—with a 5° angle giving a dispersion of about 400 A. per mm. The cost of the prism so far has been borne by Harvard University and by a grant from the Senate of Queen's University, Belfast.

Dr. E. B. Armstrong commenced erecting the Armagh Schmidt telescope in August 1950, and the final adjustments were being made and test plates taken early this year.

The remainder of the report gives a list of publications, a summary of the meteorological work, the names of a number of visitors, a miscellaneous collection of information on lectures by Dr. Armstrong at Queen's University, the synchronous motors for the meteor cameras, various internal renovations and alterations in the buildings, etc.

A NEW MEASUREMENT OF THE VELOCITY OF RADIO WAVES

By Commdr. CARL I. ASLAKSON

U.S. Coast and Geodetic Survey, Washington, D.C.

During January and February of 1951, I was privileged to assist in some new tests of improved Shoran equipment. These tests were undertaken by the United States Air Force, and in general the methods employed were those developed by me[1–4]. However, several improvements were incorporated in the equipment by the United States Air Force, the most important one being a 'gain-riding technique', whereby the gains were manually controlled and maintained, both at the ground station and in the air, at a constant level. This technique effectively eliminated the 'signal intensity' correction reported in the earlier work.

The lines measured constituted a five-sided figure with a central point. Since the distances between all points were measured, there were fifteen lines in all. These distances varied from 40 to 320 miles, as shown in Table 1.

Table 1

1	2	3	4	5	6	7	8
Line	Ground stations		Geod. distance	Shoran distance	Shoran minus geodetic	Col. 6 corrected for K	Adjusted V
	Rate	Drift					
2–6	2	3	40·6131	40·6041	−0·0090	−0·0038	+0·0008
3–4	1	3	96·7171	96·7049	−0·0122	−0·0063	+0·0024
5–6	1	2	100·3098	100·2988	−0·0110	−0·0054	−0·0007
5–1	1	3	118·9953	118·9840	−0·0113	−0·0074	+0·0002
1–6	1	2	133·0113	132·9985	−0·0128	−0·0072	−0·0009
2–3	2	3	134·9698	134·9546	−0·0152	−0·0095	+0·0013
5–2	1	2	139·1225	139·1127	−0·0098	−0·0059	−0·0025
3–6	1	2	145·8427	145·8276	−0·0151	−0·0095	+0·0006
1–2	3	2	145·8884	145·8768	−0·0116	−0·0059	−0·0029
4–6	1	2	190·5047	190·4889	−0·0158	−0·0102	−0·0013
2–4	1	2	199·1914	199·1735	−0·0179	−0·0123	+0·0002
5–3	2	3	226·9903	226·9698	−0·0205	−0·0148	+0·0010
5–4	1	2	235·5264	235·5042	−0·0222	−0·0166	+0·0023
1–3	2	3	277·0569	277·0347	−0·0222	−0·0166	−0·0003
1–4	1	2	320·1519	320·1271	−0·0248	−0·0192	−0·0002

Probable error of observation = ±0·00118

All stations were tied to the first-order triangulation network of the United States, and the inversed geodetic distances could thus be compared with the Shoran distances.

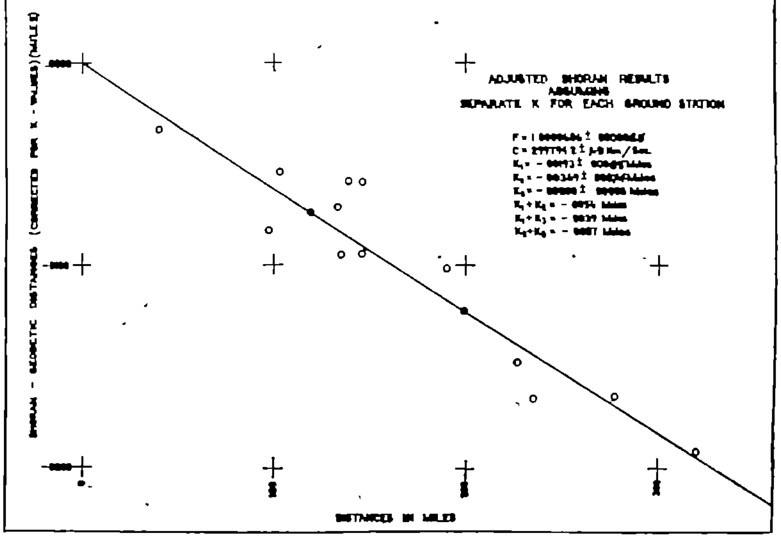
Three Shoran ground stations were used, but only a single airborne station. Each ground station is known to have a small constant error which can be determined by calibration over a known distance. This error varies from about −0·002 mile to −0·003 mile. In the present case it was possible to make an excellent analytical determination of this error from the results of the measurements.

The original Shoran measurements were made using the Anderson value of $c = 299,776$ km./sec. Therefore, that velocity must be multiplied by the factor 1·0000606 derived from the adjustment. This results in a velocity of 299,794·2 ± 1·9 km./sec.

The solution was made from fifteen observation equations, one for each line measured. The equations were as follows:

$$FS + K_1 + K_2 - E = 0.$$

Column 6 in Table 1 gives the value of E in each equation. Column 7 contains these values of E after correction for the computed ground station values of K, while column 8 shows the V's or the corrections to the distances. The other terms in the equation are defined as follows:



F is the scale factor representing the velocity change from the assumed velocity. The values K_1, K_2, and K_3 are the constant errors in measurement, which are a function of the individual ground stations, and E is the Shoran distance minus the geodetic distance.

The results of the above solution are:

$$\begin{aligned} F &= 1\cdot0000606 \pm 0\cdot0000065 \\ \text{or } c &= 299{,}794\cdot2 \quad \pm 1\cdot9 \text{ km./sec.} \\ K_1 &= -0\cdot00193 \quad \pm 0\cdot00065 \\ K_2 &= -0\cdot00369 \quad \pm 0\cdot00074 \\ K_3 &= -0\cdot00200 \quad \pm 0\cdot00053 \end{aligned}$$

The Shoran distance was S.

$$\begin{aligned} \text{Thus} \qquad K_1 + K_2 &= -0\cdot0056 \\ K_1 + K_3 &= -0\cdot0039 \\ \text{and} \qquad K_2 + K_3 &= -0\cdot0057 \end{aligned}$$

The probable errors in these values of K are sufficiently low to indicate that the analytical method of determination is satisfactory.

These results are summarized in the accompanying graph, which shows the adjusted velocity curve together with the individual observations. The derived velocity of 299,794·2 ± 1·9 km./sec. is higher than the one previously reported by me. However, the removal of the troublesome signal intensity error together with other improvements in the equipment and the techniques lend more confidence to the above figure.

In my previously reported value[3] of c, a value of the index of refraction for dry air at 760 mm. pressure and 0° C. of 1·0002835 was used. In the present work I have adopted a value of 1·0002876. That figure is based on the means of a number of measurements made by various observers in the optical band. Warner[4] adopted a statistical value of 1·0002895 ± 0·0000550, basing that figure on the dielectric constant determinations of seventeen workers between 1872 and 1946. Birnbaum, Kryder and Lyons[5] published a value of 1·0002853 for air and 1·0002877 for air as determined from its component gases. Essen[6] recently published a value of 1·0002882. In the same paper Essen states that a new optical equation of Barrel gives a value of 1·0002878. It seems certain that the figure I have adopted is accurate to about 1 part in 10^6.

Essen[7] summarizes recent determinations of the velocity of light. In Table 2 I have added my value to his list.

Table 2

Author	Method	Velocity *in vacuo*	Weight
Birge	Optical	299,776 ± 4 km./sec.	1
Essen and Gordon-Smith	Cavity resonator	299,792 ± 9	1
Bergstrand	Optical	299,793·1 ± 0·26	2
Aslakson	Radar	299,792 ± 2·4	2
Essen	Cavity resonator	299,792·8 ± 3	2
Bol	Cavity resonator	299,789·3 ± 0 4	2
Aslakson	Radar (Shoran)	299,794 2 ± 1·9	

It is particularly noteworthy that these observers used widely varying frequencies, ranging from the optical wave-lengths of Bergstrand, through the 220–300 Mc./sec. of the Shoran band to the 30 Mc./sec. of Essen's experiments.

Aslakson's 1949 value would be reduced by about 2 to 3 parts in 10^6 if the new value of the index of refraction and the corresponding interpolation equation were used. Certainly the close agreement and relatively low probable errors are significant.

At the present time a new series of Shoran measurements is in progress. The value of the velocity assumed in projects now under way is 299,793·1 km./sec. So far, comparisons of measured distances and Shoran distances indicate that this value is correct within 1 part in 150,000.

A more complete report of the measurements described here will be published elsewhere.

[1] Aslakson and Rice, *Trans. Amer. Geophys. Union*, **27**, 459 (1946).

[2] Aslakson, *Trans. Amer. Geophys. Union*, **30**, 475 (1949).

[3] Aslakson, *Nature*, **64**, 711 (1949).

[4] Warner, Radiophysics Laboratory, Commonwealth of Australia, RPR 93 (Aug. 1949).

[5] Birnbaum, Kryder and Lyons, *J. App. Phys.*, **22**, 95 (1951).

[6] Essen, *Nature*, **167**, 512 (1951).

[7] Essen, *Nature*, **167**, 258 (1951).

SCIENTIFIC MANAGEMENT

IN a stimulating article, the warden of Urchfont Manor Residential College for Adult Education suggests that there is a real danger of accepting a number of false propositions in the name of so-called 'scientific management' (*J. Inst. Personnel Management*, 33, No. 315; May–June 1951). In an analysis of what is implied by the term 'scientific management', Mr. Hunter suggests, first, that there are parts of management in which certain sciences are of use. Good statistical analysis of costs, accurate measurement, controlled experiment on alternative methods of layout or process will clearly be useful and are rightly called 'scientific'. Motion study also might be included, since the human body is in one sense a machine which will function best with certain directions of movement and load. When time study and rate fixing are included among the sciences, a little more doubt creeps in; owing to individual variation in rates of learning and final speeds attained, a subjective element is introduced. Aptitude testing suffers from similar limitations, for the world is full of adaptations successfully made by people with apparently crippling disability.

Secondly, although organization is often included in 'scientific management'—industry is fond of organizational charts and maxims regarding 'the span of control'—it is doubtful whether organization is in any real sense a scientific subject. There is, indeed, a considerable amount of experience regarding organization of, say, a company with many local branches or a flow production plant, but it is scarcely suitable to describe knowledge of this experience as scientific: it is mainly empirical.

It is when the term 'scientific management' is applied to the management of human beings, however, that real muddle begins. The object of management in this field is to get a large number of human beings working together in mutual co-operation and giving maximum output. If there is a science of this activity, it implies that there should be an ordered body of knowledge relating to it and capable of being applied by any competent student. The claim appears to have been made that there are laws of group behaviour which can be ascertained and used in the management of groups. If this were true, it would clearly be of immense importance to industry, since a systematic application of these laws for defined purposes should result in producing co-operative effort. Examining the nature of this claim more closely, Hunter considers the simple and semi-technical factors such as fatigue, boredom, lighting, rest pauses and hours of work. From this it might appear that a simple or at least a direct correlation between variations of these conditions and output might be established. But at once the Hawthorne experiment springs to mind, apparently proving that the effect of such variations, if any, can be completely masked by the simple fact that the working group was stimulated to higher effort by the evidence of management interest in their work.

The first difficulty in producing a science of management is that the material to be handled insists on taking a hand in the experiment. Moreover, there is little evidence that this reaction will itself be regular, or predictable. The shop steward may be flattered or co-operative, or he may decide that the whole experiment is designed to save man-power and will endanger his job.

Hunter then goes on to consider the nature of the knowledge which the psychological scientists in industry bring back to the manager who employs them.

The psychologists discover that healthy rivalry can increase production, and advise the introduction of merit rating and merit awards. Perhaps this succeeds; but perhaps it does not, and instead produces jealousy and suspicions of favouritism, in which case another scientific investigation will produce a new diagnosis—that there is too much competition and jealousy due to merit rating. They discover that fear plays an enormously important part in determining behaviour; that a suppressed fear may have results not apparently connected with its cause; for example, a man in fear of unemployment may suddenly be rude to the foreman. They discover that men have a sense of dignity and will react unfavourably if this is affronted, that praise and blame work better than indifference, and that natural leaders appear in small groups and may lead in good or bad directions. Experience of individual psychology should warn us that the method of detailed analysis of unique cases cannot possibly produce a system of scientific rules applicable to industrial groups. Each group is, to begin with, a collection of unique individuals; each group will be coloured by its own unique history, that of the factory or its social environment; each will be affected differently at different times by current social and political attitudes absorbed from the general atmosphere of society. Possibly a year's work by an experienced team of investigators might unravel a great deal of the psychology of a group in the machine shop, and describe it in a book of considerable length. Industrial management, however, cannot possibly work at this rate.

The manager's job in industry, as that of the military commander, is to get co-operation from a group as a result of hundreds of different personal motives and influences of history and tradition which analysis might discover among any single group. Moreover, he must succeed not only with the machine shop but also with the typists and with the whole factory, composed of many utterly different groupings. Analysis cannot give him these answers. The history and experience of human leadership will, however, tell him what qualities he must show to obtain the same good result from widely different groups.

Hunter believes that the search for 'scientific management' is a search for the lazy man's way of doing the job, for a book of rules which any manager can use. If there is such a book it is one which tells of the personal qualities which the manager must show; of the self-discipline, the imagination, and the love which he has somehow to create, very painfully, in himself in order to lead others.

In conclusion, Hunter insists that he does not want to abandon observation of industrial situations or to cease experiment on organization. The excellent work which has been done on methods of selecting foremen or of drafting joint production council constitutions, the analysis of absenteeism or the organizational chart—all these have been of high value, since they provide a better channel through which leadership can flow. But he also insists that they will never provide a science of management, because there is no such thing.

T. H. HAWKINS

FOREST POLICY IN AFRICA

UNDER the question of policy and legislature in the annual report of the Forest Department of Uganda for the year ending December 31, 1949*, the following appears: "African Local Governments are being encouraged to play an increasingly more active part in forestry work, especially in areas which have been declared to possess adequate forest estates or which are within appreciable distance of attaining that objective. As time goes on District Forest Officers will act less and less in an executive capacity in so far as local reserves, Crown Land, and the supervision of local Government Staff are concerned, and more and more in a true advisory capacity."

Such a statement is all right on paper, but its practical implications must be considered. Forestry is rather different from other branches of administration in that policies must be thought out for centuries ahead; merely changing, for political reasons, an administration from British to African in no way alters the true relation of the forest to the countryside or to the local economy. The only way to preserve forests and to improve and restore those which have been badly exploited is to place them under the *direct* administration of a staff trained in forest methods from the highest ranks to the lowest; and they must know their job and be granted annually adequate funds to carry it out. For forest work entails adequate and constant supervision from the time of obtaining the new young crop of trees until the day they come to maturity—50, 100, 150, 200 or even more years later—as is being practised in France under modern conditions. Rotations may and will be shorter in the tropics. But more rapid growth entails closer supervision and in many cases a larger staff.

From the beginning of this century some of the Colonial administrations have given in the annual forest reports statements of their forest policies; but it has been little more than words. The matter now becomes more serious. If the Africans are to enjoy in future more executive authority in charge of forests, it becomes essential that the proposed position of the trained forester, and what his authority within the forest consists of, should be closely and clearly defined. Otherwise the deterioration of the African forest estate is certain.

E. P. STEBBING

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* Uganda Protectorate. Annual Report of the Forest Department for the Year ended 31st December, 1949. Pp. iv+54+10 plates. (Entebbe: Government Printer, 1950.) 3s.

EVALUATION OF DISINFECTANTS

AT the British Pharmaceutical Conference, held at Harrogate during September 10–14, the chairman, Prof. H. Berry, in his address entitled "A Review of Disinfectants and Disinfection", emphasized the importance of disinfection both to the public health and to pharmaceutical practice. This subject, he said, is studied in all its aspects only in schools of pharmacy, and the modern pharmacist should be qualified to give expert advice on disinfectants and to evaluate commercial claims made for them; he should be proof against "high-powered sales talk" about them. In his address, Prof. Berry discussed with refreshing vigour the question of what constitutes a good disinfectant. Controversy about evaluation of disinfectants revolves, he said, around the type of test represented by the Rideal–Walker test and its product, the so-called phenol-coefficient. This biological test is still misunderstood and is often "misused in advertisements to gull the uninformed layman", but it has turned useless disinfectants off the market. Prof. Berry discussed its defects and explained why he considers that it is a badly designed test which "cannot by any stretch of the imagination be translated into terms of therapeutic activity or practical applicability or utility". Some disinfectants, such as 'Lysol', cetrimide and acriflavine, do not need a biological test, they can be, and are, controlled by chemical or physico-chemical specifications, such as those that are given in the British Pharmacopœia and its Codex.

The real problem, however, is the evaluation of the utility of a disinfectant after it has been standardized. For this the results of many diverse tests are required, and Prof. Berry discussed these. In Great Britain there is no official body which will adjudicate on new disinfectants, nor is the existing legislation for the control of claims made for them effective, although many of the British Dominions and the United States have attempted their legislative control. Prof. Berry commended, however, the Medical Research Council's valuable Memoir No. 11, entitled "The Control of Cross-Infection in Hospitals" (revised edition; pp. 49; London: H.M. Stationery Office, 1951; 1*s*. 9*d*. net), which gives in its Appendix A advice to hospitals on the disinfectants to be used for various purposes; he expressed the hope that the Ministry of Health will adopt a similar method of dealing with disinfectants on the open market.

The remainder of Prof. Berry's address was devoted to a useful discussion of the valuable properties, and also the limitations, of the quaternary ammonium compounds, which are challenging, in certain fields of use, some of the established disinfectants. The address concluded with a brief, but interesting, account of the discovery that some substances which were believed to kill micro-organisms quickly do not, in fact, kill them, but merely inhibit them, so that they can be revived by treatment with 'revivors', among which are ammonium sulphide and certain thiol compounds. Substances have been found which will revive organisms treated with iodine, hypochlorites and formaldehyde, but none is yet known that will revive organisms treated with phenol. Certain thiol compounds, such as glutathione, occur naturally in the body, and there is evidence that, if pathogenic organisms treated with mercury compounds are injected into the body, they may be revived and may become infective. The evaluation of disinfectants must take account of developments of this kind. Revivors can be used to find out whether disinfectants have, in fact, killed organisms.

In conclusion, Prof. Berry urged that the older disinfectants should not be lightly given up. The hypochlorites are, he said, very valuable, and he had great confidence in the phenolic preparations, 'Lysol', 'Black Fluid' and 'White Fluid', the wide non-specific action of which makes them very reliable. He made a special plea for 'Lysol', but added that the hospitals do need a non-toxic, non-irritating phenol preparation the other properties of which are not inferior to those of 'Lysol'.

CARNEGIE UNITED KINGDOM TRUST

THE thirty-seventh annual report of the Carnegie United Kingdom Trust, 1950[*], covers the completion of the Trust's first post-war quinquennium, and by the end of the year the grand total of grant payments by the Trustees had reached £4,065,555. During its thirty-seven years, the Trustees have thus been able to distribute to beneficiaries more than twice the amount of the original endowment of the Trust of £2 million, and at the same time to increase the income from the original £100,000 a year to rather more than £130,000. More than a third of the total expenditure has been on the development of library services which, as explained in last year's report, will now continue without further financial assistance from the Trustees. Nearly £250,000 has been devoted to playing-fields, mostly within the period 1926–40; but the combined effect of the Physical Training and Recreation Act of 1937 and the Education Acts of 1944 has been to place responsibility in this matter on the local education authorities. Under the same Acts, central and local authorities are now responsible for grants to village halls, to which, if all outstanding promises are taken up in full, the Trust has contributed more than £180,000.

More than £150,000 has been provided for community centres and the like, and about £110,000 on schemes of land settlement, operated by the Land Settlement Association, which, under the Agriculture Act of 1947, is now responsible to the Ministry of Agriculture. Some £450,000 has been provided for youth services and nearly £50,000 for the development of museum services, while on the Bureau of Current Affairs, now to be terminated, £123,344 has been expended. While the Bureau has not been able to establish itself as a self-supporting institution, the Trustees state that they do not regret having made the experiment to find out whether a method that had proved outstandingly successful during the War could be made economically self-supporting in time of peace. The Trustees also terminated at the end of 1950 their support of youth hostels, but the allocation to the National Federation of Young Farmers' Clubs is being spread over six years, instead of the five years originally contemplated. An individual survey on behalf of the Trust is now being undertaken by Mr. John Mack, Stevenson lecturer in citizenship in the University of Glasgow, of agencies and activities concerned with juvenile delinquency, with the object of directing attention to any gaps which might be filled by the action of either statutory or voluntary bodies in furthering existing schemes or initiating new ones.

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[*] Carnegie United Kingdom Trust. Thirty-seventh Annual Report. Pp viii+49. (Dunfermline: Carnegie United Kingdom Trust, 1950.)

Plans for the quinquennium 1951–55 include an increase in the allocation for the development of museum services from £30,000 to £40,000, in part with the object of strengthening the administration of the Museums Association itself. For the Councils of Social Service of England, Scotland, Northern Ireland, and Wales and Monmouthshire, £27,750 has been allocated, and a sum of £30,000 for family case-work by the Family Welfare Association and Family Service Units. With allocations of £45,000 for music and drama and £5,000 for the visual arts, the total allocation for the new quinquennium is £147,750, and there is thus some three-quarters of the Trust's funds for the period still available for allocation.

RECURRENT LONG LEAVE FOR UNIVERSITY TEACHERS

THE seventeenth issue of *Communication* contains the report of the International Association of University Professors and Lecturers on recurrent long leave. By this is meant the recurrence of substantial periods of leave over and above ordinary annual vacations; the most usual arrangement is that every seventh year is recognized as a year of leave of absence from the place of normal occupation. It is well known that some universities have such schemes, while others have not. It has not been generally known precisely which universities fell into which category, nor has there been any clear knowledge as to what variations of the typical scheme there might be in universities which operate recurrent long leave schemes. A suitable questionnaire was therefore sent to fifty-eight countries where universities exist. Thirty-seven of these have replied, fifteen of them reporting that they have no regular system for long leave. These are Sweden, Finland, France, Switzerland, Belgium, the Netherlands, Austria, Hungary, Czechoslovakia, Germany, Eire, Italy, Mexico, Chile and Bolivia. This does not mean a notable lack of interest on the part of either staff or authorities. Eire (Trinity College, Dublin), for example, though having no system, does occasionally give long leave when a member of staff is invited to spend some time in another university. In the University of Brno, a professor or his associate is occasionally granted leave with full salary for study for a period of, say, three months to a year. Similarly, the University of Chile has provision for granting leave for, say, six months on full salary for study purposes—each case being considered on its merits. In Finland, the University of Abo grants leave of absence with full salary and superannuation, the recipient usually having the obligation of paying a deputy.

The other twenty-two countries have recognized systems for recurrent long leave, although in some of the countries, like Canada, Great Britain and the United States, by no means all the universities have any definitely established systems; it is in the British Commonwealth of Nations and in the United States that the practice is most firmly rooted. The list of countries in which some or all of the universities have systems for recurrent long leave is as follows: Australia, Burma, Canada, Ceylon, China, Denmark, Egypt, Greece, Iceland, India, Israel, Lebanon, Malaya (Singapore), Norway, New Zealand, Philippine Republic, South Africa, Trinidad, Turkey, United Kingdom, the United States and Yugoslavia. From the data supplied it is clear that there is a widespread desire among the universities of the world that a regular leave system should operate. Many individuals, both members of the teaching staff and administrative authorities, of several universities, have expressed their views strongly in support of the system. The general aim would appear to be a scheme on 'sabbatical' lines in the sense that approximately every seventh year should be available for leave. The majority, however, both of those who give it and of those who take it, prefer that the leave be spent usefully in study or research, while travel and rest are not excluded.

Although on paper some of the schemes appear to be satisfactory, they may not be completely realistic. In the Hebrew University of Jerusalem the scheme would appear to be working well, a high percentage of members of staff taking advantage of it. In Egypt and Ceylon advantage is taken of the opportunities offered. The New Zealand schemes which have been quite recently financed by a special grant from the Department of Education are likely to prove very attractive. On the other hand, there would appear to be a good deal of imperfection in the machinery of some of the others which considerably reduces their effectiveness.

In most cases full pay is continued during leave, although in some there is a downward adjustment. On the other hand, Egypt and Lincoln (New Zealand) add a cost-of-living bonus. Generally, the staff-strength of a department provides for leave to a teacher without the need for a substitute; but where a substitute is required, in some cases the institution provides for the payment and in others it is the individual who pays in part or in full. One of the major expenses attending leave is that of travel. Long-distance passages are covered or partially met by a grant-in-aid by about half the universities who have replied; in other cases the whole cost falls on the member. In the latter event only teachers in universities where the salaries and other emoluments are relatively good can avail themselves of the leave or attempt to undertake long-distance travel. Another difficulty which arises in some cases is that, if a man is to take his wife and family with him, it naturally adds a good deal of expenditure, whereas if he leaves them behind he has two establishments to finance. Interesting examples in this connexion are Ceylon, Egypt, Western Australia and Yugoslavia. In Ceylon a travelling allowance is made for a wife, in Egypt for both wife and children, in Western Australia a larger house allowance is made in the case of a married man on leave, and in Yugoslavia the needs of the family are arranged for by paying to them the member's salary, the member on leave receiving instead his living and travelling expenses.

In reviewing the replies to the questionnaire, the Association recommends that a system of long leave at recurrent intervals should be established in all university institutions of the world. Where such a system cannot be established, all facilities for *ad hoc* refresher or study leave should be granted. Such leave should be with full pay and superannuation and adequate travelling allowances. If it should be necessary to pay for a substitute, funds should be provided by the institution for this purpose. The leave should be devoted to research, travel, rest or any other purpose to which the academic authorities could take no reasonable objection.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Detection of Sugars by Paper Chromatography

Since the introduction by Partridge[1,2] of filter-paper chromatography for the identification of sugars, the method has been widely applied by many workers, and has often proved of great value in detecting small quantities of a carbohydrate in the presence of large amounts of other sugars. With some justification, the tacit assumption, 'one sugar, one spot', is commonly accepted. We have made some observations which seem to call for greater care in the interpretation of chromatograms, and it is for this reason that the following facts are reported, although our knowledge of the phenomena described is still far from complete.

During an investigation of the sugars present in diabetic urines, three spots were observed when paper chromatograms, developed with the upper phase of a mixture of *n*-butanol (40 per cent), ethanol (10 per cent), water (49 per cent), and ammonia (1 per cent), were sprayed with aniline hydrogen phthalate[3], benzidine[4], or *p*-anisidine hydrochloride[5]. One of these spots had an R_F value identical with that of a reference glucose spot; the R_F values of the other two were, respectively, 33 per cent and 78 per cent of that of the reference spot. The slowest-moving of these substances stained with naphthoresorcinol[6] (Fig. 1), but not with ammoniacal silver nitrate[1]; on the other hand, the middle spot was observed with the latter reagent. No appreciable amount of ninhydrin-reacting material was present in the urine. On changing the developing solvent to *n*-butanol (40 per cent), acetic acid (10 per cent) and water (50 per cent), only glucose could be observed in the urine, while in *n*-butanol saturated with water the slowest spot moved only 11 per cent of the distance of the glucose spot and there was extensive streaking.

In connexion with other work on which we were engaged, samples of the polyglucoses dextran and starch were hydrolysed with 2*N* sulphuric acid in sealed tubes for 6 hr. at 100° C. The resulting solutions were neutralized either with barium carbonate or by using the desalting technique of Consden *et al.*[7]. When each hydrolysate was analysed on a chromatogram developed with butanol–ammonia, only glucose was detected if the amount of sugar employed was about 20 μgm.; but when this quantity was increased tenfold a spot was found which, in its R_F value and in its behaviour towards the spraying reagents mentioned above, was identical with the slowest one observed in the urine samples. However, it was never obtained as strongly as in the former case. This spot was again apparent when, in a further experiment, glucose itself was submitted to the acid treatment, followed by neutralization. Moreover, when a large quantity (200–300 μgm.) of pure glucose, freshly dissolved in water, was run on a chromatogram, the same spot could just be observed if the paper was sprayed with aniline hydrogen phthalate and illuminated with ultra-violet light. In some of these experiments the presence of the 'middle spot' was noted; but, due both to its low intensity and to its close proximity to the excessively strong normal spot, it was not always possible to claim its presence with certainty.

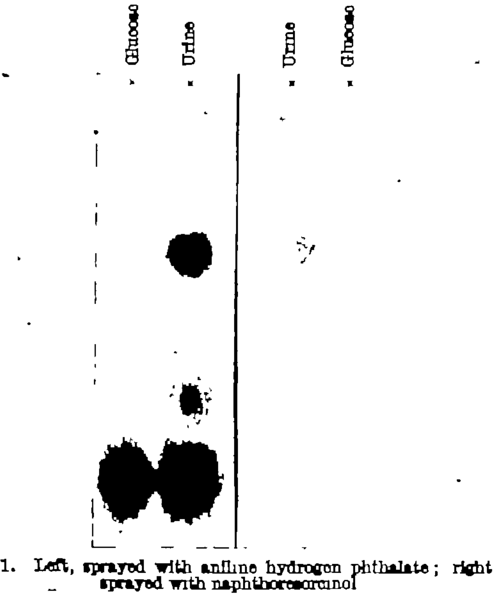

Fig. 1. Left, sprayed with aniline hydrogen phthalate; right, sprayed with naphthoresorcinol

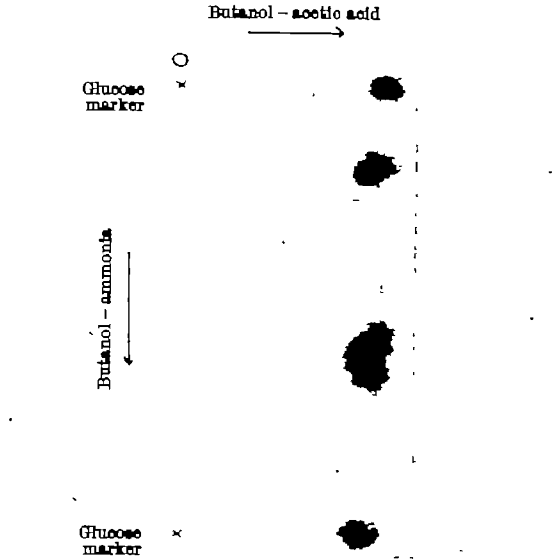

Fig. 2. Urine introduced on to the paper at position O. Chromatogram developed with (1) butanol–ammonia, (2) butanol–acetic acid, and sprayed with aniline hydrogen phthalate. Glucose markers introduced at positions × before second development

Other aldoses—both pentoses and hexoses—were found to behave similarly; but no extra spots were observed with the ketoses fructose and sorbose. The general pattern of the extra spots obtained with the aldoses was similar in all cases, and in the case of galactose the relative mobilities of the three spots were the same as in the case of glucose. However, this was not true for all the sugars examined; the slowest-moving spot obtained with ribose, for example, moved 44 per cent of the distance of the normal ribose spot. Similar phenomena have been noted with some partially methylated sugars, although the number of extra spots and their relative positions vary in a manner which appears at the moment to be almost haphazard.

When the urine sample referred to originally was run on a two-dimensional chromatogram, developed first with butanol–ammonia and then with butanol–acetic acid (Fig. 2), it appeared that all the spots reverted to glucose in the second solvent. Later, when the spot which was the least mobile in butanol–ammonia was eluted from a paper with water, using the technique introduced by Dent[7], and re-run on a chromatogram developed with the same solvent, it appeared in its original position; but if dilute acetic acid was used as the eluant the normal glucose spot was obtained on the new chromatogram. Under the same conditions the middle spot also reverted to glucose with acetic acid; likewise, the two extra spots produced from glucose by the sulphuric acid treatment were re-converted to the normal spot with acetic acid.

From the foregoing, therefore, it will be seen that we have observed on paper chromatograms phenomena which are of importance in the analysis of sugar mixtures, particularly in the examination of metabolic fluids and in the determination of the component sugars in a polysaccharide. Whether these various interconvertible spots differ in their internal structures, or whether condensation or addition reactions are involved, it is, at present, impossible to say; but the matter is being investigated further.

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Paper Partition Chromatography of Alcohols using the Potassium Xanthogenates

A FEW drops of the alcohol in a small test-tube are treated with 0·5 ml. of pure carbon disulphide and 0·1 gm. of pure powdered potassium hydroxide and the mixture shaken for some minutes. The liquid phase is decanted to another test-tube, evaporated and the residual xanthogenate dissolved in a drop of water. The resulting solution is developed by paper partition chromatography (ascending method) using alkaline butanol (2 per cent potassium hydroxide) as solvent. About twenty hours is required. The location of the xanthogenates on the paper is detected easily by their dark brown luminescence under ultraviolet light or by the yellow or blue colours produced by spraying with Grote's reagent[1]. In the case of solid alcohols, the xanthogenate formed is dissolved in formamide and developed in the same way. The R_F of formamide solutions of potassium xanthogenates, however, indicates, assuming the following reaction, the values of the corresponding ammonium xanthogenates:

$$ROCSSK + HCONH_2 + H_2O = ROCSSNH_4 + HCOOK$$

A few millilitres of ethanol, containing a trace of methanol, in a test-tube is treated with carbon disulphide and potassium hydroxide as above and is shaken for twenty seconds. After evaporation of the liquid layer, the residue of potassium xanthogenate is developed as above.

In this case two spots, corresponding to the potassium xanthogenates of methanol and ethanol respectively, are recognized clearly by ultra-violet light. Both spots appear at first yellowish in colour on spraying with Grote's reagent, but the spot of the latter alcohol turns brown in half an hour whereas that of the former still remains yellow. By using this method, 0·1 per cent of methanol contained in ethanol is easily detected. Limit of identification: methanol 18 γ, ethanol 25 γ.

The R_F values for alcohols, obtained by the potassium xanthogenate method, are as follows:

Methanol	0·23	*iso*Amyl alcohol	0·62
Ethanol	0·35	Benzyl alcohol	0 45
*iso*Propanol	0 44	Octyl alcohol	0 17
*iso*Butanol	0·54	*cyclo*Hexanol	0 64
n-Butanol	0·56	Ethylenechlorohydrin	0 91

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Partition Paper Chromatography of Some Organic Acids

IN the course of studies on the metabolism of bacteria, our attention has been focused on the question of partition paper chromatography of organic acids, especially those occurring in living bacterial cells. The present communication describes an attempt to examine the possibility of detecting and resolving organic acids by use of paper chromatography.

The technique employed by us was essentially the same as that of R. Consden, A. H. Gordon and A. J. P. Martin[1]. As a developer, we used phenol saturated with water; as a stationary phase, we used water saturated with phenol. To prevent ionization of organic acids, the atmosphere of our chromatographic chamber was saturated with the vapour of formic acid (see J. W. H. Lugg and B. T. Overell[2]). The paper strips were placed after development in an oven at 110° C. for 15 min., or were dried at room temperature for 24 hr. Then the chromatograms were treated with a solution of a suitable indicator. It has been shown that 0·04 per cent (w/v) alcoholic solution of bromphenol blue gave the best results as regards the stability of revealed spots, although the bromthymol blue seemed to be more sensitive. The locations of some organic acids were also verified by their fluorescence in ultra-violet light.

Unfortunately, we have at our disposal only a limited number of organic acids known to be common metabolites of living cells. The experiments have been conducted both with aqueous solutions of single, chemically pure acids, and with their mixtures. The R_F values were determined as well as standard deviations and 95 per cent confidence intervals, which will be presented elsewhere.

We find that in concentrations ranging from 0·5 to 5·0 per cent (w/v or v/v) there was no apparent influence on R_F values of the acids examined. Although the size and intensity of the spots seem to be proportional to the concentration of acids present, we observed that some acids form more intense and larger spots than would be expected from their concentrations. No doubt this phenomenon is closely connected with the structure of the acid molecule in question.

We did not succeed in recovering uric acid, probably due to its insolubility in water. Among the organic acids under investigation the volatile ones (formic, acetic, propionic and camphoric acid) were not detectable on the chromatograms. In the case of halogenated derivatives of acetic acid, the R_F values were unstable and varied greatly from experiment to experiment.

The R_F values of the acids examined showed no differences greater than the experimental error when the experiments were carried out with one acid or with a mixture of acids. Some acids such as *p*-aminobenzoic, benzoic, salicylic, tannic, lactic and ascorbic gave a relatively high percentage of discrepant results, which were rejected in the calculation of mean R_F values. With an improved technique, better results would be expected (for example, that of F. A. Isherwood and C. S. Hanes[3]).

We have been interested to find a numerical relationship between the structure of a chemical group and its influence on R_F values of organic acids. From a comparison of R_F values of two acids the theoretical R_F value of a group constituting the difference between these acids may be calculated. In such a manner we have determined approximately so-called ΔR_F, that is, an increase or decrease of R_F value caused by incorporation of a given group, for the following chemical groups:

1. $\Delta R_F(C)^{I} = +1{\cdot}23$ (for the first C atom of aliphatic chain).
   $\Delta R_F(C)^{II} = +0{\cdot}20$ (for the second C atom of aliphatic chain).
   $\Delta R_F(C)^{III} = +0{\cdot}10$ (for the further C atoms of aliphatic chain).
2. $\Delta R_F(COOH)^{I} = +0{\cdot}55$ (for the first COOH-group).
   $\Delta R_F(COOH)^{II} = -0{\cdot}45$ (for the second COOH-group).
   $\Delta R_F(COOH)^{III} = -0{\cdot}25$ to $-0{\cdot}30$ (for the further COOH-groups).
3. $\Delta R_F(OH) = -0{\cdot}22$ (in the aliphatic acids).
4. $\Delta R_F(NH_2) = -0{\cdot}27$ (in the aliphatic acids).
5. ΔR_F(benzene ring) $= +1{\cdot}42$.
6. $\Delta R_F(COOH)$cycl. $= -0{\cdot}55$ (the same value in all positions).
7. $\Delta R_F(OH)$cycl. $= -0{\cdot}22$ (if attached to any atom of carbon of the benzene ring).
8. $\Delta R_F(OH)$cycl. $= \pm 0{\cdot}00$ (if present in a side-chain).
9. $\Delta R_F(NO_2)$cycl. $= -0{\cdot}15$ (in the case of picric acid).
10. $\Delta R_F(SO_3H)$cycl. $= -0{\cdot}48$ (if attached to benzene ring).
11. ΔR_F(N or NH or NH_2)cycl. $= \pm 0{\cdot}00$ (irrespectively whether present in the ring or in the side-chain).

It appears advantageous to control experimentally obtained results by comparison with the theoretical R_F values.

The mean R_F values for a number of acids were as follows: *p*-aminobenzoic, 0·87; ascorbic, 0·46; aspartic, 0·36; benzoic, 0·86; citric, 0·26; fumaric, 0·64; glucuronic, 0·22; lactic, 0·79; malic, 0·43; malonic, 0·54; mandelic, 0·86; nicotinic, 0·89; oxalic, 0·33; picric, 0·75; sulphosalicylic, 0·26; tannic, 0·19; tartaric, 0·21; pyruvic, 0·35.

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Identification of Sulphonamides by Paper Partition Chromatography

The identification of sulphonamides in biological fluids is usually attempted by microscopical examination of crystals and by the use of various, rather non-specific, colour reactions[1]. Since it is common for only small quantities of fluid to be available, it was decided to investigate the possibilities of paper partition chromatography.

The method of ascending chromatography described by Williams and Kirby[2] was used in preference to the usual procedure, this method being more convenient when dealing with six or seven 'spots'. Unfortunately, no single solvent could be found which would separate all the sulphonamides to an extent permitting identification. It was found, however, that the sulphonamides tend to fall into two classes, namely, those separable with a basic solvent and those separable with an acidic solvent. By using either of or both these solvents, the sulphonamides can be separated and identified. The R_F values of some of the sulphonamides in common chemotherapeutic use are given in the accompanying table.

R_F Values

Sulphonamide	*n*-Butanol/ammonia	*n*-Butanol/acetic acid
Sulphaguanidine	0·43	0·36
Sulphathiazole	0·48	0·46
Sulphanilamide	0·56	0·42
Sulphadiazine	0·24	0·50
Sulphamezathine	0·48	0·48
Sulphamerazine	0·34	0·50
Sulphacetamide	0·71	0·44
Sulphapyridine	0·70	0·51

The solvents are prepared as follows:

(*a*) *Acid solvent.* 50 ml. of *n*-butanol is mixed with 15 ml. of glacial acetic acid and 60 ml. of distilled water. The mixture is well shaken in a separating funnel and allowed to separate. The lower aqueous layer is discarded and sufficient *p*-dimethylamino benzaldehyde added to the remaining solvent to give a concentration of approximately 0·5 per cent.

(*b*) *Basic solvent.* 40 ml. *n*-butanol is mixed with 10 ml. of ammonium hydroxide and 30 ml. water. The mixture is shaken up as with the acid solvent, separated and *p*-dimethylamino benzaldehyde added to the organic layer to give a concentration of approximately 0·5 per cent.

The paper used was a sheet of Whatman No. 1 filter paper measuring approximately 20 cm. × 25 cm. A base-line was drawn about 3 cm. from one end and approximately 0·01 ml. quantities (containing 5–15 gamma) of solutions of each of the sulphonamides in *N* hydrochloric acid spotted on the base line at intervals of 2–3 cm. At the same time an unknown sulphonamide solution was 'spotted' on the base line. The spots were then sprayed with Ehrlich's reagent (2 per cent *p*-diamethylamino benzaldehyde in hydrochloric acid) and the filter paper rolled into a cylinder and clipped at the top end with a paper clip.

Two such chromatograms were then placed in Petri dishes containing the solvents, each covered with a bell jar, and irrigation was by capillary attraction for 6–12 hr. Then the papers were removed and, if necessary, sprayed with Ehrlich's reagent. This has never been found necessary after the acid solvent has been used; but the spots usually become faint after irrigation with the basic solvent. From the position of the unknown spot on both chromatograms, the nature of the unknown can be determined.

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Elastin from Human Tissue and from Ox Ligament

THE starting material for the majority of the reported analyses of elastin has been ox ligamentum nuchæ subjected to long periods of boiling in water, the simplest of the methods described by Stein and Miller[1].

Human aorta has been treated in this fashion, and also boiled in frequent changes of 1 per cent acetic acid, a treatment which has been proved by Gross[2] to remove all structurally intact collagen, as demonstrated by the electron microscope. A hydrolysate of material subjected to prolonged treatment by either of these methods shows on chromatography a far greater concentration of basic amino-acids and hydroxyproline than would be expected from "pure elastin" (cf. Bowes and Kenten[3], and Neuman[4]).

Similar chromatograms to those reported by Bowes and Kenten can, however, be obtained from hydrolysates of aorta tissue which has been boiled for five days with frequent changes of between 50 and 100 volumes of 40 per cent urea solution. It might therefore be concluded that certain collagenous substances are more difficult to remove from human tissue than from ox ligament; but that after the complete removal of such proteins the insoluble residue is very similar if not identical in both species, and to this the name 'elastin' could appropriately be given.

Doubt, however, is cast on the validity of this definition of elastin, since it has been shown that the resistance to solution in 40 per cent urea solution of elastin preparations from both ox and human tissues is not absolute, as reported by Stein and Miller, but is a function of the liquor ratio. The whole of an elastin preparation will pass into solution if the volume of the urea solution is raised to between 100 and 200 times that of the solid.

Similarly there are indications of heterogeneity in the residues after treatment with 50 volumes of urea solution. Differences in composition, notably with respect to proline, are observed between the material dissolved from these residues and that remaining after attack by pancreatic elastase[5].

The definition for elastin, therefore, now becomes rather vague. Under the electron microscope, certain branched and rather ill-defined structures are identified as collagen-free elastin. Chemical analysis shows that these preparations are still contaminated with material having some of the significant amino-acids of collagen. A chemical definition of purity based on insolubility in urea is also suspect, since the amount of urea available alone determines the extent of solution.

A fuller examination of the chemical analysis of various preparations obtained by the action of urea and of elastase on both human and ox tissues is in progress. These results, together with corresponding electron microscope studies undertaken in co-operation with the Department of Biomolecular Structure of this University, will be published elsewhere.

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X-Ray Micro-radiography of Biological Specimens

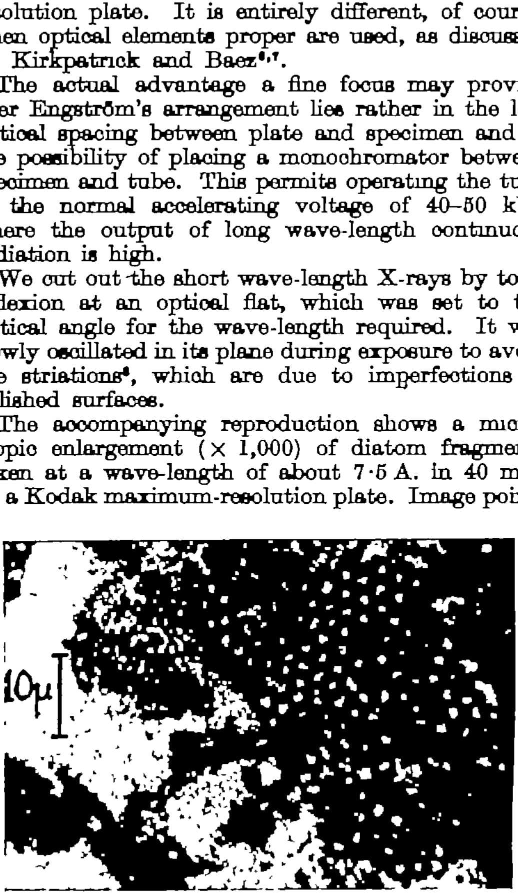
A HIGHLY loaded micro-focus X-ray tube[1,2] was used for taking X-ray photographs of microscopic specimens. Engström and others[3-5] have established a strong case for this kind of micro-radiography and have obtained remarkable photographs of microscopic sections in a wave-length range of 5–10 A. using a special tube with a focus of moderate size.

It can easily be shown that even with the fine focus now available ($4\,\mu \times 40\,\mu$) it is advisable, in this wave-length range, to rely entirely on optical magnification of shadow-graphs and to place the specimen close to a photographic plate of high resolution. For, in the case of direct shadow enlargements, the definition can never be better than the dimension of the focus, and even for a point focus at a reasonable distance from the specimen, it is limited by diffraction to less than the resolving power of a maximum resolution plate. It is entirely different, of course, when optical elements proper are used, as discussed by Kirkpatrick and Baez[6,7].

The actual advantage a fine focus may provide over Engström's arrangement lies rather in the less critical spacing between plate and specimen and in the possibility of placing a monochromator between specimen and tube. This permits operating the tube at the normal accelerating voltage of 40–50 kV., where the output of long wave-length continuous radiation is high.

We cut out the short wave-length X-rays by total reflexion at an optical flat, which was set to the critical angle for the wave-length required. It was slowly oscillated in its plane during exposure to avoid the striations[8], which are due to imperfections of polished surfaces.

The accompanying reproduction shows a microscopic enlargement (× 1,000) of diatom fragments taken at a wave-length of about 7·5 A. in 40 min. on a Kodak maximum-resolution plate. Image points



0·5 micron apart are clearly resolved. The specimen was deposited on a collodion film placed 0·2 mm. in front of the plate. The X-ray tube had a 10-micron aluminium window, and the space between this window and the plate was evacuated. The reflector was 4 cm. long and the specimen placed 16 cm. from the focus. These dimensions were chosen to make use of existing gear. The focus-specimen distance can be reduced to at least half without affecting the resolution. This would reduce the exposure time to about 10 min. Another factor of 2 could be gained by using a tungsten anti-cathode instead of the copper target of our tube. The glancing angle by which the X-rays are reflected, and hence λ(min.), changes slightly across the object plane. The effect is easily calculated and amounts to about 2 A./mm. across the specimen for a focus to specimen distance of 16 cm.

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Phosphorus Trifluoride–Hæmoglobin

There are numerous examples of complex compounds formed by trivalent phosphorus compounds which have an electron pair available for the formation of dative bonds[1], and recently this knowledge has been extended by the preparation of phosphorus trifluoride complexes of divalent platinum[2]. There is a close analogy between the lower halides of phosphorus and carbon monoxide in such compounds, and this analogy has been strengthened by the recent preparation of the tetrakistrihalogenophosphine nickels, $Ni(PCl_3)_4$ [3], $Ni(PBr_3)_4$ [4], and $Ni(PF_3)_4$ [4]; the latter is a volatile liquid similar to nickel carbonyl, $Ni(CO)_4$. It was therefore thought that phosphorus trifluoride might form a complex with ferrohæmoglobin similar to the well-known covalent complexes with carbon monoxide, nitric oxide, *iso*cyanides, etc.[5]. The existence of such a phosphorus trifluoride–hæmoglobin compound has been established, providing further evidence for the covalent bonding ability of phosphorus trifluoride.

A solution of partially oxygenated human hæmoglobin was prepared (cf. ref. 5, p. 211) and portions of this solution were diluted with disodium hydrogen phosphate citric acid buffer solutions to give a hæmoglobin concentration about 1/200 that in whole blood. Hæmoglobin was then formed by reduction with sodium dithionate ($Na_2S_2O_4$), and portions of the solution were agitated with phosphorus trifluoride at various partial pressures in pure nitrogen. A pink colour, visually different from the colour of either oxyhæmoglobin or carbonmonoxyhæmoglobin, rapidly developed and the broad band of the hæmoglobin absorption spectrum centred around 560 mμ changed to give two sharp bands centred about 540 and 575 mμ; a hand spectroscope with a scale was used for detection. No change in colour or absorption bands was evident on addition of excess dithionate.

The formation of the phosphorus trifluoride–hæmoglobin complex is not critically dependent on the *p*H of the solution in the range 5·0–8·1. The complex is unstable, persisting for only a few minutes. In alkaline solutions, the rate of formation is slower and the rate of decomposition faster than in acid solutions, presumably due to the increase in the rate of hydrolysis of phosphorus trifluoride with increasing *p*H.

It has proved impossible to measure the absorption spectrum of the compound with any accuracy due to the rapid hydrolysis; but a rapid survey of the spectrum in the region from 520 to 590 mμ was made on a Beckman spectrophotometer. Comparison with the spectra of oxyhæmoglobin (peak maxima at 576–578 mμ and 540–542 mμ) and carbonmonoxyhæmoglobin (peak maxima at 568–572 mμ and 538–540 mμ) measured in the same conditions shows the close similarity of the phosphorus trifluoride hæmoglobin (peak maxima 574–577 mμ and 540–543 mμ) with the former. The intensity of the peaks appears to be similar and the α-peak is the sharper.

Again due to hydrolysis, estimation of the half-saturation pressure is impossible; however, the compound is readily formed with phosphorus trifluoride partial pressures of the order of 1 cm. mercury.

No evidence has been obtained for the formation of a hæmoglobin complex of nitrogen trifluoride, and the reported[6] cyanosis due to nitrogen trifluoride was probably due to impurities. The inability of nitrogen trifluoride to form a compound with hæmoglobin is probably due to the absence of vacant 2*d* orbitals in the nitrogen atom, so that there is no possibility of the π-bonding which occurs in the phosphorus trifluoride complexes, where there is a vacant 3*d* orbital in the phosphorus atom. The nitrogen trifluoride used in this work was kindly given by Prof. E. G. Rochow of Harvard University.

I am greatly indebted to Prof. Charles D. Coryell for his stimulating advice and for his contribution of samples of blood.

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Free Amino Groups of Collagen

Using the technique originated by Sanger[1] for the determination of end-groups in proteins by reaction with dinitrofluorbenzene, no free α-amino- or imino-groups have been detected in ox hide collagen[2], even when the equivalent of 2–3 gm. dinitrophenyl-collagen was placed on the silica gel columns.

After heating in water at 70° C., and treating with alkali, or urea, a small number of α-amino groups were found.

Since collagen contains a considerable amount of proline, the dinitrophenyl derivative of which is unstable to acid hydrolysis, special efforts were made to detect this derivative. Recovery of dinitrophenyl-proline added to collagen, and from salmine treated with dinitrofluorbenzene, indicates that proline would have detected it if it had been present to the extent of one end-group per unit of 1,500,000.

Failure to detect an end-group in collagen suggests three possibilities: (1) that the molecular weight is very large—greater than 1,500,000 if proline is an end-group, and of the order of 2,000,000 or more if some other amino-acid forms the terminal group; (2) that the molecule has a cyclic structure; or (3) that the end-group is inaccessible to dinitrofluorbenzene, or is masked in some way by combination with some other group, or with carbohydrate. There is insufficient evidence available at present to indicate which, if any, of these hypotheses is correct; but the following observations may be made. Average molecular weights of up to 250,000 have been reported for gelatin[3]; it is known that a small number of peptide bonds are broken in the conversion of collagen to gelatin, hence the molecular weight of collagen might well be several times this figure. There is only a small amount of carbohydrate in collagen; but it is perhaps of interest to note that the amount of chondroitin sulphate estimated to be present in this collagen from its hexosamine content and the intensity of spots due to glucosamine and chondrosamine on paper chromatograms[4] corresponds approximately to one molecule of chondroitin sulphate per unit of 80,000, that is, in roughly twice the minimum molecular weight (39,000) calculated from the amino-acid composition[5].

	α-Amino groups		Reactivity of lysine ϵ-amino groups with dinitrofluorbenzene (m.mol./100 gm.)
	(m.mol /100 gm.)	Weight containing one residue	
Collagen	No end-groups detected		17
Alkali-treated collagen			17
Aspartic acid	0·07	1,400,000	
Glutamic acid	0·17	600,000	
Glycine	0·42	240,000	
Phenylalanine	0 04	2,500,000	
Collagen dissolved in formic acid			—
Aspartic acid	0 43	230,000	
Glutamic acid	0·15	700,000	
Glycine	0·65	150,000	
Alanine	0 30	330,000	
Urea-treated collagen			
Aspartic acid	0·07	1,400,000	—
Heat-shrunk collagen			15
Aspartic acid	0·15	700,000	
Glutamic acid	0·03 (approx.)	3,300,000	
Gelatin (commercial)			17
Aspartic acid	0·28	350,000	
Glutamic acid	0·12	830,000	
Glycine	0·57	180,000	
Threonine	0·14	710,000	

Lysine content of collagen: 31 m.mol./100 gm.

In modified collagens, various end-groups were detected in small amounts (see table). With alkali-treated collagen, the small number of end-groups found does not represent the total number of peptide bonds broken, since about 5 per cent of the collagen was solubilized during the treatment, some as small peptides and some as comparatively large units[5]. These fractions are now being examined. Dispersion in formic acid has often been used as a method of obtaining 'soluble collagen'. The dinitrophenyl derivative of collagen treated with formic acid was soluble and resembled dinitrophenyl-gelatin rather than the other modified collagens.

Aspartic and glutamic acids were frequently found as end-groups of modified collagen, and it would appear that the peptide bonds involving the amino groups of these acids are particularly labile. Partridge[6,7] has also found that these acids are preferentially liberated in the partial hydrolysis of a number of proteins with weak acids.

The amounts of ϵ-dinitrophenyl-lysine isolated from all the collagens were appreciably less than the amounts corresponding to their lysine contents (see table). Even in gelatin, only about half the ϵ-amino groups of lysine reacted with dinitrofluorbenzene. Dinitrophenyl-hydroxylysine was also detected; evidence suggests that some of the side-chain amino groups of this amino-acid were also unreactive to dinitrofluorbenzene. Porter[8] also found that the ϵ-amino groups of a number of soluble proteins did not react with dinitrofluorbenzene, but that after denaturation all became available. This is not so with collagen, and there is some evidence that heat denaturation actually causes a slight decrease in the number of ϵ-amino groups reacting. With soluble proteins, denaturation is generally considered to cause unfolding of the polypeptide chains. Collagen is already in the extended form, and heat denaturation, which causes considerable shrinkage, probably involves folding of the chains, which may decrease the availability of amino groups.

We wish to thank the Council of the British Leather Manufacturers' Research Association for permission to publish this communication.

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Direct Oxidation of Glucose by *Aerobacter* sp.

A PRECISE picture of a pathway of glucose metabolism existing in addition to the classical scheme proposed by Embden, Meyerhof, Parnas, Cori and many others is slowly emerging from experiments on carbohydrate metabolism[1–7]. This route, proceeding by way of 6-phosphogluconate and its derivatives, is called 'direct'. Some years ago, a study of aerobic and anaerobic acid formation with nitrogen-poor bacteria led one of us (J. D. L.) to suppose that, beside the classical respiration by triose phosphate dehydrogenase, our strain could equally well oxidize glucose by way of phosphogluconate, gluconate or a non-phosphorylative process[8].

We now report experiments demonstrating that in *Aerobacter* sp. a pathway of glucose metabolism exists in which gluconate (most probably as 6-phosphogluconate) and its derivatives are involved. (We wish here to direct attention to the the fact that the strain, obtained from the Biochemical Laboratory, Helsinki, used by one of us (J. D. L.) in the earlier experiments in the latter and later in this Laboratory, was formerly erroneously called *E. coli*. It exhibits the properties of an *Aerobacter*.)

The bacteria were cultured in a synthetic medium containing dipotassium hydrogen phosphate, sodium chloride, magnesium and ammonium sulphate and carbohydrates or their derivatives (D-glucose, sodium D-gluconate, sodium 2-keto-D-gluconate, D-ribose). Various substances believed to partake in the direct metabolism of glucose were added to the centrifuged and washed bacteria, suspended in phosphate buffer, and the oxygen consumption was measured by means of the Warburg respirometer. No oxidation could be observed with the following substrates: sodium 5-keto-gluconate, D-arabinose, sodium D-arabonate, sodium D-ribonate. The fact that D-arabinose and D-ribonate are not oxidized is not in agreement with the original hypothesis by Dickens[3], although it might be asserted that the corresponding D-arabokinase and D-ribonokinase are absent from the cellular enzymic equipment.

The following substances were always fairly rapidly oxidized with or without an initial induction phase: D-glucose, sodium D-gluconate, sodium 2-keto-D-gluconate, D-ribose, L-arabinose, sodium D-glucuronate, D-xylose. The routes of breakdown of L-arabinose and D-xylose are obscure, suggesting the need for a study of the interconversion of pentoses by means of their phosphorylated derivatives, as in the well-known fructose-glucose-galactose transformations.

Since oxidative decomposition plays an important part in 'direct' glucose metabolism, we also investigated the influence of aerobic and anaerobic cultural conditions on the behaviour of the enzymic systems involved. Our experiments demonstrate that the enzyme systems which metabolize glucose by way of gluconate are not formed preferentially in aerobic culture conditions, but are also very actively present in anaerobically cultured bacteria. The cells grown aerobically oxidize their substrates faster, however, probably because of adaptive formation of cytochromes in presence of oxygen[8]. The oxidation of glucose never showed an initial lag phase and was independent of the substrate in the previous culture. Sodium D-glucuronate, D-xylose and L-arabinose were only oxidized after a considerable induction phase, indicating the formation of adaptive enzymes. The accompanying table shows the presence or absence of the initial lag phase in the oxidation of a substrate, according to the previous cultural conditions.

Substrate for respiration	Bacteria cultured on			
	D-Glucose	D-gluconate	2-Keto-D-gluconate	D-Ribose
D-Glucose	–	–	–	–
D-gluconate	+	–	+	+
2-Keto-D-gluconate	+	+	–	+
D-Ribose	+	+	+	–

+, Induction phase; –, no induction phase.

These results may be explained by the adaptive nature of the kinases for gluconate[7], 2-ketogluconate and ribose, while the enzymes catalysing the reactions glucose → glucose-6 phosphate → 6-phosphogluconate → 6-phospho-2-ketogluconate should be constitutive, since the latter substrates are oxidized at the same rate, once the adaptive kinase has been formed. The further breakdown of 6-phospho-2-ketogluconate and the reactions leading to 5-phosphoribose are by no means clear[3,10,11].

We hope to present in the near future a closer investigation of this and related problems. A full account of this work is to be published elsewhere.

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In vitro Fungistatic Action of Phenanthrolines against Pathogenic Fungi

Working with a diffusion technique described elsewhere[1], I found in August 1948 that a number of phenanthrolines had fungistatic properties, until then unknown. *o*-Phenanthroline, highly bacteriostatic for Gram-positive and Gram-negative bacteria, has a stronger growth-inhibiting effect against *Ctenomyces interdigitalis* (= *Trichophyton interdigitale*) than *p*- or *m*-phenanthroline. Alkylation of *o*-phenanthroline increased its fungistatic action. 2,9-Dimethyl-*o*-phenanthroline proved to be the most potent fungistatic agent of all phenanthrolines tested. Further alkylation or chlorination of the latter substance resulted in a reduction of its fungistatic action. 2,9-Dimethyl-*o*-phenanthroline was still effective in the test mentioned above when used in $M/1600$ solution. The fungistatic properties of this compound were not affected by adding serum to the medium, as happens with a number of fatty acids and their sodium salts. This substance also showed marked bacteriostatic properties against Gram-positive bacteria.

The spectrum of effectiveness of 2,9-dimethyl-*o*-phenanthroline includes numerous genera and species of fungi pathogenic for man and animals, such as *Ctenomyces interdigitalis*, *Trichophyton rubrum*, *T. tonsurans*, *T. schönleini*, *Sabouraudites audouini* (= *Microsporum audouini*), *S. canis*, *Epidermophyton floccosum*, *Candida* species, *Nocardia* species, *Hormodendrum pedrosoi*, *H. compactum*, *Sporotrichum schenckii*, *Piedraia sarmentoi*, *Phialophora verrucosa*, etc.

Recently, *Aleurisma tulanense* (= *Blastomyces dermatitidis*), freshly isolated from a case of cutaneous North American blastomycosis, was tested against 2,9-dimethyl-*o*-phenanthroline. A dilution method described by Kolmer and Boerner[2] was used for this purpose. This fungus did not grow on a medium containing Sabouraud glucose agar, 'Difco' and 10 per cent serum with 0·002 per cent 2,9-dimethyl-*o*-phenanthroline. Growth was strongly inhibited by this substance in concentrations ranging from 0·001 to 0·0005 per cent. Normal growth occurred if the medium contained less than 0·0005 per cent of the substance.

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Effect of Oxidized *d*-Limonene on Micro-organisms

During our studies on microbiological problems in the citrus industry, we found it necessary to study the effect of essential oils on micro-organisms. As a first step in this study, we investigated in a synthetic medium the influence of *d*-limonene, which constitutes more than 90 per cent of the orange essential oil, on micro-organisms normally present on the surface of oranges.

It was shown in this way that *d*-limonene, freshly distilled over sodium, has no inhibitive action on the micro-organisms tested (a strain of *Sacar. elipsoideus, Wilia hansenula, Oidium lactis*) when added to the synthetic medium. However, the vapours of this limonene exhibit a bacteriostatic effect.

When exposed to air, *d*-limonene reveals inhibitive properties, which increase with the duration of exposure. Also, when samples of the oxidized limonene are tested for the presence of peroxides by the potassium iodide method, iodine is liberated and by titration an increase of peroxide formation may be shown.

Quantitative estimation of the inhibition by Hinshelwood's method[1] has revealed that this action is marked only by shifting the time of the lag phase, without any influence on the logarithmic growth phase and the number of the total population. When plotting the lag time against the increased doses of an oxidized *d*-limonene, an adsorption isotherm curve is obtained, similar to those obtained by Hinshelwood. Samples of *d*-limonene, taken at different times of exposure to air, give a set of such curves with the point of lethal dose decreasing with increasing time of oxidation.

The oxidized *d*-limonene, in the aqueous nutrient medium, however, loses its inhibitive properties on keeping. This decrease of inhibition is enhanced by the presence of *l*-ascorbic acid in the medium.

Steam distillation of oxidized *d*-limonene in presence of sodium hydroxide also destroys its inhibitive properties. Neither the distillate nor the resinous viscous residue added in adequate doses to the synthetic medium shows any inhibition of the micro-organisms tested.

Recent advances in organic chemistry[2] show that the fixation of an oxygen molecule from air in *d*-limonene will take place by forming a peroxide bond. This oxidation can be considered as an 'initiation reaction', which will catalyse a second reaction, namely, a polymerization of the activated terpen radicals. Hence, we may assume that the first reaction is responsible for the appearance of the inhibitive properties of limonene exposed to air. This accords with the generally known toxic properties of peroxides or epoxides. (However, the possibility that the second reaction may influence the specific toxicity of any peroxide formed cannot be excluded.)

There is a lack of precise chemical–physical data as to the mechanisms of the two reactions. When in our experiments the oxidation of *d*-limonene was carried out in different physical conditions, quantitative estimation of the reaction showed a change in the value of the parameters of the adsorption isotherms. A more detailed account of this work will be published elsewhere.

The fact that the oxidation is catalysed by light and chlorophyll[3] suggests that the reaction is possibly of biological importance, and experiments in this direction are under way.

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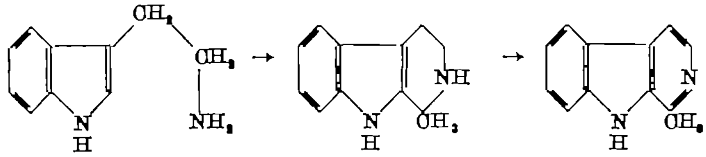
Isolation of Tetrahydroharman from *Petalostyles labicheoides*

In the course of a comprehensive study of the alkaloids in Australian Leguminosae, the examination of *Petalostyles labicheoides* was undertaken. This erect and bushy shrub grows to a height of several feet, and is found mainly in northern New South Wales and in Queensland. Alkaloids were detected in this plant in the course of the extensive field tests carried out by Mr. L. J. Webb[1], who kindly arranged for a quantity of the plant to be supplied for more intensive investigation.

The finely ground and dried plant was first intracted with chloroform to remove various colouring matters, after which the alkaloid was extracted with methanol. Concentration of the extract gave a thick syrup which was taken up in 1 per cent hydrochloric acid. The acid solution was basified, and the precipitated alkaloid extracted with ether. (The ether-insoluble material probably contained another (unstable) alkaloid, which, however, has so far resisted all attempts at purification.) The crude crystalline material obtained on evaporation was dissolved in anhydrous ether and purified by chromatography on alumina. The pure alkaloid formed very pale yellow prisms or needles, of melting point 178–180° (found: C, 77·5; H, 7·7; calc. for $C_{12}H_{14}N_2$; C, 77·4; H, 7·6 per cent). The melting point, analysis and ultra-violet absorption spectrum, the last kindly determined by Mr. R. S. Pearce (maxima at 2255 A., log ϵ, 4·57; 2830 A., log ϵ, 3·90; and 2910 A., log ϵ, 3·82), indicated that the alkaloid was tetrahydroharman (II, melting point in the literature, 179–180° [2]). The benzoyl derivative first separated from ether as colourless crystals, melting point 165–167° (in the literature, 168–169°), but on recrystallization from 50 per cent alcohol it formed long needles of melting point 194–195° (found: C, 78·55; H, 6·0; calc. for $C_{19}H_{18}N_2O$; C, 78·25; H, 5·8 per cent). This was evidently a dimorphic form. The identity of the alkaloid was confirmed by the preparation of the hydrochloride, melting point (decomp.) 265° (in the literature, 267° (decomp.)), and by a mixed melting point comparison with an authentic synthetic specimen kindly presented by Dr. R. H. F. Manske. Finally, the ultra-violet absorption spectrum of the natural product coincided exactly with that of the synthetic material.



(I) (II) (III)

Tetrahydroharman (II) does not seem to have been obtained previously from natural sources, and this proof of its occurrence in Nature is of interest in connexion with studies of the biogenesis of alkaloids. It has often been suggested[3], for example, that harman (III) and related β-carboline alkaloids, are synthesized in the plant from tryptamine (I), or tryptophan, by condensation with acetaldehyde to give (II), and subsequent dehydrogenation to (III). Tryptamine (I) has already been shown[4] to occur in several species of the genus *Acacia* (Leguminosae), and G. Hahn and H. Ludewig[5] have demonstrated that tryptamine readily condenses with acetaldehyde *in vitro* and under 'physiological' conditions of temperature and *p*H. Harman (III) has, of course, been isolated from several plants[6], and the present isolation of tetrahydroharman (II) from a natural source completes the series and supports the speculations of Robinson and others[3] in a very satisfactory way.

Note added on July 19. It has recently been announced[7] that racemic tetrahydroharman has also been isolated from *Elaeagnus augustifolia*.

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Alkaline Decomposition of Amino-acids

In the course of an examination of the amino-acid composition of soil hydrolysates by the paper chromatography technique, it was noticed that alkaline hydrolysates of soil contained greater amounts of α-amino-*n*-butyric acid than did acid hydrolysates[1]. Further work indicated that alkaline hydrolysates also contained greater amounts of glycine. These results suggested that, under the conditions commonly employed for the hydrolysis of proteins with alkali, glycine and α-amino-*n*-butyric acid are formed by decomposition of other amino-acids. Paper chromatographic examination of acid (6 *N* hydrochloric acid) and alkaline (5 *N* sodium hydroxide) hydrolysates of casein supported this, since α-amino-*n*-butyric acid was found in the alkaline, but not in the acid, hydrolysate, and the glycine spot on chromatograms of the alkaline hydrolysate was distinctly stronger than the corresponding spot on comparable chromatograms of the acid hydrolysate.

These findings led to a study of the effect of hot sodium and barium hydroxides on various amino-acids. Results so far obtained have shown that, under the conditions generally used for hydrolysis of proteins with alkali, threonine yields glycine and α-amino-*n*-butyric acid, serine yields glycine and alanine, and cysteine and cystine yield alanine. An attempt is now being made to follow these decompositions quantitatively. Preliminary results indicate that, after treatment of threonine with 5 *N* sodium hydroxide in a sealed tube at 105° C. for 24 hr., about 1–3 per cent of the original threonine nitrogen is present as α-amino-*n*-butyric acid and 60–70 per cent as glycine.

Full details of this work will be published later.

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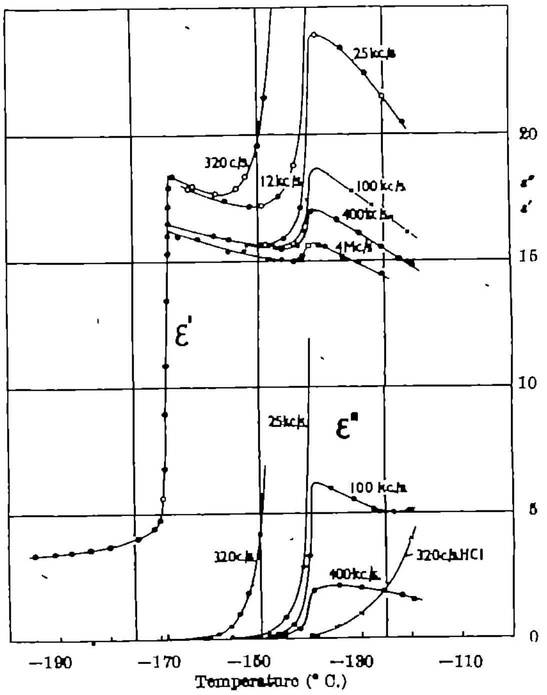
Dielectric Properties of a Sample of Deuterium Chloride containing an Impurity

Following a fairly extensive study of the dielectric properties of solid hydrogen chloride in this Laboratory[1], it was proposed to investigate the deuterated form. While hydrogen chloride was prepared by action of strong sulphuric acid on sodium chloride, deuterium chloride was obtained by dropping heavy water on thionyl chloride, the other product of the reaction being sulphur dioxide.



The first sample of deuterium chloride studied showed anomalous properties when compared with hydrogen chloride, due evidently to the presence of an impurity. The variation of ε' and ε'' with temperature for this sample are shown in the accompanying graph. As can be seen, the impurity causes a further transition point of first order to appear at − 140·5° C., that is, some 28° higher than the transition point corresponding to pure deuterium chloride, which, judging by the steepness of the rise in ε' and the value of the transition temperature itself (− 168·5° C.) does not appear to be affected by the presence of the impurity. Repeated distillation progressively reduced the magnitude of the effect, without noticeably changing the temperature of either transition. The effect decreases with increasing frequency, so that it is scarcely observable at 4 Mc./s. A twenty- to thirty-fold increase in the D.C. conductivity was also observed at the higher transition.

The properties of solid sulphur dioxide have not been previously investigated. As it was suspected that this substance was in fact the impurity, ε' and ε'' were measured at various frequencies between 80 c./s. and 6 Mc./s. over a temperature range from − 195° C. to its melting-point (− 10·0° C.). However, sulphur dioxide does not show any dispersion or transition effect in this frequency- and temperature-range.

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Nature of the Transition in Carbon Tetrabromide

MANY transitions in solids have in the past been regarded as being due to, or accompanied by, the onset of ionic or molecular rotation. There is, however, little convincing evidence that ions or molecules can rotate *freely* in crystal lattices. The balance of available data is against this interpretation of transitions, though it is clear from studies of the dielectric constant that, at many transitions in molecular solids with polar molecules, the molecules acquire much greater orientational freedom on passing into the high-temperature form.

In principle, information about the molecular or ionic motion can be obtained from the values of c_v, which can be derived from experimental measurements of c_p, the coefficient of expansion (α), and the isothermal compressibility (β), using the well-known formula $c_p - c_v = T\alpha^2 V/\beta$. This method has been applied to the transition (λ-point) in ammonium chloride by Lawson[1]. By combining his measurements of β with existing values of c_p and α, he showed that, above the transition, c_v is sufficiently near $9R$ cal./mole to enable one to say with certainty that the ammonium ions do not, in fact, rotate above the λ-point, but rather continue to undergo torsional oscillations in three degrees of freedom which are approximately simple harmonic. This conclusion has since been confirmed in other ways[2,3].

We have applied this method to the first-order transition in carbon tetrabromide at 46·9° C. This transition gives rise to a much more symmetrical high-temperature form and is accompanied by a considerable increase of entropy. A number of transitions in solids composed of molecules of high symmetry are probably similar in these respects. It is therefore of interest that our results definitely show that the carbon tetrabromide molecules do not rotate freely in the high-temperature form.

The isothermal compressibility β was measured directly at three temperatures by applying pressures between 15 and 50 atmospheres, which are sufficiently low for the figures so obtained to be regarded as the limiting values at one atmosphere. We have also determined c_p above and below the transition and the heat of transition (using an adiabatic calorimeter), and α. From the values of c_v calculated from these results, we have deducted $c_{v(\text{int})}$, the contribution from the intramolecular vibrations, to give $c_{v(\text{res})}$, the contribution from the lattice vibrations and the torsional oscillations or rotation of the molecules. The results are summarized in Table 1, v is the specific volume.

Table 1

t (° C.)	v	$\alpha\times10^5$	$\beta\times10^6$ atm.$^{-1}$	c_p	c_v	$c_{v(\text{int})}$	$c_{v(\text{res})}$
0	0·2836	3·61	24·5	28·25	24·95	13 23	11 7
37·7	0·2882	5·05	29·9	31·70	25·55	14·05	11·5
55·8	0 3119	5·82	38·7	33 0	25·8	14·33	11·5

It is difficult to assess the uncertainty in the values of $c_{v(\text{res})}$ arising from the accumulation of experimental errors in the quantities used in calculating them, but it should not exceed ± 0·5 cal./mole. Since at the temperatures concerned the contribution to $c_{v(\text{res})}$ from the lattice vibrations must be very nearly $3R$ cal./mole, the figures definitely exclude free molecular rotation in the high-temperature form, which would require $c_{v(\text{res})}$ to be $9/2\ R$ cal./mole. On the other hand, the values of $c_{v(\text{res})}$ are so near $6R$ (= 11·9) cal./mole that it is probable that both above and below the transition the molecules undergo torsional oscillations in three degrees of freedom with approximately simple harmonic motion. From calculations of the thermodynamic properties of restricted rotators, our results could also mean that the rotation of the molecules is impeded by a barrier of such a height that in the temperature-range studied the contribution to $c_{v(\text{res})}$ from the torsional oscillations has roughly the maximum possible value. It would be interesting to know how $c_{v(\text{res})}$ changes as the temperature is further increased; but unfortunately the range between the transition point and the melting point is only about 40°. But in any event the conclusions that the molecules do not rotate *freely* in the high-temperature form, and that there is essentially no change at the transition point in the type of motion they undergo, seem inescapable.

The figure we have obtained for the heat of transition is rather different from that reported by Frederick and Hildebrand[4]; but it gives a value for the entropy of transition which is almost the same as that for the transition in carbon tetrachloride. In Table 2 are given values for the entropies of transition and fusion, and also the ratio T_{tr}/T_m (that is, of the transition temperature to the melting point) for carbon tetrafluoride, tetrachloride, and tetrabromide. The close similarity between the figures for the three substances strongly suggests that the nature of the transitions in them is the same, and that the conclusions we have reached about the tetrabromide are true also of the tetrafluoride and tetrachloride. A further similarity between the three transitions is that at none of them is there a significant change in the heat capacity at constant *pressure*.

Table 2

	CF_4	CCl_4	CBr_4
T_{tr}/T_m	0·852	0·901	0·881
ΔS_{trans}	4·64	4·86	4·98
ΔS_{fusion}	1·87	2·40	2·60

Finally, we may add that we have also measured the coefficient of expansion and compressibility of ammonium chloride above and below the λ-point (— 30·5°). Our results lead to values of c_v of 18·5 cal./mole at — 44·55°, and 18·7 cal./mole at — 19·31° and 0°. These figures fit in very well with those reported by Lawson[1], and confirm the conclusion he reached about the nature of the transition in this substance.

A full account of this work will be published elsewhere.

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Solid Phase Determinations in the System Aluminium Sulphate/Sulphuric Acid/Water using Tracer Technique

In the system aluminium sulphate/sulphuric acid/water, the solid phase in the range 50–60 per cent sulphuric acid has been reported to be either $Al_2(SO_4)_3.9H_2O$ [1,2] or $Al_2(SO_4)_3.10H_2O$ [3] at temperatures between 20° and 60°, the composition of this solid being deduced by the Schreinemakers[4] method of tie-line convergence. However, in view of (a) the high molecular weight of aluminium sulphate compared with sulphuric acid and water, (b) the relative position in the equilateral triangle of the solubility curve, (c) inaccuracy in the position of the solution and moist solid points owing to the well-known difficulty of determining sulphuric acid in presence of aluminium sulphate, the published tie-lines show equally good convergence at points representing the 8, 9 or 10 hydrates or the 1 : 1 acid sulphate with eleven to thirteen molecules of water of crystallization.

This and similar cases[5] of ambiguity may be resolved by adding to the solubility mixture a suitable indicator substance which remains throughout in the liquid phase. Provided this indicator does not significantly alter the phase equilibrium and can be determined accurately in trace quantities, then the composition of the moist solid phase can be corrected for the contaminating liquid phase. Radioactive cæsium sulphate has been found to fulfil these severe conditions very well: only 0·05 c.c. of 0·045 per cent aqueous solution of approximately 15 μC. activity was required in a 50-gm. solubility mixture. This was not added until after the ternary mixture had been brought to equilibrium at 30° to avoid any co-precipitation of the tracer with the solid phase. The saturated solution and moist solid phase after convenient dilution were analysed for aluminium by precipitation with 8-hydroxyquinoline, for sulphuric acid by an accurate titration procedure, while counts were carried out in Type *M*6 Geiger–Muller liquid counters. Self-absorption errors were negligible because the counted solutions, after dilution with an equal volume of water, gave exactly half the original count. The solid phase was shown in this way to have the composition 51·4 per cent $Al_2(SO_4)_3$, 15·9 per cent H_2SO_4, 32·7 per cent H_2O, and must therefore be $Al_2(SO_4)_3.H_2SO_4.12H_2O$. This composition has been confirmed by using trace quantities of manganous sulphate as indicator, the manganese being determined colorimetrically as permanganate. The composition in this case was 51·5/15·1/33·4. It is surprising that this acid sulphate can be isolated in the pure state by simple filtration and thorough washing with 'Analar' acetone under anhydrous conditions, the composition of the dry 50° product being 51·4/15·1/33·5.

Other acid sulphates of composition 1/1/8 (two forms) and 1/1/2 have been encountered in this system, and full details will be published shortly elsewhere in collaboration with Prof. H. Bassett.

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Electrical Conductivity and Magnetic Susceptibility of Ovalene

Ovalene ($C_{32}H_{14}$) has the most compact configuration of rings among the condensed aromatic compounds which have so far been obtained. From this point of view, it is of interest to know the electrical and magnetic properties to be attributed to the π-electrons of this molecule.

Ovalene was synthesized by the method of Clar[1] with modifications, and purified by repeated sublimation *in vacuo*. The measurement of the electrical conductivity as well as the magnetic susceptibility was carried out with a powder specimen. The electrical conductivity σ can be expressed as $\sigma = \sigma_0 \exp(-\Delta\epsilon/2kT)$, in the same manner as for the other condensed aromatic compounds[2]. The values of σ at 15° C. and Δε were found to be $4 \cdot 4 \times 10^{-16}$ ohm^{-1}.-cm.$^{-1}$ and 1·13 eV. respectively. The electrical conductivity of ovalene is less than that of violanthrone or *iso*violanthrone which were reported in the previous paper. In a series of measurements on a number of the condensed aromatic compounds, we have found that the electrical conductivity depends mainly on the number of π-electrons alone, and not on the configuration of the rings. On the other hand, the magnetic susceptibility is largely influenced by the shape of the molecule.

Molecular susceptibility was found to be $\chi_M = -(353 \cdot 8 \pm 2 \cdot 8) \times 10^{-6}$, by Gouy's method. $\chi_M = \frac{1}{3}(K_1 + K_2 + K_3)$ can be assumed, where K_1 and K_2 are the molecular susceptibilities along two directions in the plane of the rings and K_3 is that perpendicular to the plane. It can also be assumed that $K_1 = K_2 = \Sigma\chi(C=) + \Sigma\chi(H)$, and calculated from Pascal's constants on the basis of spherical symmetry. H. Shiba and G. Hazato[3] have shown that it is a good approximation to put $\chi(C=) = \chi(C) + \frac{1}{4}\lambda($diethylene linkage) = $-3{\cdot}36 \times 10^{-6}$, for this purpose. From these assumptions, the magnetic anistropy $\Delta K = K_3 - K_1$ was found to be $-615{\cdot}9 \times 10^{-6}$ for ovalene. This is a very high value. The contribution of each π-electron to the magnetic anisotropy can be expressed, conventionally, by the classical theory, $\Delta K = -(Ne^2/4mc^2)\sum_{\pi}\bar{r}^2$, where $\bar{r}$ is the mean radius of a circular orbit of a π-electron. For ovalene, $\bar{r}$ is calculated to be 2·12 A. This is also a high value, when it is remembered that $\bar{r}$ is 1·44 A. for benzene, 1·57 A. for naphthalene, 1·63 A. for anthracene and 1·86 A. for pyrene, where these values were calculated by the same method as for ovalene from specific susceptibility data in the literature, which do not differ seriously from the values obtained with single crystals[4].

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Physical Basis of Internal Calorimetry

THE technique of 'internal calorimetry', a development of Gibbs's 'heated thermocouple' method[1], was devised for the measurement of blood flow in living tissues. The instrument consists of a small constantan filament connected to a source of electrical potential, variable at will. An attached thermocouple records the filament temperature. The energy required to maintain thermal equilibrium with the instrument embedded in the experimental material is recorded electrically. Its relation to blood flow has already been described[2]; our present concern, however, is with the non-circulatory heat losses from the filament.

With a recorder embedded in a gel—5 per cent gelatine in water—and heated 1° C. above ambient temperature, temperatures were measured thermoelectrically along a line perpendicular to the filament and also back along the leads. Temperatures were less than 0·01° C. in excess of the ambient temperature at a point in the gel 5 mm. from the filament and at a point on the wire distant 1 cm. from the filament.

It can be shown mathematically[3] that, with an electrically heated spherical source of heat in an infinite mass of material, a steady state is approached in which the relation between heat production and heat loss is represented by the equation:

$$I^2R = 4K.\pi.r\theta$$

(where K is thermal conductivity of the substance, r is radius of sphere, θ is temperature elevation of sphere, I is heating current and R is heating filament resistance). Where θ, r and R are fixed, I^2/K is thus constant.

That a similar relation may be applied to the present work was demonstrated using a standard instrument to record in air, chloroform, 'Vaseline', glycerine, water and mercury. Temperature was carefully controlled and convection errors eliminated by methods similar to those of Read and Lloyd[4]. In each case, the value of I^2 for $\theta = 1°$ C. was determined. Taking the values of K as given in the "International Critical Tables", the value of I^2/K was obtained for each substance and found to be virtually constant at $14{\cdot}0 \times 10^4$ (± 1 per cent). This ceased to be true if the depth of insertion or the bulk of fluid was not sufficient. The limits determined in 5 per cent gelatine, however, were 1 cm. depth of insertion and 5 mm. of substance surrounding the thermocouple.

It was thus shown, under these experimental conditions, that with θ constant, $I^2R \propto K$. In further experiments where K was constant, the relation between θ and I^2R was investigated and found to be linear except when θ was so large that the limiting conditions were exceeded.

These findings facilitate the standardization of blood-flow recorders in a manner to be described elsewhere. Moreover, they show that the method of 'internal calorimetry' may be used as a simple, quick means of measuring thermal conductivities, particularly in animal tissues.

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Effect of Tension on Water Absorption by Hair

IT seems to be generally assumed that the application of tensile stress to a textile fibre should *reduce* the amount of absorbed water in equilibrium with water vapour in the atmosphere at a given value of the relative humidity[1]. This assumption would appear to be substantiated by the recent work of White and Stam[2] on human hair, in which a substantially reversible reduction of water content amounting to 50 per cent was found to occur on the application of a tensile stress of approximately 120 kgm./cm.[2].

On the other hand, for vulcanized rubber swollen in organic solvents, the equilibrium solvent concentration is *increased* by tensile stresses and reduced by compressive stresses[3]. This result is well established experimentally, and is in quantitative agreement with the statistical theory of the swollen molecular network[4,5].

In view of the opposite nature of these reported effects for fibres and for rubber, for which no immediate explanation is apparent, it seemed worth while to re-examine the question of the absorption of water by fibres under stress.

A general theory of the phenomenon may be derived by a simple extension of the usual thermodynamic treatment of swelling pressures. From such a theory Barkas[6] has obtained a relation which, in the case of a simple tensile stress, may be written:

$$s_X\,dX = -v\,dp, \qquad (1)$$

where s_X is the fractional increment of length in the direction of the stress X due to the absorption of 1 gm. of liquid, and v is the specific volume of the vapour at the pressure p. This equation relates the change dp in vapour pressure at equilibrium to the change dX in the stress; the corresponding change in water content, at constant vapour pressure, is then readily obtained from the vapour-pressure isotherm. It is seen from (1) that if s_X is positive, that is, if liquid absorption is accompanied by an increase of length in the direction of the stress, then dp is negative. This means that the vapour pressure (at constant liquid content) is lowered, so that at constant vapour pressure the liquid absorption is increased. This result should certainly apply in the case of hair, for which s_X is known to be positive.

In White and Stam's work the water content was determined indirectly from the measured dimensional changes of the fibre. I have repeated their experiments, using horsehair, which on account of its larger diameter permitted the water absorption to be determined more directly by weighing. Eight hairs, having a total length of 3·6 metres, were stretched by means of springs on a frame which was suspended from the arm of a balance in a temperature- and humidity-controlled vessel, the temperature being 24·0° C. and the relative humidity 75·5 per cent. The procedure was to weigh the assembly with the stress alternately applied and removed, time being allowed after each change for the attainment of equilibrium. The results are given below, each figure being the mean of four or five readings.

Tension per single hair (gm.)	Tension per single hair (kgm./cm.^{2})	Total wt. of hair (gm.)	Wt increase on stressing (% of dry weight)
149	460	0 1519$_0$	0 38
0	0	0 1514$_1$	
82	250	0·1515$_5$	0·17
0	0	0 1513$_0$	

The change in water content on applying the stress, though small, was consistent and reproducible. It was in the opposite direction to that found by White and Stam. To within the experimental error, the effect was proportional to the stress, the weight increments being in the ratio 2·2 to 1 for stresses in the ratio 1·8 to 1.

An estimate of the theoretical increment of water absorption may be made by using White and Stam's data for the longitudinal swelling. For 75 per cent relative humidity, the value obtained for s_X is 0·028 cm./gm. For a stress increase of 460 kgm./cm.^{2}, equation (1) then gives a change in relative vapour pressure (dp/p_0) of 0·0069. From Chamberlain and Speakman's vapour pressure curve[7], the corresponding change in water content (referred to the dry weight) is 0·23 per cent, compared with the experimental figure of 0·38 per cent. While the quantitative significance of this comparison is questionable, in view of the experimental uncertainty, there seems no doubt that the theory gives a satisfactory interpretation of the phenomenon, at least in order of magnitude.

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Ultrasonic Velocity in Potassium Chloride Solutions in the Region of their Negative Viscosities

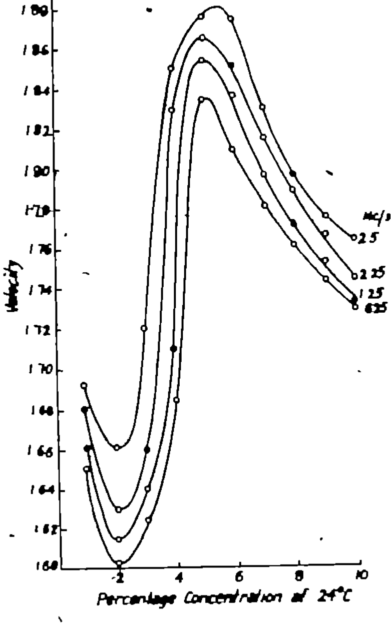
IT was observed by Poiseuille[1], Hubener[2], Sprung[3], Slotte[4] and others, that when substances like ammonium iodide, potassium chloride, etc., are dissolved in water, the viscosity of water is lowered. This phenomenon has since been known as 'negative viscosity'. The compressibility of aqueous solutions of electrolytes has been studied by Gibson[5], Falkenhagen and Bachem[6], Szalay[7] and others, and they have derived expressions for the relationship between the concentration of electrolyte solutions and their compressibilities. The existing data show that the compressibility continuously decreases as the concentration of electrolytes is increased. But these observations are confined to the positive region of viscosity. In the present communication we record our observations on the ultrasonic velocity in potassium chloride at low concentrations at 24°. The ultrasonic energy was obtained from a quartz disk and was converted into electrical energy by a similar quartz crystal for detection. The apparatus has been described elsewhere[8]. The slab can be rotated, resulting in a variation in the amplitude of the transmitted energy as recorded on the oscillograph screen. The minimum in the energy is due to the total reflexion of the transmitted energy, as the angle of refraction in the solid is greater than that of incidence. The refractive index at the discontinuity is:

$$n = \sin \theta_l / \sin \theta_s = V_l / V_s,$$

where θ_l and θ_s are the angles that the wave-train makes with the normal in the solid and the liquid respectively. V_s is the velocity in the solid, which can be determined in advance by using a liquid with known velocity. At total reflexion of the waves, due to the rotation of the slab,

$$V_\theta = V_s \sin \theta_l, \quad \text{since } \theta_s = 90°.$$

A knowledge of θ enables us to determine the velocity in the liquid.



The velocity has been determined for four frequencies, as outlined in the accompanying table.

ULTRASONIC VELOCITIES OF POTASSIUM CHLORIDE SOLUTIONS AT 24° C

Percentage of potass. chloride	2·5 Mc./s.		2·25 Mc./s.		1·25 Mc./s.		0·625 Mc./s.	
	θ_t	V_t	θ_t	V_t	θ_t	V_t	θ_t	V_t
1	57·0°	1·692	57·2°	1·680	56·1°	1·660	55·6°	1·650
2	57·1°	1·659	54·6°	1·629	53·8°	1·615	53·2°	1·602
3	59·4°	1·720	56·1°	1·660	55·1°	1·640	54·3°	1·625
4	57·4°	1·684	58·8°	1·710	66·2°	1·830	67·7°	1·849
5	69·7°	1·876	68·9°	1·866	67·9°	1·853	66·5°	1·834
6	69·6°	1·875	67·7°	1·850	66·7°	1·836	64·7°	1·808
7	66·2°	1·830	65·1°	1·814	63·9°	1·796	62·9°	1·780
8	63·9°	1·795	63·4°	1·788	62·4°	1·772	61·7°	1·760
9	62·7°	1·776	62·1°	1·768	61·3°	1·754	60·7°	1·744
10	61·8°	1·763	60·7°	1·744	60·0°	1·732	59·7°	1·726

It will be seen from the results in the table and from the graph that the ultrasonic velocities show anomalous behaviour in the region of negative viscosity (1–6 per cent solution); hence, it may be useful to correlate the ultrasonic velocity data, or in other words the compressibility data, of electrolyte solutions with the negative viscosity.

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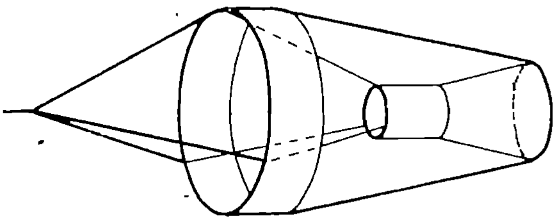
A High-speed Tow-net

IN order to investigate the changes in the distribution of young fish in the Clyde sea area it was necessary to obtain on each of a series of dates numerous samples of the population over a large area. To cover this area it was necessary for the research vessel to travel at full speed for as much as possible of the time available. This precluded the use of conventional tow-nets or trawls at set stations. Further, an apparatus like the Hardy plankton recorder would filter too small a volume of water to catch a significant number of young fish. Sheard[1] has described a net which appeared to be of the type required, in which the bucket is dispensed with and the tail of the net fliped (turned in on itself).

An ordinary plankton net was modified on this plan. The dimensions of the original net were: diameter of mouth 46 cm., calico collar 15 cm. long, silk (26 meshes per inch) 94 cm. long, bucket-sleeve 12 cm. in diameter and 17 cm. long. A metal ring was sewn into the end of the sleeve and three toggled bridles 42 cm. long attached to this ring. The tail of the net was fliped and the three toggles passed through the eye-splices of the main bridles of the net, as shown in the diagram. The bridles were shackled to a spring hank rove a fathom and a half above a cable depressor[2], on the trawl warp, and trials showed that it could be towed successfully at speeds of at least 7 knots. The general performance of the gear was found to be very satisfactory; there was no inclination to yaw and no frontal wave was observed.



By towing two such nets alternately, for four miles at a time, 5 m. below the surface, it has been possible to obtain samples continuously along the course of a 68-mile cruise. At the time of writing, each of the two nets employed has been towed for more than 160 miles without signs of undue strain. The catches which have already been obtained and analysed contained thirty-seven species, including up to 250,000 *Calanus* and 3,000 fish eggs per haul, sprats of up to 9 cm. in length and a wide variety of post-larval fish. Although more of these organisms were damaged than is usual in a normal tow-net catch, all but a few were easily identifiable, and indeed the majority of the catch was still alive when brought on board. Tests of the efficiency of the nets are in hand, and preliminary results indicate that their catching power is closely comparable with that of a tow-net of conventional design. Nets of various diameters and mesh sizes are also being tested, and the possibility of fishing at greater depths investigated.

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Beet Yellows Virus

SEVERAL plant viruses have been found to occur as elongated particles of variable length and 10–15 mμ in width. Leyon[1] has published electron micrographs showing such rod-like particles with a width of about 10 mμ in sap from plants infected with beet yellows virus and in the specific precipitates produced by mixing the sap with its antiserum. We have also found rods in these two kinds of preparation. They do not occur in sap from healthy beet plants, and by analogy with other viruses which have been purified it could readily be assumed that the rods are the virus particles themselves. There are, however, other factors which make this assumption less tenable and suggest that the rods are not the only anomalous component in sap from infected plants.

With the appropriate antiserum, clarified sap from sugar beet plants infected with beet yellows virus gives specific precipitates that appear to be of the somatic type. Their precise character is difficult to determine when working with unfractionated material; but the general behaviour in precipitin tests resembles that of viruses with spherical rather than rod-shaped particles. Precipitates are obtained up to dilutions of 1/64, which by analogy with bushy stunt virus would suggest a specific antigen of concentration about 100 mgm./l.[2,3]. By contrast, only a few rod-like particles can be seen in electron microscope mounts made from clarified sap; and although the concentration cannot be determined accurately, it seems unlikely that it exceeds 1 mgm./l.[3]. It appears, therefore, that the rods can only amount to a small proportion of the specific antigen.

Further evidence for this view has been given by experiments on the effect of freezing sap from infected plants. Freezing had no detectable effect on the precipitin titre with antiserum; but after this treatment no rod-shaped particles have been found, either in clarified sap or in resuspended antiserum precipitates.

The evidence suggests that sap from infected plants contains at least two kinds of specific particles. One of these is the rod which can be seen with the electron microscope. The other probably occurs in much higher concentration; its size and shape are so far unknown; but the character of the precipitin reaction suggests that it may be spherical. Clarified sap from healthy sugar beet plants contains large quantities of spherical particles resolvable with the electron microscope[3], and it may be that the second antigen component resembles these. Alternatively, it may have particles too small to be resolved in existing electron microscopes.

The relationship between the components is unknown. Possibly the rods are an alternative form of the spherical particles, a phenomenon known with some other viruses, or perhaps the two components are quite distinct, one being the infective particle and the other a product of the disease.

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A Rare Alga from Stonehenge

During a brief stay in England last year, towards the end of June a visit was paid to Stonehenge. It was noticed that several small holes in one of the fallen stones near the centre of the Circle contained green-coloured water, and since I am particularly interested in the flora of such small rain-water pools, permission to take samples was sought and readily granted. Water was spooned up, concentrated in a small freshwater plankton collecting net, and small quantities of the concentrate transferred to comparatively large jars. The following evening, on reaching my headquarters in Cheltenham, the samples were examined and most surprisingly proved to be very rich, active and nearly pure unialgal growths of *Hæmatococcus drœbakensis* Wollenweber[1]. I believed then that this alga was known only from pools in granite on a small island near Drobak in Norway; I have learnt since that there is one doubtful record from Wales.

This pretty little alga is most distinctive, bright green, with two pyrenoids placed symmetrically at opposite poles of the protoplast, across the centre of which is a clear, colourless zone; when grown in a rich nutrient solution, however, the latter is more or less completely obliterated by the extension of the chloroplast, while the whole protoplast becomes densely granular and much darker in colour.

Unlike the ubiquitous *Hæmatococcus lacustris*, in which reproduction is in general exclusively asexual, *H. drœbakensis* after a period of similar active asexual reproduction regularly enters a sexual phase, producing isogametes which on liberation conjugate to form zygotes. The whole process can be completed on agar and the resultant zygospores kept for months—at the time of writing I have a fresh series of active cultures raised from zygospores formed on agar last November. The alga is easily grown in culture, a rich growth being obtainable from the resting spores in a few days, and should prove invaluable to teachers of botany and biology as an example of a unicellular alga, for the study of both structure and behaviour and of reproduction by asexual and sexual methods.

Material was sent to Dr. E. F. Pringsheim, and I understand that *Hæmatococcus drœbakensis* has now been added to the collection of pure cultures of algæ maintained by him in the Botany School at Cambridge.

M. A. Pocock

Botany Department,
University of Cape Town,
May 5.

[1] Wollenweber, W., *Ber. der deutsch. bot. Gesell.*, **25**, 316 (1907); **26**, 238 (1908).

Changes in the Colour Sensitivity of the Eye with Posture

I refer to J. N. Aldington's letter in the issue of *Nature* of July 14.

My attention was directed to apparent change of colour sensitivity of the eye with its position by my sister—an artist. She pointed out to me that if the head were held sidewise, that is, with the line joining the eyes vertical instead of horizontal, all colours in a landscape appeared to be intensified. She was in the habit of using this aid in the course of her work.

On trying the method myself, I also noticed an intensification, and more particularly in the blue of a haze in the distance.

It may, of course, be the case that there is, in fact, no greater colour receptivity in the eye in this position, but that the attention is not so much distracted by form and detail in such circumstances and so colour gets a larger share of attention than it otherwise would have. The landscape certainly seemed more vague when viewed in this position.

The effects mentioned by Dr. J. N. Aldington in *Nature* of July 14, p. 86, and that described above are probably connected.

A. Blackie

Khandala Hotel,
Blackheath,
London, S.E.3.
July 19.

I was introduced some years ago, by a friend who lives in Cornwall, to a way of looking at the landscape by leaning as far to one side as possible. In this position after a short while the view takes on a much sharper impression, particularly hills and trees against the sky which appear to be seen in much greater detail.

The observation of J. N. Aldington (*Nature*, July 14, p. 86) that the colour sensitivity of the eyes differs when the two eyes are in different horizontal planes suggests a possible explanation of this phenomenon.

F. Taylor

Penwith,
The Close, Wilmington,
Dartford, Kent.
July 27.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Tuesday, September 25—Thursday, September 27

DUBLIN INSTITUTE FOR ADVANCED STUDIES (in the School of Cosmic Physics, 5 Merrion Square, Dublin).—Colloquium on "Recent Advances in the Study of Cosmic Radiation".

Wednesday, September 26

PHYSICAL SOCIETY, COLOUR GROUP (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Mr. H. G. W. Harding: Demonstration of a Visual and a Photoelectric Portable Colour Temperature Meter; Report on the Decisions reached, on matters of interest to the Colour Group, at the Stockholm Meeting of the Commission Internationale de l'Eclairage.

Wednesday, September 26—Friday, September 28

NATIONAL SMOKE ABATEMENT SOCIETY (at the Winter Gardens, Blackpool).—Eighteenth Annual Conference.

Thursday, September 27

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. W. B. Roantree: "Work in High Air Temperatures in a Fire in Mysore Mine, Kolar Gold Field".

Thursday, September 27—Friday, September 28

SOCIETY OF CHEMICAL INDUSTRY, FOOD, AGRICULTURE and FINE CHEMICALS GROUPS (at the Wellcome Research Institution, 183–193 Euston Road, London, N.W.1), at 10.30 a.m. each day.—Conference on "Problems Arising from the Use of Chemicals in Food".

Friday, September 28

HOSPITAL PHYSICISTS' ASSOCIATION (in the Lecture Room, Department of Anatomy, The University, Downing Street, Cambridge), at 8.15 p.m.—Dr. L. H. Gray: "Actions of Radiations on Living Cells—1946 and After" (Second Douglas Lea Memorial Lecture).*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

AREA SUPERVISOR (with a degree in science or the N.D.D. or N.D.D.H.) at Beverley, Halifax, Reading and Starcross, and an ASSISTANT AREA SUPERVISOR (with a degree in science or the N.D.D. or N.D.D.H.) at Newcastle-under-Lyme and Nottingham, in the National Milk Testing Service—The Secretary, Ministry of Agriculture and Fisheries, Room 406, 23–25 Soho Square, London, W.1 (September 29).

BIOCHEMIST FOR BIOCHEMICAL DEPARTMENT of the Group Laboratory—The Secretary, Stepney Group Hospital Management Committee, Raine Street, London, E.1 (September 29).

LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY at the Rutherford College of Technology—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 1 (September 29).

LECTURER TO TEACH PHYSICS to degree standard, and an ASSISTANT (Grade A) TO TEACH ELEMENTARY PHYSICS up to the standard of the General Certificate of Education (Advanced Level)—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (September 29).

PHYSICAL CHEMIST IN THE RESEARCH BRANCH, Chief Engineer's Department, London, to work in a small team engaged in research on the corrosion of steel at boiler pressures—The Secretary's Office (Establishments), Applications Section, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting AE/199 (September 29).

SENIOR EXPERIMENTAL OFFICERS, EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS at Admiralty experimental establishments in the vicinity of London, Baldock, Greenock, Haslemere, Portsmouth, Rosyth and Weymouth: MECHANICAL ENGINEERS (Ref. C.632/50A) with research and development experience in light mechanisms, ELECTRICAL ENGINEERS (Ref. D.368/50A) with experience in telecommunications, radar, electronics or light electrical mechanisms, and PHYSICISTS (Ref. A.335/50A) interested in general physical problems, electronics or acoustics—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 29).

SENIOR LECTURER IN EXPERIMENTAL PHARMACOLOGY—The Secretary of University Court, The University, Glasgow (September 29).

SENIOR LECTURER or LECTURER IN MATHEMATICS at Gordon Memorial College, Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 29).

LECTURER IN NUTRITION at the University of Otago (School of Home Science), New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

ASSISTANT EXPERIMENTAL OFFICERS (including BIOLOGISTS) in various Government Departments and divided between (*a*) mathematical and physical sciences, (*b*) chemistry and metallurgy, (*c*) engineering subjects, and (*d*) miscellaneous (including, for example, geology, library and technical information services)—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3068 (October 1).

PLANT PATHOLOGIST to assist in the subediting and making of abstracts—The Director, Commonwealth Mycological Institute, Ferry Lane, Kew, Surrey (October 1).

PROFESSIONAL ENGINEERS (general service class, main and senior grades) in Government Departments (at present in the Admiralty and in the Prison Commission)—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Street, London, W.1, quoting No. S 86/51 (October 1).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics, and knowledge of electro-acoustics and electronics with experience in the planning of research) at the R.A.F. Acoustics Laboratory—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.1063/51 (October 4).

PROFESSOR OF VETERINARY MEDICINE, PHARMACOLOGY AND MEAT INSPECTION at the Veterinary College, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (October 5).

SCIENTIST, Grade III (with an honours degree in either geology or botany) IN THE COAL SURVEY LABORATORY at Sheffield for work on the palæobotany of coal and the correlation of seams—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/374 (October 13).

SCIENTISTS, Grade III (with honours degree in chemistry), IN THE COAL SURVEY LABORATORIES at Chester and Newcastle-upon-Tyne—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/376 (October 13).

SENIOR RESEARCH OFFICERS (2) IN THE SECTION OF METEOROLOGICAL PHYSICS, Highett, Victoria (one officer will engage in studies of the general circulation of the atmosphere, the other in problems of a dynamic-synoptic nature)—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3564 (October 13).

SENIOR MARKETING OFFICER (with a university degree in horticulture or agriculture, and wide experience of commercial methods of marketing horticultural or agricultural produce, including livestock)—The Secretary, Department of Agriculture for Scotland (Room 266), St. Andrew's House, Edinburgh 1 (October 15).

ELECTRICAL INSPECTOR OF MINES AND QUARRIES—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4075/51 (October 25).

LECTURER (with a degree in biochemistry and/or organic chemistry, and experience in the analysis of foods, including dairy products) IN AGRICULTURAL BIOCHEMISTRY (Dairy Chemistry) at the Massey Agricultural College, Palmerston North, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

CHAIR OF PHYSICAL CHEMISTRY in the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 12).

ASSISTANT EXPERIMENTAL OFFICER (with degree or diploma in agriculture, and practical knowledge of general farming) with aptitude for clear and concise self-expression in writing, and an ASSISTANT (Scientific), with practical farming experience and experience of handling machines in the field—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds.

BIOLOGIST (with good honours degree) for radio-biological research laboratory—The Secretary, South Manchester Hospital Management Committee, Christie Hospital and Holt Radium Institute, Manchester 20.

CHEMICAL ENGINEERS (Principal Scientific Officer grade) at a Ministry of Supply research and development establishment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.651/51A.

CHEMIST mainly for research analytical work—The Director of Research, Research Council of the British Whiting Federation, 245 Ampthill Road, Bedford.

CHEMISTS (Principal Scientific Officer grade) at a Ministry of Supply research and development establishment near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.640/51A.

CHEMIST (Ref. K2) to look after certain aspects of field trials work and to carry out research connected with it, two SCIENTISTS (Ref. K5–K6) to assist in planning of field trials, preparation of reports, and interpretation of data; some knowledge of mathematics required, and a MATHEMATICIAN (Ref. K7) to carry out statistical analysis, experience in probit analysis preferred, for a Research and Field Testing programme of the Defence Research Board—The Chief Superintendent, Suffield Experimental Station, Ralston, Alberta, Canada, quoting the appropriate Ref. No.

CHIEF TECHNICAL ENGINEER to take charge of an engineering section responsible for all the major calculations involved in the design and construction of factories for producing fissile material—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

CIVIL ENGINEERS, SANITARY ENGINEERS and STRUCTURAL ENGINEERS in a number of Departments in England and Scotland—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting 3405.LA (December 31).

DEMONSTRATOR IN PHARMACEUTICS—The Registrar, The University, Nottingham.

DEPUTY CHIEF ENGINEER for the Central Electrification Scheme in Cyprus—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.28858.B.

MATHEMATICIAN (with Ph.D. degree in mathematics, or equivalent), to be responsible for mathematical research of a semi-theoretical nature and to act as a consultant to members of a research group—The Director of Research Personnel, Defence Research Board, Department of National Defence, 'A' Building, Ottawa, Canada, quoting No. II-12.

PHYSICIST or PHYSICAL CHEMIST for work on fundamental problems associated with the hardening of Portland cement—The Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1.

PROFESSOR AND HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING (Heavy), Indian Institute of Technology, Kharagpur, B.N.Ry., India—The Ministry of Labour and National Service, Technical and Scientific Register (A.8.12), York House, Kingsway, London, W.C.2, quoting A.12/UNE/150/51.

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS (posts are in various Government Departments covering a wide range of scientific research and development in most of the major fields of fundamental and applied science)—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3599.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

General Register Office. Studies on Medical and Population Subjects, No. 4: Hospital Morbidity Statistics, a Preliminary Study of In-Patient Discharges. By Dr. Donald Mackay. Pp. 114. (London: H.M. Stationery Office, 1951.) 3s. net. [197

Memoirs of the Geological Survey of Great Britain. The Mesozoic Ironstones of England: The Northampton Sand Ironstone; Stratigraphy, Structure and Reserves. By Dr. S. H. Hollingworth and Dr. J. H. Taylor, with contributions by Dr. W. D. Evans, G. A. Kellaway, Dr. F. B. A. Welch, Dr. Vernon Wilson and Dr. A. W. Woodland. Pp. viii+211+6 plates. (London: H.M. Stationery Office, 1951.) 17s. 6d. net. [237

Annual Report of the British Welding Research Association, 1950–51. Pp. 40. (London: British Welding Research Association, 1951.) [247

British Standard 1715: 1951, Methods for the Analysis of Soaps. Pp. 42. (London: British Standards Institution, 1951.) 5s. net. [247

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 869, Vol. 243: On the Geometry of Numbers of Non-Convex Star-Regions with Hexagonal Symmetry. By R. P. Bambah. Pp. 431–462. 7s. 6d. No. 870, Vol. 243 A Study of the Reactions that lead to 'knock' in the Spark-Ignition Engine. By D. Downs, A. D. Walsh and R. W. Wheeler. Pp. 463–524. 17s. (London: Cambridge University Press, 1951.) [247

Forestry Commission. Britain's Forests—Cannock Chase. Pp. 16. 9d. net. Guide to the National Pinetum and Forest Plots at Bedgebury. Pp. iv+66+8 plates. 2s. 6d. net. Thirty-first Annual Report of the Forestry Commissioners for the Year ending September 30th, 1950. Pp. 75. 2s. 6d. net. (London: H.M. Stationery Office, 1951.) [247

Fitzwilliam Museum, Cambridge. Annual Report for the Year ending 31 December 1950. Pp. 10+4 plates. Friends of the Fitzwilliam Museum. Forty-second Annual Report for the Year 1950. Pp. 8. (Cambridge: Fitzwilliam Museum, 1951.) [247

Report of the Second Conference of Industrial Research Directors and Managers: the Planning and Financial Control of Industrial Research. Organized by the F.B.I. Industrial Research Committee and held at Ashorne Hill, Leamington Spa, 10 to 12 November 1950. Pp. 88. (London: Federation of British Industries, 1951.) 3s. [247

Department of Scientific and Industrial Research: Technical Information and Documents Unit. A Bibliographical Survey of the Development and Use of Substitute Materials for Non-Ferrous Metals and Alloy Steels in Germany. (Report No. RMS-2.) Pp. ii+46. (London: H.M. Stationery Office, 1951.) 1s. 6d. net. [257

Scottish Seaweed Research Association. Annual Report for 1950. Pp. 36. (Inveresk: Institute of Seaweed Research, 1951.) [257

Fourth Annual Report of the Advisory Council on Scientific Policy (1950–1951). Pp. 18. (London: H.M. Stationery Office, 1951.) 9d. net. [18

Government Scientific Organization in the Civilian Field. Pp. 47. (London: H.M. Stationery Office, 1951.) 1s 6d. net. [18

British Museum (Natural History). John Murray Expedition 1933–34. Scientific Reports, Vol. 9, No. 4. The Epibionts and Parasites of the Planktonic Copepoda of the Arabian Sea. By Lieut.-Colonel R. B. Seymour Sewell. Pp. 255–394. (London: British Museum (Natural History); 1951.) 25s. [18

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines for the Year 1950—West Midland and Southern Division. Report by H. S. S. Scott. Pp. ii+22+5 plates. (London: H.M. Stationery Office, 1951.) 1s. 6d. net. [18

World Power Conference. Annual Report 1950. Pp. 22. (London: World Power Conference, 1951.) [18

The New Race. By a Disciple of Darwin. Pp. 24. (London: William Margrie, 24 Nigel Road, S.E.15, 1951.) 2s. 6d. [18

The Industrial Use of Flash Welding, dealing in particular with Ferrous Materials. (T.27.) Pp. 81. (London: British Welding Research Association, 1951.) 2s. 6d. [18

City and County of Bristol: The City Museum. Report of the Committee for the Year ended 31 December 1950. Pp. 16+4 plates. (Bristol: City Museum, 1951.) [28

Annual Reports on the Progress of Chemistry for 1950. Vol. 47. Pp. 490. (London: Chemical Society, 1951.) 25s. [28

Other Countries

Elephas maximus, the Elephant of Ceylon. By P. E. P. Deraniyagala. Vol. 1. Pp. 48+18 plates. (Colombo: National Museum, 1951.) 60 cents; 1s. [177

Distribution of British Pharmacopoeial Drug Plants and their Substitutes Growing in India. By S. L. Nayar and I. C. Chopra. Pp. 56. (New Delhi: Council for Scientific and Industrial Research, 1951.) 1.4 rupees. [177

German Hydrographic Institute. Annual Report No. 5, 1950. Pp. 70+11 plates. (Hamburg: German Hydrographic Institute, 1951.) [177

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Série scientifique, No. 49: Observations sur les réactions du cotonnier aux conditions de milieu. Par M. Lecomte, R. de Coene et F. Corcelle. Pp. 56. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1951.) 70 francs. [177

Indo-Pacific Fisheries Council. List of Scientific and other Periodicals published in the Indo-Pacific Area. Pp. 32. (Bangkok: Indo-Pacific Fisheries Council, 1951.) [177

Southern Rhodesia. Report of the Director, Geological Survey, for the Year 1950. Pp. 6. (Salisbury: Government Printing and Stationery Office, 1951.) [177

Ontario Research Foundation. Annual Report, 1950. Pp. 24. (Toronto: Ontario Research Foundation, 1951.) [177

National Museum of Northern Rhodesia. The Rhodes-Livingstone Museum, 1934–1951. Pp. v+44. (Livingstone: Rhodes-Livingstone Museum, 1951.) 2s. [177

Cuatro conferencias sobre los Indios Fueguinos. Dictadas en la Universidad de Chile y editadas por Prof. Alejandro Lipschutz y Dra. Grete Mostny. Pp. xv+86. (Santiago: Revista Geografica de Chile, 1950.) [187

Peces de Chile: clave de determinacion de las especies importantes. Por Prof. Dr. Guillermo Mann F. Pp. 48. (Santiago: Ministerio de Agricultura, 1950.) [187

Queensland Institute of Medical Research. Fifth Annual Report, Year ended 30th June 1950. Pp. 16. (Brisbane: Queensland Institute of Medical Research, 1951.) [197

Annual Report of the Queen Victoria Museum and Art Gallery, 1949–1950. Pp. 8. (Launceston: Queen Victoria Museum and Art Gallery, 1951.) [197

Birds of Montezuma Castle and Tuzigoot National Monuments. By Henry H. Collins, Jr. Pp. ii+14. (Santa Fe, New Mexico: Southwestern Monuments Association, 1951.) 25 cents. [237

Development and Welfare in the West Indies. Bulletin No. 29: The Fisheries of British West Indies; Report on a Visit in 1949. By Dr. C. F. Hickling. Pp. 41. (Barbados: B.W.I. Development and Welfare Organization, 1950.) 20 cents. [247

Académie Royale de Belgique, Classe des Sciences. Mémoires, Tome 26, Fasc. 2: La méthode du Pentasphère oblique mobile et quelques-unes de ses applications. Par Prof. F. Backes. Pp. 87. (Bruxelles: Académie Royale de Belgique, 1951.) 80 francs. [247

Apia Observatory, Apia. Magnetic and Meteorological Results for 1948. Pp. iii+154. (Wellington, N.Z.: Government Printer, 1950.) [247

Publications of the Dominion Astrophysical Observatory. Vol. 8, No. 12: A Model Atmosphere for an Early 0-Type Star. By Anne B. Underhill. Pp. 357–384. n.p. Vol. 8, No. 13: On the Luminosity Effects of the Hydrogen Lines in 0-Type Spectra. By Anne B. Underhill. Pp. 385–400. 25 cents. Vol. 8, No. 14: Spectrographic Observations of Epsilon Ursae Minoris. By J. L. Climenhaga, A. McKellar and R. M. Petrie. Pp. 401–408. 25 cents. Vol. 9, No. 1: The Spectra of the P Cygni Stars. By C. S. Beals. Pp. 138. n.p. (Ottawa: King's Printer, 1951.) [247

International Union of Theoretical and Applied Mechanics and International Astronomical Union. Problems of Cosmical Aerodynamics: Proceedings of the Symposium on the Motion of Gaseous Masses of Cosmical Dimensions held at Paris, August 16–19, 1949. Pp. viii+237. (Dayton, Ohio: Central Air Documents Office (Army–Navy–Air Force), 1951.) [257

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Nigeria. Annual Report on the Forest Administration of Nigeria for the Year 1949–50. Pp. 72. (Enugu: Government Printer; London: Crown Agents for the Colonies, 1951.) 6d. net. [257

Suomen Geodeettisen Laitoksen Julkaisuja. No. 39: On the World Geodetic System. By W. Heiskanen. Pp. 25. No. 40: The Motions of Moon and Sun at the Solar Eclipse of 1947, May 20th. By R. A. Hirvonen. Pp. 36. (Helsinki: Finnischen Geodätischen Institutet, 1951.) [267

Instituto Nacional de la Investigacion Cientifica. Estaciones de Biologia Marina para el mejor conocimiento, explotacion y conservacion de los recursos naturales, y por ende para fomentar el progreso de las ciencias naturales mexicanas. Por Prof. J. Joaquin Izquierdo. Pp. 22. (Mexico: Editorial E.C.L.A.L., 1951.) [267

Nigeria. Annual Report on the Agricultural Department for the Year 1949–50. Pp. 92. (Kaduna: Government Printer; London: Crown Agents for the Colonies, 1951.) 9d. net. [267

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Apia Observatory, Apia. Annual Report for 1941. Pp. iv+170. (Wellington, N.Z.: Government Printer, 1950.) [18

Race and Psychology. By Prof. Otto Klineberg. (The Race Question in Modern Science Series: Publication 892.) Pp. 40. (Paris: Unesco; London: H.M. Stationery Office, 1951.) 1s. 6d. net. [18

The Roots of Prejudice. By Prof. Arnold Rose. (The Race Question in Modern Science Series: Publication 865.) Pp. 44. (Paris: Unesco; London: H.M. Stationery Office, 1951.) 1s. 6d. net. [18

United States Department of Commerce: Weather Bureau. Technical Paper No. 12: Sunshine and Cloudiness at Selected Stations in the United States, Alaska, Hawaii and Puerto Rico. Pp. iii+16. 15 cents. Technical Paper No. 15: Maximum Station Precipitation for 1, 2, 3, 6, 12 and 24 Hours. Part 1: Utah. Pp. ii+44. 25 cents. (Washington, D.C.: Government Printing Office, 1951.) [18

Chicago Natural History Museum. Report of the Director to the Board of Trustees for the Year 1950. Pp. 142. (Chicago: Chicago Natural History Museum, 1951.) 1 dollar. [18

Current Scientific Researches in Mellon Institute 1950–1951: the Thirty-eighth Annual Report of the President, E. R. Weidlein, to the Board of Trustees of the Institution, for the Fiscal Year ended February 28, 1951. Pp. iv+52. (Pittsburgh, Pa.: Mellon Institute, 1951.) [28

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 31, Part 1: The Acanthaceae of Colombia, 1. By Emery C. Leonard. Pp. vi+117. (Washington, D.C.: Government Printing Office, 1951.) 50 cents. [28

Beach Erosion Board: Corps of Engineers. Technical Memorandum No. 24: The Accuracy of Present Wave Forecasting Methods with reference to the Problems in Beach Erosion on the New Jersey and Long Island Coasts. By Willard J. Pierson, Jr. Pp. vi+76. (Washington, D.C.: Government Printing Office, 1951.) [28

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FUTURE OF PARASITOLOGY

IN the early part of the present century, and to some extent, no doubt, earlier than this, the minds of zoologists, influenced by the rapid growth of those promising infants, biochemistry and biophysics, ceased to find inspiration in the great investigations of animal structure which are the glory of an earlier biology, and transferred their energies to physiological and experimental work. The science of experimental zoology was born and after a period of adolescence during which, with pardonable pride, it seemed to believe that morphology was no longer worth serious effort, it settled down to change the trend of biological research and incidentally to bring back, not the old morphology, but new conceptions of structure required, at different levels, by experimental study.

By the same process, by a shift from the static to the dynamic, from architecture to physiology, the outlook of parasitology is also being changed. The germ of this change was latent in the work of some of the older parasitologists who sought, but inevitably in vain, concepts and techniques which could only be found when biochemistry and biophysics were mature enough to make them available. But the new and powerful techniques were vigorously taken up for the study of parasites, and for some time now, in the pages of *Parasitology* and in those also of journals not specifically devoted to the study of parasitic life, a growing volume of experimental work upon parasites has been printed. It is not surprising, therefore, that a need has arisen for a journal devoted entirely to work of this kind. The new quarterly *Experimental Parasitology* (Acad. Press, Inc., 125 East 23rd St., New York), the first issue of which is to appear shortly, will help, by concentrating experimental work on parasitic organisms in one journal, to bring this kind of work to the attention of all biologists.

The scope and outlook of the physiological, experimental and immunological work now being done on parasitic organisms cannot be properly discussed in the space available here. Its literature is already voluminous and takes us back to surprisingly early dates. An idea of its quality, and of the fundamental problems that it raises, can be obtained from summaries of various aspects of it that have recently appeared. Thus Hobson[1] and Read[2] are concerned with our growing knowledge of the physiology of nematodes parasitic in the alimentary canals of their hosts, and their summaries show that the experimental study of these organisms is extending our knowledge, not only of the nematodes, but also of the biochemistry of the alimentary canal. Smyth[3] and Wardle[4] review what we know of those tapeworms the physiology of which has been investigated. Lwoff, and the distinguished contributors to the book[5] which he is editing, deal with the physiology of both parasitic and non-parasitic Protozoa, and thus enable us to make those direct comparisons between the biology of closely related free-living and parasitic organisms which throw so much light on the basic phenomena of life. Smyth, in common with the protozoologists, has, thanks to his own remarkable success in cultivating a tapeworm, had the advantage of study of a parasitic animal *in vitro*. As Read[5] and Lapage[6,7] have pointed out, the cultivation of a parasitic nematode in a sterile medium, when this becomes possible, will quickly increase our knowledge of these *remarkably adaptive* organisms. A technique for the experimental study of them free from bacteria is urgently required and, when it is available, we may expect not only better knowledge of nematode physiology but also valuable additions to general biology. In addition to work on helminths and Protozoa, there is, as every biologist knows, a great deal of similar work on the parasitic arthropods. Of fundamental importance also is the growth of modern *contributions to the immunology* of parasitic infestations, the study of which is making such rapid progress nowadays.

All this work, in one degree or another, fulfils the biological maxim that the animal cannot be properly studied apart from its environment. The protozoan in the blood, the helminth in the gut, the scab-mite in the skin, are all animals inseparable from those tissues of the host which they normally inhabit. The central problem, therefore, *is the relationship* of the parasite to its host. To the study of this, by one method or another, parasitology directs its energies. Important to it, without any doubt, are studies of those morphological and adaptational beauties of the parasite which still, we may congratulate ourselves, excite the interest and admiration of minds that are sensitive to them. Based also on the study of the host-parasite relationship is the economic work, the efficiency of which has gained so much from the modern outlook. We need not fear that, if we ask the parasitologist to be primarily a biologist, trained in biochemistry and biophysics, we shall lose, or delay, economic gains for which we hope. The greatest advances in our control of harmful parasites have come from the biological study of their activities. It is only common sense to believe that, when we know how the parasite breathes, feeds, excretes and uses, within its host and at its host's expense, whatever biochemical processes link it to that host, we may learn to control it, not by our present-day expensive use of dangerous drugs discovered rather by chance than by rational methods, but by attacks on one or other of the essential physiological links between the parasite and its host—a method which may turn out to be cheaper and much more effective.

This understanding of parasitic life, when we achieve it, will bring us, however, more than effective means of control. It will bring understanding of much more than parasitism. In the food canal, in muscle, liver, blood, in practically every tissue of almost every kind of animal, in the very cells of which the tissues are composed and even in their nuclei, some kind of parasite may live and wage with its host a battle that, in the course of evolution, ends frequently, *not* in the extinction of either the host or the parasite, but in a state of interdependence of one upon the other, in a mutual tolerance that may be scarcely distinguishable from the condition that we recognize as symbiosis. This conflict is based on physiology; its weapons are enzymes, ions, catalysts, antibodies. All the concepts of biochemistry and biophysics figure in its armouries. The study of it will, therefore, bring us wider knowledge of the basic processes of biology. It *is not too* much to hope that, when we understand, for example, the methods by which the nematode succeeds in living in environments so widely different as the sands of the seashore and the contents of the duodenum of a man or a ruminant, we may have uncovered much that is new to biology. It is not too much to hope that, when we understand the biology of the viruses, we *shall* have come nearer to understanding the origin of life upon earth. Meanwhile, if we are not dull, we shall, without doubt, have learnt how man may live in harmony with his own parasites.

The study of parasitic organisms, thus broadly conceived, becomes not merely the study of organisms that do harm to man and to the animals and plants that minister to human needs, with the limited aim of destroying these organisms so that man may prosper; but rather the biological study of a certain way of living, *of one of the ways in which living things* have come in the course of evolution to live together, of the value and interest of this way of living considered as an evolutionary device and of the basic problems that it puts to biology. It becomes the business of the biologist, and it is to biology that we must look for relief from the suffering, death and economic loss that parasitic animals cause.

If this is so, and if we wish this kind of work to be done, we *must make it possible for the young* biologist to do it. We need not try to persuade anybody to take up work of this kind. Men persuaded cannot do what men inspired will naturally do. There are, we must frankly recognize, young biologists who avoid the parasite because they have a horror of disease; there are others who are not 'amused' by parasitic life; there are others still who have worthier reasons for their interest in different fields; *but for those who are naturally attracted* to experimental work on parasitic organisms, are we doing all that could be done?

The problems posed by this kind of work are intricate and difficult. They cannot be made the shuttlecocks of scientific politics. They cannot be solved in the two or three years required for the acquisition of doctorates. They require a vocational drive that must have freedom for a period of years, years that will bring (unless there be lucky chance discoveries) failures, delays, disappointed hopes, years that will test to the utmost the staunchest scientific spirit.

If we ask young men and women to face such a prospect as this, we must not trade upon thei devotion to its joys and disciplines. We must give them *honour, freedom, financial security*—all the rewards that the quality and value of their wor demand. In return they will bring us, in terms o fundamental biological discovery, a recompense tha will be very great. In terms of relief of human and animal distress and suffering, the recompense will scarcely be measurable.

[1] Hobson, A. D., *Parasit.*, **38**, 183 (1948).
[2] Read, C. P., jun., *Rice Institute Pamphlet*, **37**, No. 2 (1950).
[3] Smyth, J. D., *Biol. Rev.*, **22**, 214 (1947).
[4] Wardle, R. A., "The Physiology of Tapeworms". *Manitoba Essays* (Toronto, 1937).
[5] Lwoff, A., *et al.*, "Biochemistry and Physiology of Protozoa", vol. 1 (Academic Press, Inc., New York, 1951).
[6] Lapage, G., *Pub. Imp. Bur. of Agric. Parasit.* (St. Albans, 1935).
[7] Lapage, G., "Nematodes Parasitic in Animals" (Methuen and Co., Ltd., London, 1937).

ADVANCES IN MEDICINE

Annual Review of Medicine

Windsor C. Cutting (editor), Henry W. Newman (associate editor). Vol. 2. Pp. x+485. (Stanford, Calif.: Annual Reviews, Inc., 1951.) 6 dollars.

In this publication, twenty-six contributors under the editorship of Cutting and Newman review the advances made during the past two or three years in a wide variety of medical topics. There are nineteen sections in the book, the last being an annotated list of such review articles as appeared in the major medical journals during 1950.

The several authors show a considerable diversity of approaches in the presentation of their subjects, and not all are equally successful in securing clarity. The opening chapter, by Burnet, on virus and rickettsial diseases, is an excellent beginning to the book. It is at once readable, informative and well but not excessively documented—there are 136 references in twenty pages of text. Attention has been chiefly confined to advances significant for clinical medicine and public health, and the subjects discussed include the use of antibiotics in rickettsial and virus diseases, recent work on poliomyelitis, influenza, rubella in pregnancy, *Q*-fever, and the Coxsackie viruses.

Grimson and Howe, who review gastro-intestinal tract diseases, approach the subject from a surgeon's point of view. The presentation is far from lucid, however, and apart from the encouraging results attributed to Banthine (β-diethylaminoethylxanthene-9-carboxylate-methobromide) in disorders ranging from peptic ulcer, œsophageal stricture and hiatus hernia to diverticulitis, ulcerative colitis and pancreatitis, there is little major progress recorded.

Diseases of the cardiovascular system are reviewed by Page and Corcoran, and this section is one of the most disappointing in the book. It certainly contains a host of recent references—338 in thirty-one pages of text—but the text to these references is extremely brief and frequently quite uninformative. The authors have assumed a knowledge of cardiovascular research on the part of the reader which few general physicians are likely to possess, and this chapter is consequently far too concentrated and technical for any but a specialist in cardiovascular diseases in search of references. Nesbit and Lapides provide a reasonable and readable evaluation of reports on tuberculosis and other infections of the urinary system, nephrolithiasis and neoplasms of kidney and bladder. An excellent and well-balanced review of the coagulation problem and hæmorrhagic diatheses and disorders of leucocytes is contributed by Finch. The general physician may perhaps feel that this section, too, is somewhat over-documented and technical, but the field covered is small and the references come in a logical sequence. Meiklejohn and Passmore confine their attention, among nutritional topics, to kwashiorkor, famine and ascorbic acid metabolism, and under the heading of allergy Rose has dealt with the relationship of the pituitary adrenal mechanism to hypersensitivity. Both these sections, and particularly the latter, are most informative and clearly written.

The chapters on the reproductive system, the nervous system, psychiatry and the respiratory system are adequate reviews which the authors wisely confine to a few specific topics in each of the fields. The traumatic effects of stress and physical agents are well discussed by Behnke. Garland's section on radiology contains much interesting material but is marred by the fault, common to so many contributors in this work, of quoting too wide a bibliography with the minimum of textual reference. In a chapter on laboratory aids to diagnosis and therapy, Peters reviews only topics in which his own experience has been considerable. They include much research on serum content of precipitable iodine, lipids and proteins, measurement of body-fluid volumes and renal clearances. Scholtz and Williamson stress the growing appreciation of the close relation between skin disease and internal medicine and review progress in fields where this relationship is conspicuous.

Selye contributes an essay on the general adaptation syndrome which provides an admirable summary of his own work and views on this subject. He does not attempt to cover all recent work in this field, and the twenty-two references are all to the author's own publications. Aub and Nathanson summarize the clinical and experimental work done with adrenotropic hormone and cortisone in neoplastic conditions and conclude that these drugs affect the environment of the tumour rather than the growth itself. Kuzell has limited his contribution on diseases of bones and joints to rheumatoid arthritis and gout, and his review of the work on these subjects is most valuable. There is a full discussion of the use of adrenotropic hormone and cortisone in these diseases.

The content of this book may be summarized as a laudable attempt to perform an impossible task.

Lionel Whitby

JACOBSON'S ORGAN

Ouvrages sur l'organe voméro-nasal

Par Louis Jacobson. Avec préface et notes par O. C. Hollnagel-Jensen et Dr. Erik Andreassen. Pp. xxxi+175. (Copenhague: Einar Munksgaard, 1948.) 30 kr.

Louis Levin Jacobson, having so far escaped the inquisitive attentions of the denigrator, enjoys the unusual distinction of having actually discovered the vomeronasal sense organ of vertebrates with which his name is associated. Its duct, however, the nasopalatine canal or Stensen's foramen incisivum (canalis incisivus), had been seen by Vesalius in the dog and horse, and, apparently, in its vestigial state, in man himself. This Vesalian observation, which is described on p. 54 of the 1543 "Fabrica" and on p. 67 of the 1555 edition, is not correctly quoted in Cuvier's report reprinted in the present volume. Jacobson's organ in its most highly developed condition, as exemplified in some reptiles[1], is in communication with the nasal cavity, and secondarily also with the buccal cavity by the incisive or nasopalatine canal. Jacobson was the first to establish the latter connexion. The organ itself is represented in the early human fœtus, but later it becomes vestigial, and may be absent in the adult. Jacobson's discovery was first made known by Cuvier in 1811[2] during Jacobson's life-time.

This exhaustive and beautifully produced work by Hollnagel-Jensen and Andreasen, printed in an edition of three hundred numbered copies, includes the following eight sections: (1) Portrait of Jacobson. Preface of 20 pp. describing the main events of his life, and bibliographical details of his unpublished MSS. which the authors succeeded in finding. Apart from the discovery of the vomeronasal organ Jacobson's most important contribution to the literature of comparative anatomy was the demonstration of the existence of a second portal vascular system, the renal portal system, in all classes of vertebrates except mammals. The authors dispose of the claims on behalf of Ruysch and v. Soemmerring to have anticipated Jacobson in the discovery of the vomeronasal sense organ. We learn that Jacobson was not eligible for a chair in the University of Copenhagen in 1815 on the ground that he was "un homme adhérant à la religion mosaïque". (2) French translation of 22 pp. of an undated MS., with notes, presented to the Academy of Science of Denmark on January 4, 1811, which contains a description of a secretory organ in the nose hitherto unrecorded. Three figures are mentioned in the MS. but were not found by the senior author when the text was discovered. The Academy did not publish the paper, which opens with the well-known and impeccable quotation from the Latin edition of Galen—"Quicunque vult operum naturæ esse contemplator, non oportet eum anatomicis libris credere, sed propriis oculis". (3) The only description of the vomeronasal organ published by Jacobson himself was a paper in Danish printed in a Copenhagen veterinary journal in 1813. This paper is not recorded in bibliographies and is practically unknown. In it Jacobson states that he had already sent to the Denmark Academy of Science a complete description of the organ which was not published, but which he now uses and supplements as the basis of the article in the veterinary journal. This paper is also translated into French in 19 pp. of the present work, and its two plates of the horse are reproduced. The animals mainly dealt with are the ox, horse, pig and dog. (4) When Jacobson was in Paris in 1812 he deposited with the Institute of France a memoir on his discovery entitled "Description anatomique d'un organe observé dans les mammifères", which was read on January 13 of that year but not printed. The text of this MS. was recovered by our authors in 1946, but the 12 plates by which it was illustrated could not be found. This was the MS. used by Cuvier in drafting his report of "1811". It is now published in full in 17 pp. (5) Reprint of 8 pp. of Cuvier's report on the preceding MS. dated March 2, 1812, with a collotype reproduction of the first page. The report itself was published contemporaneously in the Annales du Muséum d'Histoire Naturelle, XVIII, "1811". (6) Collotype reproduction of 57 pp. of the whole of the most important MS. which was recovered by the senior author and is described in section 2. (7) Preserved in the archives of the Veterinary Society of Denmark is a packet of unpublished figures inscribed "Jacobson's drawings for his researches on Jacobson's organ". They are apparently not all by Jacobson himself, and the authors reproduce on 25 pp. those which have a particular bearing on the subject. The animals included are monkey, cat, dog, otter, hedgehog, rat, rabbit, hare, little anteater, pig, deer, sheep, ox, musk-deer and horse. (8) Notes and commentary.

Such are the contents of this important and conclusive work. It is no exaggeration to claim that on the subject of which it treats there is no more to be said. The senior author died in 1946. It is to be hoped that the junior author, Dr. Andreasen, will pursue his historical studies on Jacobson, and let us have another memoir of the same class on Jacobson's classic researches on the renal portal system. It is a remunerative subject and needs clarification.

F. J. Cole

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[1] Cf. Bellairs and Boyd, *Proc. Zoo. Soc.*, 120 (1950).

[2] So dated, but Cuvier's report was not completed until March 1812.

HUMANISM AND TECHNOLOGY

Man the Maker

A History of Technology and Engineering. By R. J. Forbes. (The Life of Science Library.) Pp. xv+355+41 plates. (London: Constable and Co., Ltd., 1950.) 25*s*. net.

This volume is a recent addition to the Life of Science Library and maintains the established tradition of the series by its treatment of the history of technology in relation to its human setting. In his preface, the author claims that in the combined experiments and technical creations of hundreds of generations the figure of humanity rises as clearly in this field as in the fields of literature and art. He continues, "In order to make this clear and to show how deeply such mechanical arts as engineering and technology are embedded in the spiritual life of mankind, we have followed up a few threads of this history from the dawn of human life to the dawn of the Atomic Age. . . . In keeping with the general design of the 'Life of Science Library' we have accordingly restricted ourselves to the story of such essential topics as power resources, transportation and communication, metallurgy, textiles, glass, chemical technology, and some aspects of civil engineering."

The first chapter, "Man and Nature", is important as an introduction to what follows. It is concerned with man's relation to Nature, the difference between discovery and invention, and the widespread diffusion of certain inventions. In the main, the first half of the book is arranged chronologically so that successive chapters deal with "The Dawn of History", "The Great Empires of the Ancient Near East", "Greeks and Romans", "Wardens of the Classical Heritage". The last-named refers to the important part played by the Arabs. The next chapter, "Technology and Theology", covers roughly the same period and describes many developments which paved the way for the birth of the 'New Science' treated in Chapter 7 under the title "New Wine into Old Bottles (1500–1750)". The three remaining chapters relate to steam, the conquest of distance, and steel and electricity. The first is closely associated with the Industrial Revolution and the perfecting of steam power; the new iron metallurgy, textile factories and the rise of a chemical industry are treated in some detail. In Chapter 9 the development of road building, bridges, canals, means of transport on land, sea and in the air, all make interesting reading, and, with modern applications of electricity described in the last chapter of the book, a fitting climax is reached in the story of man's achievement. The epilogue—"Technology and Progress"—though brief is apt. The limitations of science are recognized, the essential unity of mankind is stressed and the author concludes: "No world can be built on the basis of material progress alone. We must supplement our material gains with a deeper understanding of the mind and spirit. Using the science of matter to implement the science of man is the task of present and future generations."

The numerous plates and illustrations, together with a good bibliography, add to the value of this informative and readable book.

H. D. Anthony

PREHISTORIC METALLURGY OF COPPER AND BRONZE

Notes on the Prehistoric Metallurgy of Copper and Bronze in the Old World

By H. H. Coghlan. (Pitt Rivers Museum, University of Oxford. Occasional Papers on Technology, 4.) Pp. 131+16 plates. (Oxford: Pitt Rivers Museum, 1951.) 15s.

Though doubtless the last word has not been said on the prehistoric metallurgy of copper and bronze in the Old World, this work by H. H. Coghlan is certainly the most important treatise on the problem that has been published for many a long day. In the Tripos examination at the University of Cambridge the question, "Starting with the appropriate ores, how would Bronze Age man proceed to fashion a palstave?" has once or twice appeared; I venture to think that few of our older archæologists would have been able to obtain an 'alpha plus' on this question, which yet is fundamental to the subject. However, the publication of this book now renders any excuse untenable.

What makes the book authoritative is the fact that Mr. Coghlan had had years of metallurgical experience before he became curator of the Newbury Museum. It is thus written by a man who has knowledge, not by an archæologist who has merely read about smelting. The work opens with chapters on native copper and non-ferrous ores and their discovery in antiquity. Chapter 3 deals with the sequence of the metals and the results of analysis. There follow chapters on the mechanical properties of copper and bronze and the different methods of casting. An important chapter describes the various implements known to have been used by the prehistoric metallurgist, such as tongs, drills, files, etc. Later in the book the methods of soldering and welding are outlined. The work concludes with several chapters on the results of metallurgical examinations of a number of ancient examples of the metal-worker's art.

Mr. Coghlan does not think it possible that Bronze Age man could have obtained his copper from the abundant copper sulphide ores. Here one may perhaps hesitate to agree. Bronze Age man was a skilled metallurgist. Everything seems to point to the fact that he was perfectly aware of what he was doing. It was not all mere chance. The speed with which the knowledge spread that copper with 10 per cent tin and without other ingredients was the most suitable alloy is impressive. It argues that the development of metal-working took place in a limited geographical area, that the men themselves were consciously experimenting and that they knew what they were trying to do. Sulphide ores require the prior process of roasting before reduction; but the abundance of these ores would surely have interested the Bronze Age metal workers, and they were quite capable of finding out how to utilize them to obtain the needed pure copper.

M. C. Burkitt

BRITISH VARIETIES OF CEREALS

Cereal Varieties in Great Britain

By R. A. Peachey. Pp. 202. (London: Crosby Lockwood and Son, Ltd., 1951.) 21s. net.

During the past fifty years there has been an endless interest in the subject of cereal varieties, largely due to the increased demand for agricultural produce of definite quality for specific purposes, such as is required in the processes of baking and malting. With the great increase in agricultural production in Great Britain and indeed throughout the world since 1939, the interest in cereals has been accentuated still more. This is partly due to differences in their yielding capacity; but recent advances in the mechanization of harvest operations have shown the greater suitability of some varieties of cereals to the changes required by this development. In "Cereal Varieties in Great Britain", the author has brought together in a most available manner the information of a general nature regarding the principal varieties of wheat, oats and barley in cultivation throughout this country.

This book is in reality a photographic record of the varieties of cereals grown in Great Britain at the present time. It is obvious on looking at the illustrations that each specimen ear has been selected with great care to show so far as possible the distinguishing botanical features of each variety. On the whole the illustrations are very faithful to the living specimens. The book illustrates and describes sixty-seven varieties of wheat, sixty-one varieties of oats and eighteen varieties of barley—that is to say, nearly all the varieties which could possibly be found growing as field-crops in the British Isles. The selection of the varieties is on a wide scale and not confined to those varieties the superiority of which in some or other direction has been demonstrated by authoritative field trials and qualitative determinations.

Particular attention has been paid to the origin of a variety. Wherever possible the parentage of the variety, and the breeder or introducer, as well as the date of introduction into commerce, are given.

The book is of outstanding importance to all concerned with the cultivation and identification of cereals. With the aid of the descriptions of the young plant, ear, glume, grain and straw and the series of exceptionally good illustrations, the identification of any unknown cereal should offer few difficulties. Methods of harvesting and the factors which are important in considering the suitability of varieties to certain conditions of soil, climate, etc., are also dealt with. This part should appeal to the practical man. Seedsmen and crop inspectors especially will find it a most useful guide and reference book.

J. S. L. Waldie

The Heaviside Centenary Volume

Pp. v+98+6 plates. (London: Institution of Electrical Engineers, 1950.) 10*s.*; 4*s.* to members.

THIS well-produced and attractive volume is a record of the special meeting of the Institution of Electrical Engineers, held on May 18, 1950, to commemorate the centenary of the birth of Oliver Heaviside (see *Nature*, 165, 991; 1950). It contains the texts of the tributes paid to his memory by Prof. E. B. Moullin, president of the Institution, Sir Robert Robinson, president of the Royal Society, Sir Edward Appleton, Dr. M. J. H. Ponte, representing the Société Française des Électriciens and also the Société des Radioélectriciens, Sir Archibald Gill, Dr. O. E. Buckley, president of the Bell Telephone Laboratories, Prof. Harold Jeffreys, Sir Edmund Whittaker and Dr. G. F. C. Searle.

In addition, there are the following papers: "Oliver Heaviside—The Man", by Sir George Lee; "Some Unpublished Notes of Oliver Heaviside", by H. J. Josephs; "An Appreciation of Heaviside's Contribution to Electromagnetic Theory", by Prof. Willis Jackson; "Heaviside's Operational Calculus", by Prof. Balth van der Pol; "Fifty Years' Development in Telephone and Telegraph Transmission in relation to the Work of Heaviside", by Dr. W. G. Radley; "Heaviside's Pure Mathematics", by Prof. Harold Jeffreys; and "Oliver Heaviside—A Personal Sketch", by Dr. G. F. C. Searle. These papers bring to light many facts about Heaviside's character and his work which had been obscured by the seclusion in which he lived and by the mode of presentation and inherent difficulty of many of his published papers. The most important section of the book is the impressive reconstruction by Mr. Josephs of portions of Heaviside's unpublished work under the following five headings: infinite integrals, 'physical' mathematics, electric circuit theory, electromagnetic theory and unified field theory. It is to be hoped that the contents of other portions of the manuscripts now in the possession of the Institution will also be published in due course.

The Institution of Electrical Engineers is to be congratulated on the preparation of a magnificent tribute to one of the most famous of its honorary members and to the man whom it selected to be the first recipient of the Faraday Medal.

The World of Science

By Dr. F. Sherwood Taylor. Second edition. Pp. xviii+1064+48 plates. (London: William Heinemann, Ltd., 1950.) 21*s.* net.

THIS encyclopædic volume can be confidently recommended to the man of science and layman alike, both for general reading and as a reference book. I have found the first edition, published in 1936, to be a most valuable source book and its index a reliable guide. This second edition should prove equally valuable and interesting reading, for it is, in fact, largely a reprint of the first (bearing the same page numbers), but with a number of pages inserted at various points to carry the new material. Most of the remarkable advances that have been made since the first edition are covered; they include atomic energy, radar, gas turbines, new elements, recent astronomical theories, new drugs, and modern theories of the origin of man.

The printing, especially the line blocks, is not as sharp as it might be, doubtless owing to the method of reproduction from the first edition which has been employed. On the other hand, this slight shortcoming is offset by the remarkably low price of 21*s.* for these days (which might be compared with the 8*s.* 6*d.* for the first edition which had almost the same number of pages).

The last chapter "Looking Ahead" differs only by the addition of a sentence or two from that written fourteen years ago; surely the author's publishers will encourage him before an equally long period passes to produce a third edition which will not have to be so closely tied to the original text. H. R. LANG

Mechanics

A Text-Book for Engineers. By James E. Boyd and Prof. Percy W. Ott. Third edition. Pp. xii+422. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 38*s.* 6*d.*

IT is always a pleasure in welcoming a book which bears the stamp of thoroughness, and this book is an example of a carefully thought-out plan to put clearly before students the fundamentals of the subject. The execution of this plan has resulted in a really sound book, now in an enlarged third edition, which cannot fail to assist the student. The aim is to emphasize with illustrative examples the fundamental principles, and to encourage the student to use logical thinking and suitable mathematical methods in solving problems based on the principles. Greater stress is placed on the application of the principles to problems, especially numerical ones, rather than on the mathematical derivation of the principles or the relationships which they bear to one another.

The authors have evidently spared no time or trouble in an endeavour to make things clear, and they have eminently succeeded. The short space devoted to the principle of virtual work gives the clearest exposition of this very useful method seen by the reviewer in a book of this standard. The same thoroughness which pervades the text is repeated in the diagrams, which are excellently done.

Progress in Biophysics and Biophysical Chemistry

Editors: Dr. J. A. V. Butler and Prof. J. T. Randall. (Progress Series.) Pp. viii+279. (London: Butterworth-Springer, Ltd.; New York: Academic Press, Inc., 1950.) 50*s.*

THIS book is the first of a new series which will present at intervals review articles of selected topics in biophysical research. Biophysics is a borderline subject which is difficult to define precisely. Interest in recent years has perhaps centred more on the structure of cells and tissues than on the physics of the mode of operation of organs. However, the nine contributions to this first volume have been well chosen and cover a wide field.

The reviews are in general well documented and provide a useful starting-point for further reading. They are written in a critical vein and give expression to the opinions of the various authors. They combine, therefore, the personal interest of an essay with the substance of a progress report. The aspects covered include the properties of solutions of large molecules, fundamental molecular structures in biological systems, X-ray and light scattering by protein solutions, bioelectric potentials, phase-contrast microscopy, the theory of local refractometry, the assay of biological materials by soft X-ray absorption, the tolerance of man for radioactive isotopes and the mechanical properties of muscles and fibres.

The production of the book is of a high standard.

D. P. RILEY

NATURAL AND ARTIFICIAL PRODUCTION OF ATMOSPHERIC PRECIPITATION

A DISCUSSION on the "Natural and Artificial Production of Atmospheric Precipitation" was held on August 10 at Edinburgh as part of the programme of Section A (Mathematics and Physics) of the British Association. The session was opened by the president of the Association, H.R.H. the Duke of Edinburgh.

B. J. Mason (Imperial College of Science and Technology, London) read the first paper and began by describing the mechanisms responsible for the release of natural precipitation, emphasizing that an understanding of the fundamental physical processes is essential if artificial rain-making experiments are to be carried out intelligently and their results assessed in a realistic manner. He said that the collision and the resultant coalescence of droplets having differential rates of fall, while capable of producing only drizzle or light rain from layer clouds, can release a heavy shower from a deep, vigorous, cumulus cloud by initiating a water-drop chain reaction. This process will be favoured in tropical regions, particularly in unstable maritime air-masses, where sea-spray may supply the larger droplets required to start the coagulation process. In temperate latitudes and well inland, showers are more likely to be released by the action of ice crystals. Growing initially by diffusion, the crystals afterwards sweep up supercooled cloud droplets to form pellets of soft hail, which may melt to form raindrops. Rain falling from deep layer-clouds generally originates from melting snowflakes, which are formed by the coalescence of ice crystals. In cumulus clouds containing strong updraughts and high concentrations of liquid water, a water-drop chain reaction may be initiated by the shedding of large droplets from hailstones which amass supercooled water at a rate greater than it can be frozen.

In describing and assessing the results of artificial rain-making experiments, which attempt to induce precipitation by 'seeding' suitable clouds with pellets of dry ice, crystals of silver iodide or small water-droplets, Mr. Mason said that there has been a distinct tendency to draw spectacular conclusions on the basis of too few observations, and that too little attention has been paid to the need for adequate control experiments. However, many cases have been reported of rain falling from clouds a few minutes after seeding. Although in any particular case it is not possible to ascertain that this would not have happened without seeding, in many careful dry-ice experiments carried out in Australia by the Council for Scientific and Industrial Research (now the Commonwealth Scientific and Industrial Research Organization), under the direction of Dr. E. G. Bowen, rain has been observed to fall from seeded cumulus clouds, while similar clouds in the immediate vicinity produced no precipitation. Since, for a high probability of success in the dry-ice experiments, the cloud top must be colder than − 7° C. and rain is likely to fall naturally if it is colder than − 12° C., there is only a narrow range of conditions in which seeding with dry ice can anticipate natural events. The position is still more unfavourable in the case of silver iodide, which suffers the additional disadvantage that it becomes inactive as an ice nucleus when exposed to strong sunlight for about one hour. Calculations indicate that spraying small water-droplets into the base of the cloud should be a more efficient method of releasing showers from warm cumuli, and the results of recent experiments in Australia are encouraging.

The introduction of dry ice into supercooled layer clouds tends to produce 'over-seeding' and therefore to inhibit precipitation. This danger is reduced by the dissemination of silver iodide from the ground; this method is being used extensively in the United States, but an accurate assessment of the results will be possible only after extended trials in many different regions, comparing the precipitation on a statistical basis with that produced naturally in corresponding control areas. Generally layer clouds will produce little precipitation unless they possess considerable depth, in which case their tops may often be sufficiently cold for precipitation to be released naturally.

Mr. Mason said that there is little doubt that precipitation may be released by seeding techniques. The important questions are how much can be so released which would not fall naturally, and whether the time of release and hence its distribution can be altered. It is possible that, by seeding, the onset of precipitation from a growing cumulus may be advanced by a few minutes, and from frontal cloud systems by perhaps a few hours. This might be of importance in increasing the rainfall in a given area; but judging the optimum time for seeding would, in most cases, be very difficult. It seems unlikely that the rainfall pattern over large areas can be altered materially by cloud seeding, although local modifications may be effected.

It was suggested by Mr. Mason that perhaps the greatest value of rain-making experiments is to be found in the impetus they have given to fundamental research in the physics of clouds and precipitation; they should be continued as scientific experiments in close collaboration with theoretical and laboratory work on the fundamental physical problems, for only in this way can their potential economic value be satisfactorily assessed.

F. H. Ludlam (Imperial College of Science and Technology, London) emphasized that the time-scale of precipitation processes is controlled mainly by the macroscopic features of cloud development, and showed by time-lapse photographs of cumulus clouds that the life-history of a particular mass of cloudy air may be completed in a few minutes. He went on to discuss quantitatively the formation of raindrops and hailstones in shower clouds, tracing the growth of these elements by coagulation in relation to the elapsed time and their height above the cloud base. His calculations show that a droplet of sea-spray of radius about 30μ is capable of releasing a shower via a water-drop chain reaction in a warm cumulus cloud having a strong updraught; alternatively, this process can be started by a wet hailstone in the manner described by Mr. Mason.

It was Mr. Ludlam's opinion that, even in temperate latitudes, rain is released from shower clouds without the aid of ice crystals; but more critical observations are needed. He also discussed the possibilities of inducing and inhibiting showers by seeding techniques, pointing out that seeding can be used as a tracer in studying the further development of a cloud. For this reason, and also because he was more optimistic about their potential economic value than other speakers, he hoped that such experiments would be conducted on an increasing scale in the British Isles.

In a paper entitled "Radar Echoes from Precipitation", R. F. Jones (Meteorological Office) pointed out that normal radar equipments working on wavelengths of 3 or 10 cm. can, at ranges greater than ten miles, detect only that part of the cloud in which there are either raindrops, ice crystals exceeding 1·5 mm. diameter, aggregates of ice crystals or ice crystals with a wet surface. He described some results obtained with the radar equipment at East Hill (near Dunstable) which has both position-plan indicators and range-height indicators to give a three-dimensional picture of the echoes received from precipitating clouds. Different weather types are associated with markedly different radar responses, a fact which was clearly illustrated by photographs of the echoes obtained from cloud systems associated with a warm front, a cold front and an occlusion, all of which were of very different character from those obtained from shower clouds. The echoes from layer clouds are generally of limited vertical extent and contain a narrow band of great intensity (the 'bright band'), while those from cumulo-nimbus appear as narrow vertical columns attaining heights of perhaps 40,000 ft.

Mr. Jones went on to relate the appearance of the echoes, the rate of ascent of their tops and the temperatures of their summits as measured by aircraft, to the mechanisms of precipitation release. In particular, he associated the appearance of the 'bright band' in layer clouds with the melting of snowflakes, and the echoes from cumulo-nimbus (which show no 'bright band') with the existence of large water-droplets, often supercooled, which must have formed by the coalescence process. He reported on some aircraft observations which appear to support these interpretations.

In a paper read by H. P. Palmer, Dr. A. W. Brewer (Oxford) stated that in Great Britain nearly all rain originates from ice crystals, and because of this it is a reliable rule in weather forecasting that cumulus clouds will not give showers until the temperature of their summits falls below − 10° C. As first suggested by Bergeron, an ice crystal will grow rapidly in a supercooled water cloud; but it is important to consider the origin of these crystals. Suitable ice-forming nuclei are found in the atmosphere; but they are comparatively rare. Their concentration has been measured by Findeisen *et al.* in Prague, and also in Oxford, by the cooling of air by expansion in Wilson cloud chambers. In the relatively polluted air of these cities the ice nuclei were present in concentrations of only about 1 per m.^{3} at − 10° C. Dr. Brewer suggested that ice crystals must multiply during their growth by sublimation since it is not until much lower temperatures than − 10° C. are reached that the ice-forming nuclei are sufficiently numerous to account for all the raindrops which are produced. He reported that ice crystals which are growing rapidly and have dendritic structures release very small splinters of ice. Thus, although only a very few ice crystals may appear originally in a supercooled cloud at − 10° C., they will grow rapidly in a form liable to fracture; several splinters may form at each fracture, and themselves act as ice nuclei. In this way, a sufficient number of ice crystals may be formed to account for the number of raindrops reaching the ground.

I. C. Browne (Cambridge) described his use of a radar set with a vertical beam and range-amplitude display to study precipitating clouds, in conjunction with observations of the mass and electrical charge of raindrops and the electric field at the ground. He has made a particular study of the variations of echo intensity with height in order to determine the mass and growth-rate of the precipitation elements. In particular, thunderstorms sometimes show a striking increase of echo intensity with decreasing height in a region beneath the freezing-level, which affords some evidence for the growth of drops by coalescence and their multiplication by a chain reaction. The observations yield a value for the updraught velocity in the chain-reaction region. In warm-front rain the echo intensity indicates that at about 1 km. above the melting-level ice crystals are growing at a rate of about 150 μgm./km. Calculation indicates that they could grow at only 50 μgm./km. by sublimation, the inference being that they were growing at about 100 μgm./km. by accretion. The observations also indicate that near the 0° C. level each snowflake, on the average, coagulates with another.

B. J. Mason

SEED PATHOLOGY*

By Dr. MARY NOBLE

Department of Agriculture for Scotland

Agricultural and Horticultural Aspects

EVEN the earliest agriculturists realized the general desirability of using good seed; but it is very surprising that to-day so little attention is paid to the presence of disease in what is otherwise regarded as 'good' seed. I refer in this respect to true seed in the botanical sense, the health of other planting-stock having been greatly improved recently owing to certification schemes covering potatoes, soft fruits, etc. This is probably because most seed-transmitted parasites do not have any immediate effect upon germination; they do not kill the seed outright but multiply upon the emerging seedling, which often then succumbs to the attack; or, as in the case of loose smut of barley, the parasite may pass most of its life-cycle as a symbiont. Such seed, if tested by orthodox methods, is classed as 'good seed' but is, in fact, responsible for considerable loss of crops not only in Great Britain but also the rest of the world. To take, as a case in point, an example from one of our most familiar crops—the turnip. Dry rot of turnip caused by *Phoma lingam* has been known for very many years; but although the farmer has known this disease as a rot of the root, the growers of swede and turnip seed only recognized it comparatively recently. Swede roots are replanted for seed-production in the second year, and it was found that the base of the shoot was often attacked by the disease known as 'canker'. The important point is that it was not until 1930 that this 'canker' was proved to be merely 'dry rot' in another form; and what was even more important, that the fungus also infects the seed heads, the pods and even the seed itself but without causing reduction in germination. Until this point was properly understood, turnip and swede seed samples were frequently severely infected by dry rot, because although the seed grower was careful to select only the finest roots for propagation he very often planted them in soil which he proved to be suitable for the purpose but which had also thereby become infected with the fungus. The disease is soil-borne as well as seed-borne, so that until recently the importance of seed-borne infection was not fully realized, and even yet it is frequently overlooked that soil infection may have arisen from seed. Some years ago observations made at East Craigs showed that as little as 2 per cent infection of the seed could lead to considerable loss of crop and that this amount of infection is still quite common.

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* Substance of a paper read on August 13 before Section K (Botany) of the British Association meeting at Edinburgh.

This is not surprising when the method of growing the crop is considered. The seed is sown about ten times more thickly than the resulting crop and infection is disseminated throughout the field. At the time of 'thinning', the rejected plants are not removed but left lying in close proximity to those which remain, so that the risk of infection is not reduced at thinning time but multiplied tenfold. This principle applies to very many similar seed-borne diseases. Again, if seed is sown thickly to make up for low germination the risk of infection is correspondingly increased, as in this disease the fungus does not die before the seed.

Dry rot infection can be very well controlled in the seed by treatment with hot water, and in the north of England this is done as part of the National Agricultural Advisory Service. Generally, however, swede and turnip seeds are sown without any treatment, although even dusting with a mercurial fungicide greatly reduces infection; and from this disease alone the crop loss is considerable.

Again, infection sown with the seed of one crop may remain in the soil to attack a later one. For example, another brassica crop following a swede crop which had dry rot may become in turn infected. In 1948 the ubiquitous fungal parasite *Sclerotinia sclerotiorum* was found carried as a sclerotium in turnip seed. This provided the source for soil infection capable of attacking artichoke, carrot, etc. Blind seed disease of rye-grass presents quite a different case. This disease, caused by one of the Sclerotiniaceae, was not recognized in Britain until some ten years ago, although rye-grass was for a very long time the only British cultivated grass and indeed the only one of which the seed could be purchased for sowing. The causal fungus, the fructification of which arises from the seed, is very tiny and insignificant, and it is possible that this disease was present much earlier but unrecognized; on the other hand, certain changes had occurred in the rye-grass seed-growing industry which may at least have led to its increase.

One change was the concentration of seed-growing in the areas where the best pastures were found in Britain (Kent, Ayrshire, Aberdeenshire) and, overseas, in New Zealand. This arose from the fact that farmers could not be sure of getting seed of the best pasture strains anywhere else, seed certification schemes being a very recent development. It does not follow that seed production requires the same ecological conditions as pasture development, and in this case the disease is most severe where cool moist weather conditions prevail.

Another change which was more important from the seed pathology point of view was the introduction of improved, leafy strains of rye-grass in Britain as well as in New Zealand. These strains comprised much more uniform populations than the old 'commercial' strains and came into flower much more synchronously than the latter. Thus in adverse weather conditions the damage was greater. Again, these new improved strains have proved genetically to be more susceptible to the fungus and some at least are now being re-selected with reference to this factor. Trials are also in progress with growing the seed in suitable 'seed' areas as against the good pasture areas.

In horticulture the problem of seed health is studied even less than in agriculture. For example, all the sugar beet seed now sown in Britain is disinfected chiefly against the black leg organism (*Phoma betae*); but very few market gardeners treat red beet seed although it is quite as common as sugar beet.

Dwarf beans, especially of the variety 'Canadian Wonder', are often infected with halo blight, a bacterial disease, and no great effort seems to be made in Britain to avoid the disease. In New South Wales, an inspection scheme ensures the health of dwarf bean seed.

Seed Pathology and Seed Testing

The practice of seed testing or seed analysis is, of course, intimately bound up with seed pathology, and in this Great Britain has from the beginning lagged behind the Continent and the United States—at least in officially implementing the recommendations of the few who pointed the way.

Thus the first official seed-testing station in the world was established in Saxony in 1869. In 1885 a writer in the *Transactions of the Highland and Agricultural Society* pleaded that Scotland might also set up such stations, especially as the Royal Agricultural Society of England had been testing seed for its members since 1871 and had in 1882 laid down standards for purity and germination. But although a departmental committee set up to examine farm seeds had recommended in 1900 the establishment of a station, nothing was done as it was officially considered that the public would not take advantage of such facilities, or perhaps the reason given by R. H. Elliot, addressing the British Association in 1904, was more accurate: "The bewildering variety of our national affairs no doubt leaves little time for the Government to notice the needs of the biggest and most important industry of the kingdom", a reproach which is fortunately not true to day.

But seed pathology was even at this time being studied elsewhere in the world. At Iowa the work was begun by Bessey, and in 1886 a State College bulletin was issued on the results of germination tests with notes on the fungi. It is surely not without significance, considering the leading part still taken by Iowa in seed testing and seed pathology, that from the first these two studies were so closely allied in that State. Every mycologist knows the initials which represent the authorities for the fungus name *Helminthosporium sativum*, P. K. and B., but how many know that Pammel was a botanist on the staff of the Station, and that Charlotte King, at that time assistant botanist, became an official seed analyst of Iowa? Nevertheless, this fungus, so commonly seed-borne in American crops, was not named until 1910, when these authors published a bulletin on *Helminthosporium* spp. on barley, including *H. gramineum* and *sativum*, which they described as seed-borne.

For very many years the leading work in seed pathology was carried out in the United States and in Holland, where Dr. Lucie Doyer was the pathologist at the State Seed Testing Station at Wageningen, a centre which has always been noted for generously helping and co-operating with others.

In Britain very little attention indeed was paid to seed testing in relation to pathology, and this in spite of the repeated warnings even from the time of Jethro Tull: "In some sorts of seeds the goodness cannot be known by the eye". Sir John Sinclair said in 1782: "So far as oats are concerned—the clearest and best-looking oats when sown often produce the worst crop". But at last in 1920 the first and only British Seeds Act was passed, giving the farmer much greater protection and security in purchasing seeds than ever before. But even then, only certain crops were safeguarded; the Act does not apply to all seeds. Not that this was required where honest seedsmen were concerned, and there were several excellent seed firms all over the country whose names to-day still are sufficient guarantee; but there always have been less scrupulous merchants and individuals whose activities caused severe loss to farmers and gardeners.

However, even the most skilled and honest seedsman could not be blamed for selling seed carrying infection which no one knew how to detect. In many cases, indeed, it was not even known that the seed was infected at all, as has been shown in the case of dry rot of swedes. Surveys of the various seed crops would have given valuable information; but plant pathological survey work of this nature in Britain was greatly restricted because of lack of staff and facilities.

But pioneer survey work was done by Dillon, Weston and Brett on cereal seed in England, by Hickman on pea seed, when he found twenty-six out of twenty-nine English-grown samples to be infected with pod spot; the Ministry of Agriculture's Plant Pathology Laboratory continues to examine seed for export, and in Northern Ireland Prof. A. E. Muskett and his collaborators are doing valuable work. In Scotland the work begun by Mrs. Alcock, who published in 1931 an annotated list of seed-borne diseases, has been to some extent continued.

In Canada, however, such a survey began in 1937, where, to quote Craigie: "Seed-borne diseases exact a heavy annual toll from every important farm crop in this country".

As already noted, the United States and Holland were among the first countries seriously to study the problem.

The development of techniques by which these diseases could be detected is in itself a fascinating study which can only now be briefly outlined.

There are two main lines of approach: (1) to reveal the total number of seeds in any given sample which are harbouring an organism—fungal, bacterial, animal or virus, saprophytic or parasitic; (2) to assess the likelihood of specific infection giving rise to disease in the crop.

The first approach is appropriate when surveying and also when examining seed for export, and the second when examining seed for such purposes as the operation of inspection schemes where specific diseases require to be detected. With any one sample of seed the result obtained is greatly affected by the method used. In a recent paper from Canada, Wallen and Skolko state: "Standardization of seed testing methods in respect to germination and purity has been attained through the Association of Official Seed Analysts of North America and, at the international level, through the International Seed Testing Association. Much less agreement exists in the matter of testing seed for the presence of pathogenic organisms. The reason for this lack of uniformity in methods of disease diagnosis may be attributed primarily to the development by individual laboratories of seed testing methods especially suitable to their own requirements, facilities and personnel. Standardization has undoubtedly also been hampered by the fact that comparatively little is known of the seed-borne phases of many of these organisms, the failure to develop satisfactory methods of detection for seed-borne pathogens, and the emphasis on the empirical application of seed treating procedures for their control, with the consequent neglect of fundamental information as to how the seed treatment is operative. As a consequence of the differences in seed testing methods, misunderstandings are inevitable and proper interpretation of reports is not possible."

In this paper the authors were dealing with the 'Ulster', 'Ottawa' and 'New Zealand' methods—variations in the agar plate method of testing flax seed. The seed to be examined is, in the Ulster method, plated directly on to malt agar without prior surface disinfection or washing; slow-growing fungi are soon overgrown if the seed is heavily contaminated. In the Canadian method a disinfectant is used, and this makes the separation of the fungal flora easier. But in both methods the seed germinates, and in so doing may lift the infected cotyledons or even the testa above the surface of the agar. In the New Zealand method this difficulty is overcome by using deep agar and submerging the seeds, which are first washed in running water. More recently, Hagborg and Warren in Winnipeg have very ingeniously used 2,4-*D* to inhibit germination of the seed, simply adding the 2,4-*D* to the agar. Wallen and Skolko draw this very reasonable conclusion from their study: it is not the purpose of this paper to suggest which of the three methods should be adopted in seed-testing procedure but rather to indicate the necessity of defining the method on which a given report is based.

It might be further mentioned that even the disinfectant used for surface sterilizing can alter results. Thus in examining wheat seed for *Septoria nodorum* by plating, I found that 'Chloros', a chlorine type of dairy disinfectant, was less drastic in killing fungi than methylated spirit, but controlled bacterial contaminants more efficiently. This type of disinfectant has also the added advantage that the seed need not be washed again before plating—a process in which certain fungi (for example, those with pycnidospores ?) may be spread from an infected to a healthy seed. These methods, however, do not differentiate between saprophytes and parasites. It is often easier to grow the seed in such conditions as are known to induce the parasitic fungi to attack the developing seedling, identification then depending on the symptoms produced. Thus in Sweden *Fusarium* infection in rye is determined by sowing seed under ground brickstone, which induces characteristic twisting of the shots. A variation of this method using sterilized sand has proved successful at East Craigs for testing oats for *Helminthosporium* as well as *Fusarium* spp. Some samples with 'official' germination capacity of around 95 per cent were found by this method to be perhaps 20–30 per cent infected, so that their value to the grower was reduced accordingly. In the case of oats infected with these diseases, the official figure is generally too favourable; but in others the reverse is true. *Ascochyta imperfecta*, the cause of black stem disease, is very common in trefoil samples and spreads very rapidly from seed to seed under the conditions of the official test in incubators, so that infection appears much higher than if the seed is sown in soil. This fungus illustrates another point: that certain seed-borne diseases are already well known to skilled analysts because of their effect on the appearance of the seed: trefoil seed severely infected by *Ascochyta imperfecta* is dark brown in colour and rather flat, while more superficial infection appears as thin black lines, which are, in fact, thick-walled hyphæ, visible on the seed to the naked eye. The analysts at East Craigs recognized these marks as indications of poor quality seed before we proved them to be specific fungal infection. There is no doubt that similar investigational and survey work on seed crops as well as seed after harvesting would yield most interesting results. There is now a very large industry in crop protectants, including seed disinfectants, but more attention should be paid to the production of healthy, vigorous seed. In this respect chemistry has outrun biology.

International Aspects of the Problem

These problems are not confined to Britain, for this country is involved in the international trade in seeds. In 1950 Britain imported seeds to the value of £4½ million and her exports were more than £2½ million. It may, of course, be argued that so far as seed-borne disease is concerned we must already have spread them around and received every possible foreign trouble and that it is now too late to shut the stable door. There are, however, still some diseases which might be imported here; bacterial blight of peas is one, and as it is most severe where frost pockets are found we might expect it to do great harm in Scotland to our expanding industry of growing peas for canning. Then a recent attempt to grow soya beans in Scotland was unsuccessful owing, at least in part, to seed-borne bacterial blight. Our seed came from Sweden, where the disease was unknown until a few years ago, when it was imported with seed of new American varieties.

To endorse this aspect of the problem, I should like to quote again from a paper read at the British Association at Cambridge in 1904. The speaker was R. H. Elliott, of Clifton Park, Kelso, to whom Stapledon has referred as the father of grassland husbandry. In his paper he appealed for seed testing to be begun officially in Great Britain. He died in 1914, the year that the Department of Agriculture for Scotland began the first advisory, as against statutory, seed testing. But he also asked that our farmers should be protected against the introduction of diseased seed from abroad. Now, almost fifty years after, it seems that there is hope that this also will be done.

Last year the Government issued the report of the committee set up to investigate the qualitative control of seeds. As a member of this committee recently said: "In the early stages of the development of seed testing practice, the emphasis appears to have been upon providing a ready means of assessing seed values, largely for the purpose of facilitating trade in seeds, without particular thought as to the value of the data to the grower".

The committee in its report has fully met this point and has further recommended, so far as health is concerned: (1) there should be an early extension of health surveys of home-grown and imported seeds; (2) there should be further research into methods of detecting seed-borne organisms, and to find suitable technique whereby seed samples can be examined speedily and accurately for the presence of diseases or pests; (3) seed-testing practice should be extended to cover health; (4) seed certification schemes should include inspection for disease.

Further, there should be close collaboration between the seed-testing stations and the plant pathology services and continued close liaison with the International Seed Testing Association.

The International Seed Testing Association, which had its first post-war meeting in Washington in 1950, has a Pathology Committee which will undoubtedly welcome this approach. Then in spring 1951 Great Britain signed the convention of the European Plant Protection Organization, under which we now commit ourselves to survey our crops for the presence of certain pests and diseases with the view of ensuring, in collaboration with the other subscribing countries, that those are not further spread abroad. One of the means of dissemination to which attention will be paid will undoubtedly be the seed.

In conclusion, therefore, the outlook for the further study of seed pathology in Great Britain and abroad is distinctly promising.

MINERALS AND MAGMAS: STUDIES AT HIGH TEMPERATURES AND PRESSURES*

By E. D. LACY

Department of Geology, University of Birmingham

A CARDINAL aim of the petrologist must be to explain the natural history of the rocks of the earth's crust in physico-chemical terms. To that end investigation of equilibria in dry silicate melts has been pursued for many years, with fruitful results, notably in the Geophysical Laboratory, Washington. Although studies on hydrous silicate systems were commenced there as long ago as 1914, their range has been limited until comparatively recently.

Water is an important component of magmas and of many minerals, and its presence in magmas is significant in several respects. The viscosity of the fluid is diminished and crystallization temperatures are lowered. Hydrous minerals such as amphibole or mica may be precipitated, though it does not necessarily follow that they will. At a late stage in the cooling a fluid rich in water may remain, capable of profoundly modifying either the early crystallized material or neighbouring rocks, or of transporting substances, such as sulphides, to a locality where lower temperature brings about their precipitation. When magmas reach the open air, the water they contain is largely fugitive, but when they cool at depth the water may be retained, at least for a time, because of the load of superincumbent rocks.

The part played by water in the metamorphic rocks is less well understood. Here the mineralogy and texture now displayed is due to recrystallization, which took place in the solid. Complex conditions attend such change and it is certain that water in trace amount has a considerable influence in promoting the breakdown of unstable minerals and the simultaneous growth of stable ones. When available in larger amounts, water may enter into the composition of metamorphic minerals such as chloritoid or staurolite. Water is undoubtedly instrumental in promoting the transfer of material both by processes of ionic diffusion and of solution. In metamorphism the rock load tends to promote closure of the system with respect to water.

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* Substance of a paper read on August 14 before Section C (Geology) of the British Association meeting at Edinburgh.

Fundamental to all understanding of silicate crystallization phenomena, both in melts and in solid media, is a knowledge of phase stability relations. The range of temperature/pressure conditions to be covered is wide. Magmas are known to reach temperatures up to 1,185° C. Burial in the earth's crust involves a hydrostatic load increasing at the rate of 400 atmospheres per mile; hence experimental work faces formidable difficulties. A considerable number of workers, many in American laboratories, have contributed in this field. The designs for the necessary specialized apparatus can be classified broadly under three headings.

(1) *Closed bombs.* The material to be investigated is placed in a thick-walled vessel along with a calculated amount of water. The sample may be protected from contamination by the bomb wall by being placed in a crucible or by lining the bomb with noble metal. As in all similar work, it is desirable to bring about the reduction to room temperature very rapidly, in order to preserve the high-temperature products without change. This is done by quenching the bomb in cold water. Temperatures as high as 700° C. may be reached, but the pressure range is limited. The bomb typically is of about 100 c.c. capacity. Morey, Ingerson and Grunner are among the workers who have used this method, which is not preferred for precise work as the pressure developed on heating is known only approximately by computation, and leakage readily leads to inaccuracy.

(2) *Controlled autoclaves and bombs.* In this category come pressure vessels, varying largely in internal capacity, provided with pipe connexions to control valves and to gauges for measuring the pressure. The pressure may be generated solely by water placed in the bomb before sealing, or a high-pressure pump may be employed to inject water into the system as required. The vessel may be lined or the sample placed in a crucible as before. Variations of such apparatus have been designed which permit the sample to be refluxed or which expose the sample to percolation under pressure. The working space within apparatus of this type tends to diminish with increase in the severity of the pressure/temperature conditions.

The apparatus used by Bowen and Tuttle has yielded results of outstanding importance and is capable of withstanding an internal pressure of 1,000 atmospheres at a temperature of 1,000° C. The bomb is of very small capacity, and is rapidly cooled at the end of an experiment by using a retractable furnace and a water spray.

(3) *Apparatus using capsules.* In all the designs mentioned above, the pressure medium is water, a constituent of the system being investigated, which is thus an open one.

Goranson developed a technique for enclosing the solid sample and the volatile component in a thin platinum capsule. The system was thus completely protected from contamination, and furthermore several samples of varying composition could be dealt with at once. The capsules were heated in a furnace which was itself enclosed inside a pressure bomb, which latter was water-cooled. The pressure medium was carbon dioxide, supplied by an external pump. Under pressure, the sealed capsules collapsed until the pressure of water vapour within equalled the carbon dioxide pressure. With this apparatus runs were made at 1,200° C. under 4,000 atmospheres pressure. The drawbacks lay in the great cost and complexity of the apparatus and the apparently rather low rate of cooling.

A technique embodying new features has been developed in the Department of Geology, University of Birmingham. A sample is taken which may consist either of an artificial mixture, or of a cylinder of rock up to nearly ½ in. in diameter and large enough to make it possible to cut thin sections. The sample, together with any necessary water, is placed in a platinum capsule after the manner of Goranson. One or more capsules are placed in a pressure bomb connected to a supply of inert gas (argon) at pressures up to 600 atmospheres.

The bomb is long and narrow, one end only being heated and kept slightly higher than the other in order to prevent convective circulation of the argon. The other end is tapered in diameter, protrudes from the furnace, and, because of the low thermal conductivity of the metal, does not get much hotter than 100° C. Consequent upon the heating the pressure undergoes a large increase, but may be reduced to any required figure by releasing excess argon. The pressure/temperature conditions are maintained until equilibrium has been reached or some chosen period has elapsed.

The capsules can be transferred from the hot to the cold end of the bomb by tilting the bomb to a vertical position, where they are rapidly quenched in dense cool gas. This is made possible by mounting the bomb on a pivot and by making the connecting pipe to the bomb of flexible steel tubing having an external diameter of only 0·110 in. The equilibrium may thus be 'frozen' and the contents of the quenched capsules subjected to petrographical examination.

The maximum pressure reached so far is 1,800 atmospheres (nearly 12 tons per square inch), corresponding to a depth of burial of about 23,000 ft. (nearly 7 km.). The temperature on this occasion was 650° C. At 1,000 atmospheres the apparatus has been operated at 870°C. Development of the apparatus to cover a wider range of conditions is proceeding.

The pressure bombs have hitherto been made throughout from 'Nimonic' creep-resistant nickel–chrome alloy, developed for use in turbo-jet aircraft engines. Care must be taken to see that critical temperature/pressure limits are not exceeded. About 1,000 hr. of running, devoted to a series of exploratory experiments, has been accomplished.

Thus artificial thermal metamorphism has been produced in slate, with decomposition of chlorite to orthorhombic pyroxene completed at 650° C. At higher temperatures (760° and above), idioblastic andalusite was well developed after 100 hr.

Certain members of the amphibole family have been synthesized at 500° C. and 1,000 atmospheres.

The calcium carbonate/silica reaction is being studied, and preliminary results suggest that under anhydrous conditions decarbonation may proceed only at higher temperatures than has been predicted.

Recent research. The importance of this type of experimentation is demonstrated by the results of recent research in the United States.

For example, silica in any form is commonly regarded as being completely insoluble in water at ordinary temperatures. Under low pressures of liquid water a slight solubility can be shown, but this drops almost to zero as the critical temperature is approached. Under pressures of the order of 1,000 atmospheres of water vapour, however, a different state of affairs is found, for with increasing temperature the solubility progressively increases and has been determined up to a value of about ¼ per cent. These observations are clearly relevant to some problems of silica transport.

Unquestionably the most important family of minerals in igneous and metamorphic rocks is the feldspar family. Microscopic, heat treatment and X-ray studies have shown the group to be complex. Dry-melt investigation of feldspar crystallization has been laborious because the alkali feldspars take weeks or months to crystallize; but, by contrast, crystallization is completed within an hour in the presence of water vapour at a pressure of one thousand atmospheres. Recent high-pressure work has confirmed the existence of a high-temperature series and of a low-temperature series of plagioclase feldspars, with the consequence that a number of difficulties attending the identification of feldspars in lavas and porphyries are well on the way towards being cleared up. A further most important conclusion is that the stability relations observed between the alkali feldspars and leucite under dry-melt conditions broadly apply in the presence of water vapour under pressure, crystallization temperatures being much reduced to figures quite compatible with our current notions of magmatic temperatures. The value of earlier dry-melt work is thus confirmed.

A further notable research is that on the system $MgO–SiO_2–H_2O$. The temperature/pressure stability curves for substances such as pure forsterite, olivine, serpentine, enstatite, talc and periclase in the presence of water have been determined. The conditions under which serpentinization may and may not take place in Nature have been indicated, and the conclusion has been drawn that neither a dunite magma nor a serpentine magma is likely ever to exist. A possible mechanism for the formation of dyke-like masses of olivine rock in pyroxenites, depending on silica transport by water vapour, has been outlined.

The future. That hydrothermal research will play an increasing and vital part in formulating petrogenetic theory seems certain.

The keystone of further progress must be the study of the hydrostatic phase equilibria. Certain problems, such as the progressive decarbonation of a siliceous dolomite, discussed by Bowen and Tilley, offer a prospect of unusual interest and elegance. Replacement phenomena will continue to be enigmatic until the relevant phase-equilibrium conditions have been determined.

A topic of great interest concerns the primary or secondary nature of the water so copiously evolved as steam during volcanic eruption, and is a reminder that our knowledge of the solubility of water in molten silicates is fragmentary. Goranson's work on granite melts, twenty years ago, requires extension to melts prepared from other igneous rock types. The carbonatites present an intriguing puzzle in this connexion.

Quantitative assessment is yet barely possible of the magnitude of the forces responsible for the penetrative shearing movement and preferred orientation demonstrated in some metamorphic fabrics. This problem is a challenge to experimental ingenuity and, in addition, calls for a study of the kinetics of mineral crystal disintegration and growth at the atomic level.

Large-scale diffusion has been put forward repeatedly as an important petrogenetic process by many petrologists. There is no branch of the subject where quantitative laboratory evidence is so scant and where there is greater need for a strict physico-chemical treatment of the problem.

CHEMOTHERAPY OF TUBERCULOSIS

A COLLOQUIUM on the chemotherapy of tuberculosis was held in Dublin during July 10–13. It was sponsored by the Medical Research Council of Ireland, and the organization was in the hands of a small committee under the chairmanship of Dr. V. C. Barry. The meeting was international in character, the speakers being drawn from Great Britain, the United States, Germany, France and Ireland. There was a registered membership of 170, more than seventy of whom were overseas visitors, representing as well as the above countries, Switzerland, Holland and Sweden. The members came together for the first time on the eve of the opening at a reception given in Newman House by the President of University College and Mrs. Tierney.

The official opening of the colloquium in University College on July 10 was by the Minister for Health and Social Welfare, Dr. James Ryan. Prof. R. P. Farnan, chairman of the Medical Research Council, presided, and the attendance included the Taoiseach, Mr. de Valera. The colloquium was divided into seven sessions, each of which occupied a morning or afternoon. On Thursday afternoon the members had the honour of being received by the President of Ireland and Mrs. O'Kelly at Árás an Uachtaráin.

Each session was opened by a lecture and, after an interval for light refreshments, a discussion lasting about an hour and a half followed. The most interesting feature of the colloquium was that it brought together for four days the organic chemist and the biochemist, the bacteriologist, the pharmacologist and the clinician. The arrangement of the lectures was a logical one, beginning with the chemistry and biochemistry of the tubercle bacillus, followed by the organic chemists' approach to the problem of producing an adequate chemotherapeutic agent for tuberculosis. The story was continued with a description of the methods of preclinical evaluation of the agent. In the fourth lecture the present status of antibiotics in tuberculosis was assessed. At this stage the clinicians took over, and the last three lectures dealt with the thiosemicarbazones in tuberculosis, and the clinical evaluation of potential chemotherapeutic agents in pulmonary and urogenital tuberculosis. The formal and informal discussions which arose in this heterogeneous scientific gathering must prove of great value to all workers in this field.

Prof. Jessop presided at the first lecture, which was delivered by Dr. E. Lederer, on the chemistry and biochemistry of mycobacteria. This was an extensive review of the literature since 1940 on the carbohydrates, proteins and lipids of the bacilli. Dr. Lederer emphasized the extreme variability of the composition of mycobacteria and showed how it depends on environmental factors and the age of the culture. Perhaps of greatest interest was his account of the researches of his colleagues and himself on the mycolic acids. Their probable formula is $C_{88}H_{176}O_4$, which contains a —COOH, an —OH and an —OCH$_3$ group. Pyrolysis of the mycolic acid at 300° *in vacuo* gives *n*-hexacosanoic acid, $C_{26}H_{52}O_2$; chromic acid oxidation yields among other products stearic acid, *n*-hexacosanoic acid, hexadecane and a 1 : 16-dicarboxylic acid. Chromatographic purification on alumina has led to the isolation of two distinct, and apparently isomeric, mycolic acids (α- and β-). Degradation experiments indicate that a mycolic acid is a high molecular weight β-hydroxy acid with a long aliphatic side-chain in the α-position (α-*n*-tetracosyl-β-hydroxy acid). The difference between the α- and β-acids must reside in the C_{62} fragment, which still awaits investigation. Human virulent strains of *Myco-tuberculosis* contain methoxylated mycolic acids, while the *H*37 *RA* avirulent strain contains an α-mycolic acid free from methoxyl. The interesting new amino-acid, α,ε-diamino-pimelic acid, which Work isolated for the first time from the diphtheria bacillus, has now been found in all strains of Mycobacteria so far examined. Among other matters of interest covered in the lecture was the problem of acid-fastness. It seems that all our present knowledge of this phenomenon can be explained by the observation of Yegian and Vanderlinde, who have shown that, in the stained bacterial cell, the greater part of the dye is in solution inside the cell. Its introduction is effected by heating with a phenol solution of fuchsin, and it cannot be removed by acid-alcohol washing since the cell wall is impermeable to this solvent. Boiling alcohol does remove the stain. Acid-fastness is probably due, therefore, to the presence of a characteristic mycolic acid containing lipopolysaccharide in the cell membrane.

During the discussion which followed, Dr. C. Iland referred to work carried out with Prof. M. Stacey's team at Birmingham. A urea extract of young living tubercle bacilli gives a complex material which has the biological properties of fresh unheated tuberculin. It yields an electrophoretically homogeneous protein which gives a complement fixation test with human tuberculous sera. The use of urea for extracting living cells may prove of particular value in providing cheaply a tuberculin skin-testing reagent. Prof. R. A. Q. O'Meara pointed out that the subject of Dr. Lederer's address was the end-products of mycobacterial metabolism; of greater importance from the point of view of chemotherapy are the products of the intermediate phases of metabolism, the substances which are most elusive are likely to be the most important. Dr. D. Twomey referred to the isolation of branched-chain fatty acids from other natural sources; for example, the *iso*- and *anteiso*-series of acids isolated from wool-fat, and phytomonic acid from *P. tumefaciens*. These latter acids probably exist as such in Nature, unlike phthioic acid, which is now known to be an artefact. Dr. Twomey also provoked a discussion on 'permeability', which he suggested exists as a crude conception in the minds of many chemists and biologists.

In the second lecture, Dr. V. C. Barry described an organic chemist's approach to the chemotherapy of tuberculosis. He reviewed the work of his team, which is a unit of the Medical Research Council of Ireland. They have produced some drugs of potential value in tuberculosis and leprosy. *B*.53, a dialkyl succinic acid half-ester, has been used successfully in the treatment of tuberculosis of the urinary bladder. This substance has low *in vitro* activity in the presence of serum. A planned synthetical approach led to the production of a series of long branched-chain hydroxyamines which are much less antagonized by serum. One of these, *B*.390, a branched-chain pentadecylamine derivative, has shown a suppressive effect in guinea pig tuberculosis when given orally. A series of long-chain alkylpyrrolidines and piperidines was also described. In Dr. Barry's experience, this was the first example of a fatty compound exhibiting anti-tubercular activity *in vivo*, and it provides some justification for the long preoccupation of workers in this field with substances of a fatty nature. Another aspect of the work showed the development from the lichen product, diploicin, by successive synthetical modifications, of a series of phenazine dyes highly active against the bacillus in serum broth. One of these, *B*.283 (2-anilino-3-imino-5-phenyl-phenazine), has shown a suppressive effect in mouse and guinea pig tuberculosis. Dr. Barry described six types of compound which up to date are known to modify the disease in the guinea pig. These were all produced empirically. The testing of antitubercular compounds in liquid media enriched by serum can be relied on to make possible the selection of agents likely to exhibit activity *in vivo*. Dr. J. Barnes exhibited a series of photographs showing the effect of *B*.283 in a series of cases of lepromatous leprosy in Nigeria. In his view, *B*.283 is more rapidly effective than any other drug in current use for the treatment of this form of leprosy. A very lively discussion followed to which Dr. D. A. Peak, Mr. F. A. Robinson, Prof. J. Algar, Dr. Lederer and others contributed. The discussion centred for the most part on the question of the empirical versus the rational approach to chemotherapy. It was remarkable for the high level of honesty sustained, there being general agreement that no successful chemotherapeutic agent has yet been discovered by a completely rational approach. Prof. T. S. Wheeler presided at this session.

Dr. W. H. Feldman spoke on the preclinical appraisal of antituberculosis agents. He emphasized that certain prerequisites must be satisfied before a given agent is considered worthy of clinical trial. This necessitates the collection of a considerable amount of data from many experimental studies. He discussed in detail *in vitro* testing, the *in vivo* – *in vitro* test and the conduct of many *in vivo* screening routines. These included the use of the chick embryo, the baby chick, the rabbit (intracorneal infection), the mouse, the hamster and the guinea pig. No summary of this lecture is possible. The refinement and careful control of Dr. Feldman's *in vivo* experiments are wholly admirable. However, animal experimentation is not an end in itself, and in the present writer's view there is a stage in its development when further elaboration may lead only to results of purely theoretical significance. In the discussion, Mr. Francis compared the pathology of the disease in the monkey, dog and smaller animals. The dog does not develop much allergy, and must be regarded as a resistant animal. Dr. J. Ungar expressed the belief that *in vitro* testing is valueless unless carried out in complex media rich in protein. Substances with marked reticulocytic stimulation influence mice more than guinea pigs. The effect of streptomycin in experimental tuberculosis in the mouse is quite different from that in the guinea pig. Further contributors to the discussion were Dr.

A. Q. Wells, Dr. Carmichael, Dr. Conalty and Mr. W. Freeman. Prof. F. S. Stewart presided.

In the fourth session, the chair was occupied by Prof. T. G. Moorhead. Dr. George Brownlee opened the proceedings with a talk on the present status of antibiotics in tuberculosis. This was a stimulating and original contribution, which characteristically had little relevance to the title. Dr. Brownlee described six biochemical lesions which follow invasion by a tubercle bacillus: multiplication of the parasite, chemiotaxis of monocytes, inhibition of proteases, hypersensitivity effect, skin allergy and acquired resistance. Specific antimicrobial chemotherapy is associated only with the first. Three factors influence the effect of chemotherapeutic agents on a bacterial population: the efficiency of the agent, the effect of the number of the organisms, and the rate of emergence of resistant strains. Dr. Brownlee dealt at length with the role of hypersensitivity in the spread of the disease. He visualized the advent of an anti-anaphylactic drug which will effectively modify tuberculin hypersensitivity. This may be expected to revolutionize our present-day concepts of the limitations of conventional chemotherapy of tuberculosis. He also expressed the opinion that the evidence appears to be complete that a chemical entity exists in suitably prepared dead tubercle bacilli, which is antigenic and protective. Though this substance may be labile in character, he believed that ways will be found of extracting it. Opening the discussion, Dr. D. G. Madigan described the treatment of a group of patients with bacillary emulsion under the cover of effective chemotherapy with streptomycin and *p*-aminosalicylic acid. In 50 per cent of patients, it is possible to achieve desensitization as measured by the skin test (to 1 in 10) in six weeks. Dr. P. Swift described the treatment of tuberculous meningitis with streptomycin. In his opinion it is not now justifiable to use streptomycin by itself. The remainder of the session was devoted to a lively discussion on the origin and nature of streptomycin resistance, in which Prof. Kennedy, Dr. D. A. Mitchison, Mr. G. W. Dawson, Dr. J. Crofton and Prof. Julius took part.

The second half of the colloquium opened in Trinity College with Dr. Gerhard Domagk's lecture, Prof. W. R. Fearon presiding. Prof. Domagk said that three compounds have been used in the treatment of chronic tuberculosis infection: the thiosemicarbazones (conteben), streptomycin and *p*-aminosalicylic acid. All three are active against different types of tubercle bacilli both *in vitro* and *in vivo*. In the experimental animal, a combination of conteben and streptomycin has proved more effective than streptomycin alone or any other combination. Side reactions at first attributed to the thiosemicarbazone itself are to some extent due to dead or damaged bacilli. It is possible to obtain extensive fatty degeneration of the liver by injection of dead bacilli only. The thiosemicarbazones are being used extensively in South America and Central Africa for the treatment of leprosy. In the discussion, Dr. A. R. Martin pointed out that *TB III* (*p*-ethylsulphonylbenzaldehyde thiosemicarbazone) is better tolerated in man than conteben and produces much higher blood-levels with equal dosage. Dr. Barnes described a trial which he has conducted with a series of cases of tuberculoid and lepromatous leprosy. Conteben was effective in the former type, but very much less effective with the latter. In reply to Mr. Francis, whose experience has been that none of the partially successful tuberculosis and leprosy drugs have any appreciable effect on rat leprosy, Dr. Domagk pointed out that the strain of leprosy bacillus infecting man is quite different from the rat leprosy bacillus. It also emerged from the discussion that there is little information available as to the effect of thiosemicarbazones on streptomycin-resistant strains of tubercle bacilli.

The sixth and seventh lectures were mainly of interest to clinicians. Dr. Marc Daniels spoke on "The Clinical Evaluation of Potential Chemotherapeutic Agents in Pulmonary Tuberculosis". He described the various rigorous procedures and teamwork which alone can make a clinical trial of a new drug of value. Prof. J. M. O'Connor presided.

At the final session, Prof. J. McGrath presiding, Mr. J. T. D. Lane described his experience in the treatment of a number of cases of renal tuberculosis with streptomycin and a smaller number with *B*.283. The latter cases had failed to respond to streptomycin. It was clear that both drugs are more effective when dealing with early lesions. He thought it likely that a combination of the two drugs may prove more effective than either alone. In vesical tuberculosis persisting after nephrectomy, *B*.53 appears to be very effective. In this type of case, in his experience, streptomycin is only effective when the lesions are superficial.

It was a highly successful and lively conference, owing much of its success to the presence of workers interested in every stage of the chemotherapy of the disease, to the logical arrangement of the programme and finally to the fact that the limited number of contributions did not produce the mental indigestion frequently associated with gatherings of this kind. The chemists' contributions were tinged somewhat with melancholy, but not completely despairing. The biologists were optimistic and fruitful in theories. The bacteriologists among them appeared to be quietly confident that their routine procedures were adequate to any demands that might be made on them. The clinicians, however, as instanced by Dr. E. T. Freeman, were polite but firm in pointing out that the desired chemotherapeutic agent for tuberculosis has yet to be discovered.

A complete record of the proceedings will be published later this year as a special issue of the *Irish Journal of Medical Science*. VINCENT C. BARRY

THE FAWLEY REFINERY

FOR the past two years, ever since the first grader started site-clearance in July 1949, the word 'Fawley' has taken on a new meaning in British oil circles. The place itself was of small consequence on a comparatively little-known peninsula between Beaulieu River and Southampton Water, save for the existence of the original Esso Petroleum Company's oil refinery, in operation for some thirty years past. All this has now changed. The new Esso refinery, officially opened by the Prime Minister on September 14, is an accomplished fact, a triumph of American and British brains and skill, a monument to the close ties binding the two countries in peace as well as in war.

The history of this outstanding example of initiative and enterprise is as impressive as is the vista of the whole complex plant itself. Begun in 1949, it was actually completed this year four months ahead of schedule. The scheme involved clearing and levelling 450 acres of wooded gravel-land; construction of roads; laying down a railway system to connect up with permanent way to Southampton; erecting a huge building, 800 ft. long, 180 ft. wide and occupying more than 3 acres, first to house constructional materials, ultimately to serve as maintenance and machine shop; lay-out of a construction camp on site for 750 workmen; erection of a huge concrete plant with output of 140 cubic yards per hour, one of the largest in the world; installation of the main refinery units, in itself a colossal task of erecting and linking-up the bewildering maze of pipes, tanks, stills, furnaces and huge towers that go to make up a modern oil refinery. Add to this permanent houses for key-staff, a beautiful theatre and games building (social club) and it is at once obvious that the Fawley we used to know has been completely transformed into a self-contained city of potentially some 2,000 inhabitants; incidentally, some of the original inhabitants appeared to be almost Americanized.

A tour of the refinery during the day before the official opening provided unrivalled opportunity for studying the lay-out in technical detail. Crude oil is delivered by tanker to a specially constructed marine terminal, a 3,200-ft. jetty jutting into Southampton Water and connected to the main plant by a 2,000-ft. long approach road, constructed over salt marshland, carrying oil, steam and salt-water pipe-lines into the heart of the refinery itself. Thence fed to storage tanks, oil eventually passes through pipe-still furnaces to heat it up to 750° F.; thus vaporized, it enters the fractionating tower where condensation takes place at different levels on 'bubble trays'.

There are three fractionating towers here, two operating at atmospheric pressure, and a third under vacuum with steam distillation to deal with 'bottoms' from the other two. An outstanding feature is undoubtedly the huge catalytic cracking plant ('cat cracker') fed with gas oil, using a catalyst in an extremely fine state of particle division (technically known as 'fluid catalytic cracking'). A specially designed thermal-cracking plant converts lubricating oil and motor spirit into high-octane spirit plus gas. A polymerization plant determines increase in octane-rating of motor spirit obtained by distillation. A debutanizer tower, 113 ft. high, weighing 135 tons, separates butane and associated volatiles from motor spirit, designed to meet current vapour-pressure specifications. The copper sweetening unit removes corrosive compounds and evil-smelling vapours from motor spirit. Then there is the Edeleanu plant for improving burning qualities of kerosene; a hypochlorite plant for removing unpleasant sulphur compounds from kerosene and turbo-jet fuels; the lubricating oil plant, involving propane de-asphalting, phenol extraction, propane de-waxing and clay treatment processes. The oxidizing plant produces some well-known 'blown' grades of asphaltic bitumen; a 'specialty' unit manufactures anti-corrosive additives for lubricating oil; a hydro-desulphurization plant effects removal of sulphur from tractor-fuel.

In view of the serious shortage of sulphur at the present time, a vitally important unit under construction is the sulphur plant, for the conversion of hydrogen sulphide, released during varying stages of refining crude oil, into chemically pure 99·5 per cent rock sulphur. Full sulphur production is scheduled for early 1953; output will be of the order of 12,000 tons a year.

Fawley now assumes priority as the largest oil refinery in Europe. It cost £37,500,000 to build. When in full operation it will produce 6,500,000 tons of petroleum products a year; more than a million gallons of motor spirit a day; and nearly 30 per cent of present total demand for petroleum and products in the British Isles. Not least in these financially stringent times, this brilliantly planned and executed work will effect a saving in foreign exchange of more than 2 million dollars a week.

Someone concerned with the lavish series of publications which a great occasion like this official opening obviously presented had the foresight and sensitive imagination to commission H. E. Bates to write a commemoration "Fawley Achievement", "as a tribute to the vision, skill, and energy of all those who helped to plan and build it". Much praise was heard throughout the time of our tour of the new Fawley; but many read this tribute with a feeling that no one could have done it better than Bates, nor given to the sponsors of this great enterprise more encouragement for the future than is justly their due.

H. B. MILNER

OBITUARIES

Mr. G. Udny Yule, C.B.E., F.R.S.

GEORGE UDNY YULE was a member of a family distinguished for its scholarship and administrative talent. His father, Sir George Udny Yule, a very successful administrator in the Indian Civil Service, was one of three sons of Major William Yule, of the East India Company's service, who was born in 1764 and was in his day a well-known Orientalist; of the others, one, Lt.-Colonel Robert Abercromby Yule, a rising cavalry officer, was killed at Delhi in command of the 9th Lancers in 1857; the other, Colonel Sir Henry Yule, is remembered internationally for his authoritative edition of Marco Polo's travels. Udny Yule thus had an oral tradition of learning and of civil and military administration reaching back to the end of the eighteenth century. Udny Yule himself was educated at Winchester and University College, London. Science and engineering were his early interests, and he spent a postgraduate year under Hertz at Bonn on research into the passage of electric waves through dielectrics, which formed the subject of his first published paper. This field, however, was not very close to his heart, and he never reverted to it.

Udny Yule's scientific career proper began in 1893, when he joined Karl Pearson at University College, London, as lecturer in statistics. Pearson was laying the foundations of the science of theoretical statistics and it was not long before Yule himself was making fundamental contributions to the subject. For the next fifteen years he devoted himself mainly to the theory of statistical relationship, publishing basic memoirs on correlation (1897, 1907) and on association (1900). His work on association was later (1912) summarized in a further paper, and little has been added to it since; his work on correlation, in one form or another, continued throughout most of his life.

From 1902 onwards Yule gave a series of Newmarch Lectures which in 1911 were amplified and published as "An Introduction to the Theory of Statistics". This famous text-book remained for many years the only extensive account of the subject. There are very few students of statistics even to-day who do not owe something to it. With numerous subsequent revisions it has reached its fourteenth edition and appears to be maintaining its place in spite of its now numerous competitors; it has been translated into several languages, notably Czech and Spanish.

In 1912 Yule went to Cambridge, where he became a Fellow of St. John's College and University reader in statistics. His academic career was interrupted by the First World War, and he spent the four years 1914–18 in the Contracts Department of the Board of Trade, his services being recognized by a C.B.E. Thereafter, scientific recognition followed by easy stages. He was elected a Fellow of the Royal Society in 1921, and president of the Royal Statistical Society in 1923, having been awarded that Society's highest honour, the Guy Medal in Gold, in 1911. He was honoured by several foreign societies and in 1947 was made an honorary member of the International Institute of Statistics.

During the phase from 1912 until 1927, Udny Yule's work fell into two classes. In conjunction with Major Greenwood he laid the foundations of the study of accident distributions, a subject which nowadays has a much wider field of application than when Yule began on it. His interest in statistical relationship found expression in a paper of 1921 on time correlation and one in 1926 on 'nonsense correlations'. His work culminated in a famous paper in 1927 on sunspots, which forms the starting point of the modern theory of oscillatory time-series.

In 1931 Yule retired and, characteristically, took up flying as a hobby. He was very proud of obtaining a pilot's certificate *A* at the age of sixty; but unfortunately his heart gave serious trouble shortly afterwards, and the remaining twenty years of his life were spent in comparative seclusion at Cambridge, which he rarely left.

His main scientific work was now at an end; but the literary and philological interests of his family began to show themselves. Moved by doubts cast on the traditional attribution of the authorship of the "Imitatio Christi" to Thomas à Kempis, he was led to a statistical study of literary vocabulary, on which he published his last book in 1944. His strength then failed, and during the closing years he was able to accomplish very little. He died at the Evelyn Nursing Home at Cambridge on June 26, 1951, at the age of eighty.

Yule's work is characterized by its originality, its thoroughness and a wonderful insight into the problems which he studied. A great many of the basic ideas of statistical theory can be traced back to his papers, where they find expression with the modesty and simplicity of genius. He was one of the statistical giants of his age. In spite of some provocation he never embarked on controversy, and his objectivity towards his fellow statisticians is without blemish. In character he was kindly and sociable, with opinions soundly based, firmly held but moderately expounded—a thoroughly lovable man.

M. G. KENDALL

WE regret to announce the following deaths:

Dr. K. C. Bailey, registrar of the University of Dublin, and during 1935–47 professor of physical chemistry in the University, aged fifty-five.

Sir Eric Maclagan, K.C.V.O., C.B.E., during 1924–45 director and secretary of the Victoria and Albert Museum, London, on September 14, aged seventy-two.

Prof. F. W. Oliver, F.R.S., emeritus professor of botany, University College, London, on September 14, aged eighty-seven.

NEWS and VIEWS

Higher Technological Education in Great Britain

THE statement of Government Policy for the Development of Higher Technological Education in Great Britain (London: H.M. Stationery Office, 3*d*. net) issued on September 20 sets forth the Government decisions on the report of the National Advisory Council on Education for Industry and Commerce, but gives little indication of real policy in either technical or technological education. The two are not clearly distinguished; but so far as the former is concerned, the policy would appear to be 'the mixture as before'. In regard to technological education, the chief feature is the rejection of the idea of a technological university, whether an entirely new institution or by the expansion of some existing institution. The cost of such a proposal is estimated at £6 millions, and its creation by either method is regarded as requiring too large a diversion of available resources. Instead, a policy of diversified expansion is to be pursued. The universities are to be encouraged to expand their existing departments in technology and to institute postgraduate courses in particular fields of technology, while the University Grants Committee is considering the possibility of expanding much more considerably at one or two places. On this side it will not be possible to pass judgment until the University Grants Committee indicates its proposals for the next quinquennium; but the Statement intimates that the Government proposals for making improved financial assistance available for selected technical colleges and courses will be announced shortly.

According to the Statement, some sixty technical colleges in England and Wales and six in Scotland provide higher technological education; but until these further details are made public it cannot be judged whether the proposed policy will yield any effective return and not lead to waste of resources through excessive diffusion. The Government has accepted the dubious proposal to establish a College of Technologists—though the use of the title 'Royal' is temporarily to be withheld—with responsibilities limited to granting awards of associateship, etc., and for the approval of courses for this purpose. Until the details of the Government's own proposals for selected technical colleges and those of the University Grants Committee in regard to the universities are made known, the value of the proposals cannot be judged. The trend of the Statement indicates a desire to court the favour of the universities and of the local education authorities, rather than to deal imaginatively with the real issues and to ensure that existing resources are used to the best advantage, from the national, and not from any sectional, point of view.

City and Guilds of London Institute

At a special general meeting of the members of the City and Guilds of London Institute, held at Skinners' Hall on September 21, H.R.H. the Duke of Edinburgh was elected president. The first president was King Edward VII, when Prince of Wales; but on his accession to the throne he became visitor in accordance with the Institute's Royal Charter granted in 1900, and the office had since remained vacant. This further connexion with the Royal Family is a high tribute to the Institute's independent work extending over a period of seventy years. It is also a reminder that much still remains to be done by all concerned with scientific and technological education, as the Duke of Edinburgh so clearly indicated in his presidential address to the British Association this year.

The Institute was founded by the Corporation and certain of the Livery Companies of the City of London in 1878, during the period which His Royal Highness described as the high-water mark of British industrial expansion. There was a great need for better scientific and technical grounding for those engaged in industry, and the Institute accordingly set itself to meet this need by founding Finsbury Technical College, the Central Institution (now the City and Guilds College) and the Art School at Kennington. Concurrently the Institute, having taken over the technical examinations of the Royal Society of Arts, began to build up the Department of Technology, the syllabuses and certificates of which are so well known to industry and to countless students and teachers in technical colleges. This is a long list to the credit of one body, and the common parentage is not always appreciated. The influence of each, from craft to professional level, on technological training and education has been considerable. This year recalls the 1851 Exhibition, which was also of practical significance to the Institute, for the City and Guilds College is among the educational institutions built on the site purchased with the proceeds of that great enterprise of Prince Albert.

United Nations Technical Assistance to Underdeveloped Countries

In view of the demands which the Colombo Plan and other schemes for technical assistance to the underdeveloped areas of the world may make upon British and other resources, particularly in scientific and technical man-power, the pamphlet "United Nations Work and Programmes for Technical Assistance" (pp. 40; New York: United Nations; London: H.M. Stationery Office; 1951; 15 cents. 1*s*.), issued by the United Nations Department of Public Information, makes a welcome appearance. Its forty pages contain a clear explanation of what is meant by technical assistance, how the programme came into being, the principles which determine the selection of experts or of projects, the way in which the programme works and is administered, and where the particular responsibilities lie, as well as the way in which it is related to other programmes of technical assistance. An annexe records the technical assistance given in 1950, including the countries aided, and a brief bibliography indicates where further information about the technical assistance work of the United Nations and the Specialized Agencies may be found. The pamphlet is strictly factual and should assist in the discussions of a subject that, as the recent report of the Advisory Council on Scientific Policy indicates, is likely to become increasingly important. While it outlines what is required of the assisted countries and should help to keep discussion free from prejudice, there is one important omission which doubtless is unavoidable in a pamphlet of this nature and length: it does not indicate the factors, such as population pressure, which may determine, independently of the merits of the programmes themselves, the success or failure of technical assistance. Such factors must receive full recognition in deciding on the allocation of limited scientific and technical resources, whether from the United Kingdom or elsewhere.

Natural Resources of Canada: Annual Departmental Report for 1948–49

The report of the Mines, Forests and Scientific Services Branch of the Department of Mines and Resources, Canada, for the year ended March 31, 1949 (pp. 117; Ottawa: King's Printer, 1950), which has been reprinted from the Department's annual report, covers the activities of the Bureau of Mines, Dominion Forest Service, Geological Survey of Canada, Surveys and Mapping Bureau, Dominion Water and Power Bureau, Geographical Bureau, National Museum of Canada and the Dominion Observatories. Special stress is laid upon the continued success of drilling operations in the new oil-fields in Alberta, and Canada's dependence on foreign supplies is expected to diminish considerably; besides a large increase in production for 1949, a considerable expansion of refining facilities was anticipated. Closely related to these developments are developments with natural gas which may markedly affect the economy of the country. There were also important developments in relation to iron ore, titanium and uranium. The salt industry continued to expand, as well as the forest industry, and exports of pulp and paper attained new records. Increasing attention is being given to the depletion of forests, and especially to more efficient utilization of the hewn wood, but losses through forest fires were again high. The Geological Survey's facilities for assisting in the search for radioactive minerals were extended, as well as those of its Geophysical Section for dealing with the plotting of magnetic data acquired with the airborne magnetometer. A pilot plant for the separation of bitumen from the bituminous sand of northern Alberta was ready for operation at the end of the year, and the practicability of structural steel welding in Canada under winter conditions has been demonstrated. Work on the use of red-stained jack-pine in sleepers and poles is likely to conserve timber supplies, and the Surveys and Mapping Bureau has been considerably expanded to meet the increased demand for maps in the study and development of Canada's natural resources.

Training for Social Work

An international survey of training for social work has been prepared by the United Nations Department of Social Affairs to provide the Social Commission and the Economic and Social Council with a detailed description and analysis of the methods of training of social workers in various countries. The study is based on reports submitted to the United Nations Secretariat and analyses the various conceptions of social work revealed in the definitions submitted. It also contains a survey of the general systems of education for social work that have been evolved for the professional training of social workers. In addition, it presents a comparative analysis of the non-curricular and curricular aspects of schools of social work in forty-one countries; the general body of knowledge imparted to social work students; the general pedagogical methods used in the preparation of social workers; the administrative and financial aspects of schools of social work; the duration of the period of study; the relative importance assigned to the subjects included within the curriculum; and the methods by which theoretical knowledge and technical proficiency are imparted. The study also reviews United Nations' activities relating to training for social work and offers suggestions for future action in the national and international fields. Three useful appendixes contain statements of the definition of social work and the social worker received from various countries; a descriptive summary of the organization and programme of study of one school of social work in each of forty-one countries; and a directory of schools of social work in all countries which have established such schools. Copies of the document may be obtained from H.M. Stationery Office, price 15*s*.

National Research Development Corporation

The President of the Board of Trade has made three new appointments to the membership of the Corporation, and has re-appointed those members whose initial period of service recently expired. The Corporation now comprises: Sir Percy Mills (*chairman*); Lord Halsbury (*managing director*); Prof. P. M. S. Blackett; Prof. E. C. Dodds; Sir John Duncanson; Sir Edward Hodgson; W. E. P. Johnson; J. F. Lockwood; Sir Rowland Smith; Sir Edward de Stein; and Sir Henry Tizard. The new members are: Mr. Lockwood, managing director of Henry Simon, Ltd., and a director of other engineering companies; Sir Rowland Smith, chairman of the Ford Motor Co. and chairman, or a director, of a number of associated companies; and Sir Henry Tizard, chairman of the Advisory Council on Scientific Policy and the Defence Research Policy Committee.

"Blue Sun and Moon"

Referring to their communication under this title on p. 554 of this issue, Dr. William Paul and Prof. R. V. Jones write: "Since our communication was written, Mr. R. R. Wilson, of the Royal Observatory, Edinburgh, has given an account, before Section A (Mathematics and Physics) of the British Association during the recent Edinburgh meeting, of his observations on the blue sun of September 26, 1950, and his deductions. Mr. Wilson succeeded in making spectrophotometric measurements of I_N/I_B for various wave-lengths, where I_B and I_N are the intensities of the blue and normal suns. The observed curve of log I_N/I_B against wave-length shows a minimum in the blue. Mr. Wilson has compared his results with theoretical curves as calculated by Van de Hulst and others and deduces a numerical value of $d(m-1)$, where d is the diameter of the scattering particles and m is the refractive index. He has discussed the probable nature of the scattering particles."

The Night Sky in October

New moon occurs on Oct. 1d. 01h. 57m., U.T., and full moon on Oct. 15d. 00h. 51m. The following conjunctions with the moon take place: Oct. 14d. 04h., Jupiter 5° S.; Oct. 26d. 17h., Mars 2° N.; Oct. 26d. 23h., Venus 0·04° S.; Oct. 28d. 18h., Saturn 5° N. In addition to these conjunctions with the moon, Mars is in conjunction with Regulus on Oct. 3d. 03h., Mars being 0·9° N. Mercury rises about an hour before the sun on October 1 and is in superior conjunction on October 13; it is too close to the sun to be seen during the remainder of the month. Venus, a morning star, rises at 3h. 10m., 2h. 40m. and 2h. 35m., on October 1, 15 and 31, respectively. The stellar magnitude of the planet is −4·3, and the visible portion of the disk varies between 0·20 and 0·42. Mars rises soon after 2h. throughout October and can be seen in the constellation Leo, close to Regulus early in the month. Jupiter is in opposition on October 3, rising early in the evening throughout the month and setting at 6h. 10m., 5h. 0m. and 3h. 50m., on October 1, 15 and 31, respectively. Saturn is too close to the sun in the early part of the month to be seen but rises 1h. 20m. before sunrise on October 15 and 2h. 40m. before sunrise on October 31. Occultations of stars brighter than magnitude 6 are as follows: Oct. 10d. 17h. 57·4m., δ Capr. (*D*); Oct. 10d. 18h. 50·4m., δ Capr. (*R*); Oct. 17d. 23h. 14·2m., *q* Taur. (*D*); Oct. 17d. 23h. 36·5m., 20 Taur. (*D*); Oct. 17d. 23h. 57·7m., 16 Taur. (*R*); Oct. 18d. 0h. 28·3m., *q* Taur. (*R*); Oct. 18d. 0h. 32·6m., 20 Taur. (*R*); Oct. 18d. 0h. 55·9 m., 21 Taur. (*R*). (*D*) and (*R*) refer to disappearance and reappearance, respectively, and the times refer to observations made at Greenwich. Strong moonlight towards the middle of the month will prevent good observations of the Orionid meteor shower.

Announcements

Prof. W. T. Astbury, professor of biomolecular structure, University of Leeds, has been elected a corresponding member of the Istituto Lombardo di Scienze e Lettere.

The Lord President of the Council has appointed Sir Eric Rideal, professor of physical chemistry in King's College, University of London, to be a member of the Advisory Council for Scientific and Industrial Research from October 1. Prof. H. W. Melville retires from the Council on September 30, on completion of his period of service.

An informal conference on cationic polymerization and related topics will be held in the University College of North Staffordshire during March 24–26, 1952. Intending contributors should send the titles of their papers not later than October 31, and summaries not later than January 15, 1952. The fee, comprising also meals and accommodation, will be approximately £3. All communications should be addressed to Dr. P. H. Plesch, The College, Keele, Staffs.

The Meldola Medal is the gift of the Society of Maccabaeans and is normally awarded annually. The next award will be made early in 1952 to the chemist who, being a British subject and less than thirty years of age on December 31, 1951, shows the most promise, as indicated by his or her published chemical work brought to the notice of the Council of the Royal Institute of Chemistry before December 31. Communications should be addressed to the President, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1, the envelope being marked "Meldola Medal".

PHYSICS OF SOCIAL EQUILIBRIUM

THE paper read by Dr. R. Fürth, reader in theoretical physics in Birkbeck College, London, on August 15 at the Edinburgh meeting of the British Association under this title broke new ground, and the enterprise of the author is a welcome sign that the natural scientist is making even more strenuous endeavours than he has done in the past to apply the concepts he has developed to social problems. A large amount of the work which has been carried out in the 'natural' and 'social' worlds has always been of common interest to both, as, for example, the theories of evolution developed during the nineteenth century. Nothing but good can come from the sharing of ideas and co-operative endeavour, provided that there is a clear understanding that there are fundamental differences between, as it were, the 'climates' of the two worlds, and that what is useful and will prosper in one world will not necessarily survive in the other.

At the beginning of his paper, Dr. Fürth has underlined the dangers that beset us when this proviso is neglected. As he points out, the use of physical models for the understanding of social phenomena has often led to gross over-simplifications, and sometimes to disastrous misunderstandings. Examples cited in the paper include the familiar analogies which are drawn between the concepts of 'forces', 'balances' and 'equilibrium', which refer to the properties of solid structures, and the behaviour of social communities. The model of a rigid body is, in fact, often used in popular literature to explain the processes of social change. Expressions such as 'the swing of the political pendulum' have crept into everyday language, and the result, as Dr. Fürth points out, is to give the ordinary citizen the erroneous belief that "present difficulties will in due course resolve themselves automatically by the working of some miraculous social mechanism".

Dr. Fürth is, of course, correct when he finds the distinction between mechanical machines and social communities in the *voluntary* working of the latter, and in the *intelligent* co-operation which exists between its parts. But he tends to over-state his case when he argues that the use of statistical techniques in the analysis of human behaviour may tend to predictions that are "completely wrong". It is perfectly just to point out that "the fate of the spinning ball is in no way influenced by the results of previous games", and to argue that predictions of social, as contrasted with natural, events are often invalidated by the mere fact that they have been communicated to the persons whose behaviour was the subject of the experiment. But in this case the statistician's 'other things' are not 'equal', and the validity of statistical techniques is left unimpaired. Indeed, the value of prediction in the social field often lies in the fact that processes of social change can be set in motion to avoid the occurrence of such phenomena as population decline that would otherwise take place.

Dr. Fürth's criticism of statistical techniques is, surely, only valid if the end-product of social science is accepted as the understanding of the very purposes of human life itself, and few social scientists would be presumptuous enough to maintain anything so outrageously ambitious. The main achievements of social scientists during the past generation have been to demonstrate that the extent to which human society is, in fact, 'voluntary' and human co-operation 'intelligent', is very much less than the intelligent Victorian believed or the common-sense man of to-day assumes. It is the unconscious influences that determine our everyday behaviour, and the undirected processes that shape the structure and development of human societies, to which we are turning our attention in increasing degree, and it is in that area of human experience that the methods of the natural sciences are most directly applicable. To what extent the unconscious can and should be made conscious, and the undirected brought under control, remains to be seen. But much (perhaps everything) that makes for human survival depends on it.

Dr. Fürth ends his paper with a plea for the application of statistical mechanics, the branch of theoretical physics which has been developed for the theoretical treatment of many physical phenomena, to the problems of social organization. In so far as the principal field of application, as Dr. Fürth points out, has been to the physics of systems or 'assemblies' of very large numbers of identical particles, there is a strong probability that social scientists will find in this branch of knowledge a valuable means for unravelling the very baffling problems which arise from the interaction between the individuals which compose a social group or community. But to argue more than this at the present time is highly misleading. To compare (as Dr. Fürth does) the behaviour of 'communities' of crystals of pure substances with that of human societies is surely to create the confusions and encourage the errors which he so rightly deplores at the beginning of his paper. To ascribe the political stability of the United Kingdom and of the British Commonwealth of Nations to "the soundness of their structures on the physical principles of strength of material bodies" is, at least, a gross over-simplification. The value of "statistical mechanics" for the social scientist must first be demonstrated by painstaking experiment in the factory working group or the housing estate neighbourhood before such generalizations are permissible.

T. S. SIMEY

FIELD-WORK IN ZOOLOGY

A DISCUSSION on "Zoology at the Marine, Freshwater and Field Stations" was held in Section D (Zoology) of the British Association at Edinburgh on the morning of August 13. Mr. E. Ford, director of the Marine Station at Millport, opened the discussion by describing the development of marine stations in Great Britain and abroad. His own station at Millport had as its first home the *Ark*, originally a floating laboratory moored in a submerged quarry at Granton, Edinburgh. Whereas in former days the attitude was that of the general practitioner in the broad field of zoological inquiry, the present tendency is to think and work as specialists. Specialization not only canalizes aim and effort but also leads almost inevitably to specialized institutions. The majority of the stations in Great Britain were at first committed by constitution to study the life of fishes in the interests of British commercial fisheries.

To-day, however, the main responsibility for this highly important public service is exercised directly by the Government through its different fishery laboratories and its permanent boards and commissions. There are special staffs and special laboratories dealing with other aspects. The Oceanographic Laboratory in Edinburgh, engaged in a plankton survey by means of automatic plankton recorders towed behind commercial ships; the newly constituted National Institute of Oceanography, devoting special attention to marine physical science; and the new Institute of Seaweed Research were quoted as examples.

Mr. Ford believes that there is a limit to the size of the station, beyond which it begins to lose that priceless opportunity for close personal association between all within its walls. A station that is too small has limited activities; a station that is too large is an impersonal workshop, and not a meeting place for colleagues.

Dr. H. D. Slack described the field laboratory on the west shore of Loch Lomond which was established in 1946 by the Zoology Department of the University of Glasgow for the study of life in fresh water and of insect life on land. This, being purely an extension of the Department of Zoology, has the same dual role of research and teaching. In the undergraduate course during the summer term, the benthic fauna of the Loch along a transect from the shore forms a part of the practical work, together with methods of hydrological investigation and a study of the plankton. Students specializing in freshwater biology undertake a research problem for presentation as a thesis in their honours degree examination.

Loch Lomond is divided into two by the Highland Boundary Fault: a shallow southern portion not more than 30 metres deep on Lower Carboniferous and Devonian rocks, and a long and narrow northern part on Cambrian mica-schists and grits with a greatest depth of more than 200 metres. Preliminary investigations of the hydrological data show that a thermal stratification is established in the deeper portion in July, but not in the shallow portion. The Loch is in general oligotrophic in character, but less so in its southern than its northern half. How far this tallies with the distribution and quality of the fauna has still to be determined, for very few observations have been made on the fauna of the deeper waters. Perhaps the distribution of fishes may afford evidence of the Loch's differential evolution. A perch-pike stage has been reached in the lower loch, and roach are common below the Highland Boundary Fault, while brown trout are still numerous throughout the Loch and appear to be more so toward the northern end. Only a reference in an old statistical account of 1796 stands as evidence of char having once been present, but the powan (*Coregonus clupeoides*) is abundant. This fish lives for the most part in deep water, feeding on pelagic plankton, but appears in large shoals in littoral regions during the summer.

Prof. L. A. Harvey's paper on field zoology at Exeter was read for him in his absence by Mr. J. Delany. He described the development of an annual course on ecology organized as a fortnight's camp under canvas. This started with only two students in 1932, was thrown open to the Universities of Britain in 1935, and now accommodates up to thirty students with a staff of three or four teaching members. Ladram Bay near Sidmouth was selected as a site from which ready access to as wide a variety of habitats as possible could be had. The programme is varied each year according to the interests and needs of the students and also of the staff. But whatever the individual items, the major aim has been to teach the principles and practice of ecological investigation rather than merely to elucidate the ecological relations within any given habitat. Quantitative methods used include ¼-m. sq. transects on the shore and salt-marsh and on moorland and bog, the use of random squares for assessing, in particular, plant populations, methods of estimating hardness, salinity, oxygen content, *p*H of water and various methods of trapping small mammals and of estimating the vegetation pattern associated with their distribution. Special techniques have been used at different times for assessing grasshopper populations, quantitative scoops for mud and gravel communities in the River Otter and the like.

Prof. Harvey, after brief mention of a fortnight's course of field studies for teachers which continued for some years but is no longer arranged, described a third project, namely, the investigation of the ecology of Lundy Island in the Bristol Channel. The Lundy Field Society has been founded, membership of which is open to anyone interested, and by this means it is proposed to weld together the interests and activities of both professional biologists and amateur naturalists. So far this has been most successful on the ornithological side, and an ornithologist is maintained as warden. Considerable progress has been made on surveys of the shores of the Island. Here, within a very small compass, exists a high degree of variation—from extreme exposure on the granite of the west and south-west to full shelter on the east, while entirely different shore conformations are provided by the little tag of slate at the south-eastern tip.

Dr. J. P. Harding, in expressing a museum attitude to work at marine, freshwater and field stations, said that there are many problems in zoology which can be best attacked by uniting the efforts of workers in many different fields. Among the most important are those concerning the mechanisms of evolution and the origins of species. The museum worker has helped with these problems not only by naming, describing and classifying species, but also by studying their geographical distribution. Animals living at any one time in a small area such as the British Isles can be divided into a number of quite different species. Each species consists of a population of individuals distinguished from other species by the possession of a number of characters which, while they will vary to a greater or lesser extent from individual to individual, do not do so sufficiently for there to be any overlap between one species and the next. Over a large area, however, such as that of a continent, the population living at one end may be quite distinct from that at the other; but there may be a complete series of intermediate populations in between. The herring gull and the lesser black-backed gull provide a very good example. These behave in Great Britain as two quite distinct species with no intermediates; yet a continuous series of birds linking up the two can be found by studying these gulls throughout their geographical ranges. Herring gulls extend in North America from Labrador to Alaska, and lesser black-backed gulls in Europe from Norway to Siberia. The birds in Siberia are, however, very much more like the herring gulls of Alaska than the lesser black-backed gulls of Britain, although they are linked with the latter by a more-or-less continuous population. This is an extreme case of a continuously varying species, the end members overlapping but not inter-breeding.

The museum man with large collections of specimens from all over the world is in a favourable position for studying this type of geographical distribution; but it is the field-worker who can best study local variations of physiological characters, and these, being more intimately concerned with the animals' welfare, are often of great adaptive value. The museum worker is constantly finding differences between his specimens and being unable to decide whether these are due to the effects of the environment or not; only someone in the field can find out for him.

The president of Section D (Dr. C. F. A. Pantin), Mr. J. Colman, Mr. H. C. Gilson, Prof. H. R. Hewer, Prof. A. D. Hobson and Dr. C. F. Hickling took part in the discussion which followed. Dr. Pantin drew a distinction between biology and the physical sciences; workers in either research or teaching in biology have to derive general principles from very complex situations. The solution of biological problems, he said, often comes from unexpected directions, and can only be appreciated by those with a direct contact with the animals themselves.

TRANSFER OF LIGHT ENERGY WITHIN THE PIGMENT SYSTEMS PRESENT IN PHOTOSYNTHESIZING CELLS

By L. N. M. DUYSENS

Biophysical Research Group, Utrecht

IN investigations[1,2] on photosynthesis of diatoms, it was found that light quanta absorbed by the carotenoid fucoxanthin brought about as strong a fluorescence of chlorophyll *a* as light absorbed by chlorophyll *a* itself; thus, energy transfer occurs with an efficiency of one hundred per cent.

With more refined spectral methods, we have carried out a more general investigation of the energy transfer between pigments within the photosynthetic apparatus. The work covers the main groups of photosynthesizing organisms. Fluorescence spectra were determined by means of a monochromator and a slightly modified photoelectric A.C. amplifier as described by Milatz and Bloembergen[3]. Various wave-lengths of incident monochromatic light were used for exciting fluorescence; the absorption of the incident light in the cells was also determined. Action spectra of photosynthesis of the same organisms were determined by J. C. Goedheer in this Laboratory, using a polarographic method[4]. In some cases phototaxis action spectra, which may be assumed to correspond with the photosynthesis action spectra[5,6], have been measured with Manten's bacteriophotometer[5].

The main photosynthetic pigment in purple bacteria, bacteriochlorophyll, probably occurs in three distinct bacteriochlorophyll-proteins[7], distinguished by absorption maxima at 800, 850 and 890 mμ respectively. For the sake of convenience they will be called here *B* 800, *B* 850 and *B* 890.

By examining fluorescence spectra, it was found that only *B* 890 shows fluorescence.

Transfer of light energy from the carotenoids to *B* 890 was found to occur in *Chromatium* strain *D* and in a strain of *Rhodospirillum molischianum* with efficiencies of 35–40 and 50 per cent respectively. If complete transfer to *B* 890 occurred, the fluorescence action spectrum (corrected for absorption) would be proportional to the absorption spectrum of the bacteria, also between 450 and 550 mμ, in which region the absorption is mainly due to the carotenoids. If, on the other hand, no energy transfer to *B* 890 occurred, the fluorescence action spectrum would be proportional to the absorption spectrum of bacteriochlorophyll, and only a small activity for fluorescence excitation would be found between 450 and 550 mμ. The fluorescence action spectrum actually found (Fig. 1) proves that a partial transfer takes place. Fig. 1 further shows that the action spectrum for *B* 890-fluorescence is proportional to the action-spectrum for phototaxis (or photosynthesis). This indicates that the carotenoids take part in photosynthesis only by transferring their excitation energy to *B* 890.

Additional experiments in the infra-red region showed that *B* 800 and probably *B* 850 also transfer their excitation energy to *B* 890.

By determining fluorescence spectra for various wave-lengths of incident light, it was found that, in vital cultures of *Chlorella*, only chlorophyll *a* shows fluorescence. From the fluorescence action spectrum it could be concluded, in an analogous way as above, that an almost complete transfer of excitation energy from chlorophyll *b* to chlorophyll *a* occurs, which is in agreement with the high efficiency of chlorophyll *b* in photosynthesis.

In solutions of about 10^{-6} *M* of both pigments in acetone, transfer of energy from chlorophyll *b* to *a* was also established, the efficiency being about 50 per cent.

The rather complicated fluorescence spectra of the red algæ *Porphyra laciniata* and *Porphyridium cruentum* and also of the blue alga *Oscillatoria* sp. could be analysed reasonably well in terms of fluorescence spectra of chlorophyll *a*, of the phycobilins and of an unknown pigment with a fluorescence maximum at about 725 mμ.

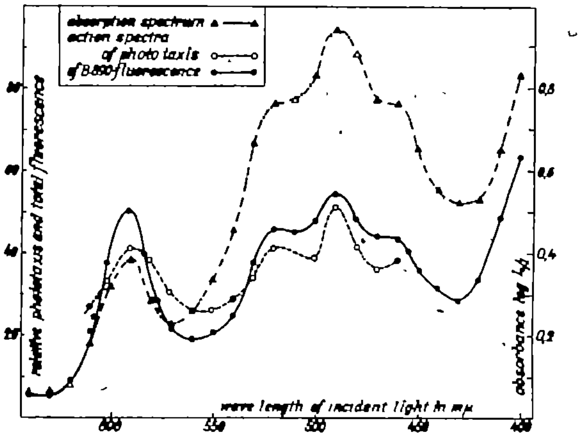

Fig. 1. Absorption spectrum, and action spectra for phototaxis and for *B* 890-fluorescence of *Chromatium* strain *D*. The absorption peak at 590 mμ is due to bacteriochlorophyll, the absorption between 450 and 550 mμ mainly to carotenoids. The carotenoids appear to be active with about the same efficiency both for phototaxis and for bacteriochlorophyll fluorescence. The fluorescence molecule is *B* 890 (see text)

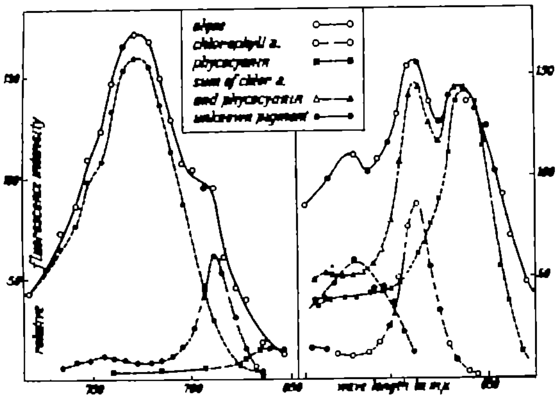

Fig. 2a. Fluorescence spectrum of *Porphyra lacineata*; relative fluorescence per quantum of incident light absorbed by chlorophyll *a* at 420 mμ (70 per cent of the absorption is due to chlorophyll *a*)

Fig. 2b. Fluorescence spectrum of *Porphyra lacineata*; fluorescence per quantum absorbed by all pigments at 546 mμ (approximately 70 per cent of the total absorption being due to phycoerythrin)

The fluorescence of chlorophyll *a* in *Porphyra lacineata* (Fig. 2b) per quantum absorbed by all pigments (incident light of wave-length 546 mμ) appears to be stronger than the chlorophyll *a* fluorescence (Fig. 2a) per quantum absorbed by chlorophyll *a* itself (incident light of wave-length 420 mμ). As the absorption at 546 mμ is mainly due to the phycobilins and chlorophyll *a*, it follows that quanta absorbed by the phycobilins excite chlorophyll *a* molecules to a stronger fluorescence than quanta absorbed by chlorophyll *a* itself. This surprisingly high yield of chlorophyll *a* fluorescence for light absorbed by the phycobilins, as compared with the yield for light absorbed by chlorophyll *a*, was also found—but still more pronounced—in the other species of blue and red algæ investigated.

From these observations it may be concluded, not only that chlorophyll *a* occurs in these cells in two different modifications, differing in fluorescence yield, but also that energy is transferred from the phycobilins to the highly fluorescent part of chlorophyll *a*, probably with high efficiency, and that consequently energy is not, or only to a slight degree, transferred to the weakly fluorescent chlorophyll *a* molecules. The weak fluorescence of these molecules in *Porphyra* may be due to transfer of energy to the above-mentioned unknown pigment, since its fluorescence is particularly strong (Fig. 2a) for the wave-lengths of incident light for which chlorophyll *a* fluorescence is comparatively low. The following observations support this view. By preliminary spectral and chromatographical investigations of *Porphyra* extracts carried out by F. van de Veerdonk in this Laboratory, a pigment was found—there are indications that it is chlorophyll *d*—of which the absorption was only about one-thousandth of that of chlorophyll *a* at the respective maxima of absorption. If we assume that this pigment occurs in *Porphyra* in the same ratio to chlorophyll *a* as in the extracts, its absorption is too small to be responsible for the strong fluorescence found. Therefore this fluorescence can only be due to energy-transfer from another pigment.

Energy transfer was also established in the red algæ from phycoerythrin to phycocyanin with an efficiency of probably more than 80 per cent in *Porphyridium cruentum*, and also from phycocyanin to chlorophyll *a* with about the same efficiency as from phycoerythrin. In these experiments, the wave-lengths of incident light exciting the fluorescence were: 546 mμ, mainly absorbed by phycoerythrin, and 600 mμ, mainly absorbed by phycocyanin.

Prof. C. S. French, working with *Porphyridium* at about the same time, kindly sent me action spectra, for incident light in the region 400–550 mμ, for the fluorescence of chlorophyll *a*, phycoerythrin, and phycocyanin. The action spectrum for chlorophyll *a* fluorescence demonstrates in an elegant way the low yield which occurs in the region in which chlorophyll *a* is mainly absorbing, as compared with the region in which phycoerythrin is mainly absorbing. The action spectra suggest, as Prof. French remarks, that light energy is transferred from phycoerythrin via phycocyanin to chlorophyll *a*. Hence our results seem to be in good accordance with his.

Light absorbed by the phycobilins proved to be more active in photosynthesis than light absorbed by chlorophyll *a*, as was previously established by Haxo and Blinks[4] for other species of red and blue algæ. Owing to experimental difficulties, hitherto we could only establish qualitatively the parallelism between the yield of chlorophyll *a* fluorescence and photosynthesis in red and blue algæ. Considering the position in other groups of organisms already described, we put forward the following picture of the two paths of energy transfer in red algæ:

(1) Phycoerythrin → phycocyanin → chlorophyll *a* → photosynthesis
↘ ↘ ↘
fluorescence fluorescence fluorescence and other energy losses.

(2) Weakly fluorescent chlorophyll *a* → unknown pigment →
↘ fluorescence
heat and other energy losses and other energy losses.

In the blue alga *Oscillatoria* the path of energy transfer was found to be the same, the only difference being that phycoerythrin is lacking. It should be emphasized, however, that in *Porphyra* the fluorescence of the unknown pigment is more pronounced than in the other species of red and blue algæ; so the energy transfer from the weakly fluorescent part of the chlorophyll *a* to this pigment is only assumed on grounds of analogy.

The transfer of electronic excitation energy between pigment molecules as reported above probably takes place through inductive resonance between the excited molecules and the molecules in the ground-state, a theory for which Förster[5] has given a quantum-mechanical treatment, with the aid of which the probability of energy transfer can be calculated from experimental data. Estimations, based on Förster's considerations, are in accordance with, or at least do not contradict, the results recorded above.

Summarizing, we may say that the evidence obtained is in favour of the view that, in algæ, light energy absorbed by a pigment, active in photosynthesis, is transferred to the 'chemical' part of photosynthesis only via chlorophyll *a*, and in purple bacteria only via bacteriochlorophyll *B* 890.

A detailed report of this and related work will be published elsewhere.

This investigation has been made possible by a grant from the Netherlands Organization for Pure Research (Z.W.O.) and was carried out under the direction of Prof. A. J. Kluyver (Delft) and Prof. J. M. W. Milatz (Utrecht). [May 9.

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CONFIGURATION OF POLYPEPTIDE CHAINS

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WE have recently formulated a number of configurations of polypeptide chains that differ from all those previously discussed in that they conform rigorously to the structural principles that have been set up on the basis of the precise X-ray studies of crystals of amino-acids, simple peptides, and related substances that have been made in our Laboratories during the past fifteen years[1-4,8,9]. In the proposed configurations, the interatomic distances and bond angles have the values found experimentally, the amide groups are planar, and hydrogen bonds N—H. . . O are formed with the N—O distance 2·8 A. and with the oxygen atom close to the N—H axis. Agreement in dimensions of units of structure and in observed and calculated intensities of X-ray diffraction maxima has provided strong evidence that these configurations are present in various synthetic polypeptides[4] and fibrous proteins[5-8], and also in hæmoglobin[9].

Perutz has recently suggested[10] a way of testing for the presence of our 3·7-residue helix, which he describes as "a simple and decisive criterion in the X-ray diffraction pattern". In the 3·7-residue helix (which we call the α-helix) there are approximately 3·7 residues per turn of the helix, which has a pitch of about 5·55 A., and thus the axial length per residue is 1·5 A. Perutz has pointed out that the form factor for the helix would show a strong maximum in the meridional direction at the spacing 1·5 A., and that accordingly synthetic polypeptides and proteins with this helical structure would be expected to produce a diffraction maximum at the spacing 1·5 A., if the specimen be suitably oriented. He found that the reflexion is given by poly-γ-benzyl-L-glutamate, hair, and porcupine quill-tip, but not by hair stretched to the β-form. He concluded that the "presence of this reflexion does not in itself prove the correctness of Pauling and Corey's structure, but taken in conjunction with the favourable agreement of observed and calculated intensities of other reflexions already obtained by these authors, it leaves little doubt about their structure being right". It should be mentioned that we had previously mentioned the existence and significance of the 1·5-A. reflexion, in the following words (ref. 7): "We would expect that side chains of different kinds on the α helix would repeat after an integral number of residues, corresponding to an integral multiple of the residue length along the helix axis, about 1·53 A, and that accordingly those orders of basal plane reflection for which the spacing approximated closely to certain multiples of 1·53 A. would be enhanced in intensity. It is in fact found that about 80 per cent of the meridional reflections are of this type; for both Venus clam muscle and porcupine quill they are multiples of 1·51 A. The reflections at 1·49 A, 3·05 A, 4·50 A, and 6·19 A for porcupine quill, which represent the first four orders of enhancement, are the strongest features of the wide-angle meridional pattern, except for the 5·2-A arc."

Perutz also looked for the 1·5-A. reflexion on X-ray photographs of feather rachis keratin, for which we suggested a structure involving 3·7-residue helixes as well as pleated sheets of extended chains[8], and he states: "Prolonged exposure of seagull's feather rachis set at the appropriate Bragg angle revealed no trace of such a reflexion, which shows that the structure proposed by Pauling and Corey must be wrong". (We may add that we have recently discovered a type of pleated sheet differing somewhat from that described in our earlier papers; this new pleated sheet, with alternate chains reversed in direction, might be present in feather rachis keratin and other proteins, instead of the polar pleated sheet.)

We agree with Perutz that the 1·5-A. reflexion is an important criterion for the 3·7-residue helix, but our assessment of the significance of the absence of this reflexion differs from that of Perutz. We agree with him that the presence of the reflexion does not in itself rigorously prove the presence of the 3·7-residue helix, but that a strong reflexion in the right position relative to the fibre axis direction and with spacing in the range 1·46–1·55 A. is to be taken as very strong evidence of the presence of the α-helix. On the other hand, Perutz, as shown by his statement about feather rachis quoted above, has assumed that the absence of such a reflexion rigorously eliminates the α-helix from consideration. This is not true. For example, a protein or synthetic polypeptide might have a structure involving α-helixes packed together in such a way that half the helixes are displaced along the fibre axis relative to the other half by an odd multiple of 0·75 A. In this case the radiation scattered by one chain in the direction giving rise to the 1·5-A. reflexion would be exactly out of phase with the radiation scattered by a neighbouring chain, and interference would result which would cause the intensity of this reflexion to be zero. We hence conclude that the presence of the 1·5-A. reflexion is to be taken as strong evidence of the presence of polypeptide chains with the 3·7-residue helical configuration, but that the absence of this reflexion is not to be taken as strong evidence of the absence of the 3·7-residue configuration; it indicates either that these helixes are not present, or that they are present but are arranged in such a way as to produce strong inter-chain interference for this reflexion.

Let us consider as an example the crystalline synthetic polypeptide poly-γ-benzyl-L-glutamate, which we have described[4], on the basis of data published by Bamford, Hanby and Happey[11], as having a monoclinic (pseudo-orthorhombic) structure involving two polypeptide chains per unit, these chains having the 3·7-residue configuration, with eleven residues in three turns. The two chains in the unit appear to be related by a two-fold axis or a two-fold screw axis. If they were related by a two-fold axis the 1·5-A. reflexion would be expected to appear. If, on the other hand, they were related by the two-fold screw axis the two chains would be displaced along the direction of the fibre axis relative to one another by one-half the identity distance, that is, by one-half the distance occupied by eleven residues, and hence by an odd multiple (eleven) of 0·75 A.; the structure factor for the 1·5-A. reflexion (the reflexion 0.11.0 from the unit with fibre axis length b_0 = 17·3 A.) would be 0, and this reflexion would not be observed. The fact that Perutz has observed this reflexion for poly-γ-benzyl-L-glutamate shows that the two chains in the unit are not related by a two-fold screw axis.

Feather rachis keratin is similar, in that the structure which we have proposed for this protein involves two helical chains with the 3·7-residue configuration per unit of structure. We point out that there is a reasonable probability that the two α-helixes are displaced relative to one another by 0·75 A. or an odd multiple of this distance, which would lead to zero intensity for the 1·5-A. reflexion, and that accordingly Perutz's statement that "the structure proposed by Pauling and Corey must be wrong" is not justified. As to the structure itself, we may mention that we have proposed it for feather rachis keratin with some reserve, whereas our assignment of the 3·7-residue helix to the synthetic polypeptides poly-γ-methyl-L-glutamate and poly-γ-benzyl-L-glutamate and to α-keratin, α-myosin and related proteins, as well as to the rods discovered by Perutz and his co-workers in the hæmoglobin molecule[12,13], was made with much confidence, as was also our assignment of the three-chain helical structure to the fibrous proteins of the collagen–gelatin group. Our comparison of calculated and observed intensities of equatorial X-ray reflexions of feather rachis keratin provides some support for our proposed structure, but the support is far from conclusive. The statement by Ambrose and Elliott[14] that the infra-red spectrum of feather rachis indicates the presence of hydrogen bonds oriented parallel to the fibre axis as well as laterally also provides some support for the proposed structure, inasmuch as the α-helices involve parallel hydrogen bonds, those for the pleated sheet being lateral. Perutz's failure to observe the 1·5-A. reflexion does not eliminate this structure from consideration.

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Polypeptide Chains in Muscle

In a recent paper on the configuration of polypeptide chains in keratin, myosin and related proteins[1], we have discussed a mechanism of the contraction of muscle, involving the conversion of the contractile protein from a pleated sheet of nearly completely extended polypeptide chains to a double row of 3·7-residual helixes. Through oversight we omitted to discuss the apparent incompatibility of our proposal with the X-ray data of Astbury and Dickinson[2], who reported a number of years ago that both extended and contracted muscle give X-ray photographs of the α-keratin type. Our attention has been directed to the oversight by several correspondents, and by a note by Huxley and Perutz[3], who have found that both extended and contracted dried frog sartorius muscle show the 1·5-A. reflexion characteristic of the 3·7-residue helix, and proposed by Perutz[4] as a criterion for the presence of this helix.

There are several different proteins present in muscle, and we think that it is likely that the protein which makes the greatest contribution to the X-ray diffraction pattern is not the one which undergoes significant structural change during the process of contraction. We suggest that the structural units 100 to 200 A. wide and 200 or 300 A. long, indicated by electron micrography to be attached together in a muscle fibril, consist of boxes made of α-keratin (and perhaps also in part of collagen), within each of which there are strung (in the extended fibril) pleated sheets of the contractile protein between the two ends connecting the box with the adjacent boxes in the fibril. We think it likely that the pleated sheets of contractile protein are not packed together in the way that they are in dried β-keratin or in silk fibroin, but are instead separated from one another by layers of solution which may be 50 A. thick, this separation permitting the easy access of solute molecules to the contractile protein. With such an arrangement of pleated sheets the characteristic β-keratin X-ray pattern would not be observed; the relative positions of pleated sheets so widely separated from one another would probably be sufficiently random to cause the aggregate to give rise only to a diffuse diffraction pattern, not much different from the molecular form factor for a single pleated sheet. In the extended muscle, the non-contractile α-keratin oriented parallel to the fibre axis of the muscle would give rise to the X-ray pattern reported by Astbury and Dickinson and by Huxley and Perutz. On contraction of the muscle the pleated sheets of contractile protein would be converted, according to our suggestion, into α-helixes, which would be well oriented with respect to the fibre axis of the muscle, whereas the non-contractile protein of the α-keratin type would become somewhat disoriented, as a result of the shortening of the structural unit of which, we postulate, it forms the framework. This structure could thus also account for the X-ray observations of Astbury and Dickinson and of Huxley and Perutz on contracted muscle.

We have proposed this mechanism of muscle contraction as a reasonable one, which is compatible with our present knowledge of the structural chemistry of polypeptide chains, and which accounts for the usually observed extent of contraction of muscle, namely, about 55 per cent. Although, as shown by the preceding discussion, the interpretation of the X-ray pattern will not be simple, a very thorough X-ray investigation might reveal the structure of the contractile protein as well as of the non-contractile protein in muscle. [August 10.

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HIGH-POWER PHOTO-FLASH TUBES

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IT is of very great advantage to be able to extend to cinematography, involving ultra-rapid exposures (less than 10^{-4} sec. duration) repeated at the requisite frequency over a long working time, the type of flash-tube which hitherto has been limited to use in simple photography with single exposures or with exposures taken at long intervals. This extension, however, presents entirely new problems in regard to the construction of such tubes. When flashes, each dissipating energy $W = \frac{1}{2}CV^2$ (energy of a condenser discharge), are repeated at the frequency n per sec., the average power dissipated over the working time t of the tubes is $\frac{1}{2}nCV^2$ watts. Flash tubes as at present constructed dissipate powers of less than 20 watts; for example, those giving a maximum of one flash of 100 joules every 5 sec.

We have made some progress in developing high-power tubes, which will operate, for example, at some hundreds of watts for a long working time, or at some kilowatts over a period of a few seconds. The following are the main principles of the design:

(1) The general dimensions, particularly the tube cross-section, are very large in order to permit adequate cooling.

(2) Instead of using internal electrodes, the electrodes form part of the envelope of the tube. The Kovar electrodes are joined to the glass (Moly glass) forming the rest of the tube by means of a gas-tight solder seal. The external surface of the electrodes is cooled by direct contact with the outside air; the cooling may be improved by the use of fins, or by the circulation of compressed air or water.

(3) When the tubes are used as optical sources, it is nearly always necessary to locate the light source in some definite position. This result is obtained by means of an axial canalizing tube (Fig. 1) of small section. This tube is made of quartz because of the high temperatures it has to withstand; and its diameter, of a few millimetres, is chosen so that the current density may attain values corresponding to the maximum light efficiency. In order that the discharge should pass only through this canalizing tube and not through the annular space between it and the envelope, the canalizing tube is extended by two bell-shaped ends B_1 and B_2 inside which each electrode projects towards the inside of the tube. This arrangement, which makes the discharge path through the canalizing tube shorter than any path passing through the annular space, was found to be completely efficient.

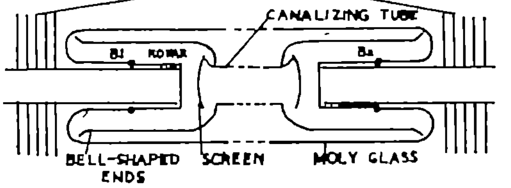

Fig 1

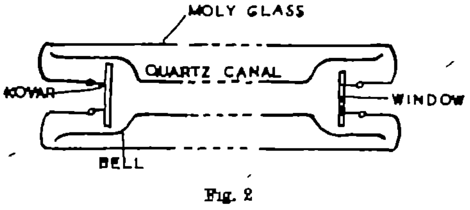

Fig. 2

(4) Intense pulverization of the cathode occurs in these high-power tubes, so producing an opaque deposit on the walls of the canalizing tube, which should be kept transparent. Owing to the fact that the metallic particles shot off from the cathode travel in straight lines, the canalizing tube can be kept transparent by placing a screen between it and the cathode, or by bending the tube at the cathode end.

Figs. 1 and 2 show two models of high-power flash-tubes which have been constructed in accordance with the above principles. That of Fig. 1 is used to make moving pictures, and operates for prolonged periods with an input power of 500 watts at the rate of 50 flashes/sec. (two flashes for one image). In the other model (Fig. 2) the extra high brilliance of the emitting tube at its end can be utilized, and in this case the cylindrical electrodes are sealed by Moly glass soldered to the metal by high-frequency heating[1]. This tube has made possible, for the first time, cinematography of living non-stained preparations with a phase-contrast microscope. The energy of a flash is about 10 joules, so that the tube must operate with an input of 1 kilowatt for a series of exposures at the rate of 100 images per sec.[2].

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LEARNING ABILITIES OF BIRDS

A COMPREHENSIVE and meritorious survey of existing knowledge of the learning abilities of birds and their relation to the theory of instinctive behaviour has been set out in two recent articles by W. H. Thorpe (*Ibis*, 93, Nos. 1 and 2; January and April 1951). It is pointed out that the concepts of instinct and of learning are intimately related as complementary aspects of total behaviour, and that one cannot be understood without the other. Besides the definitions necessary for the description of instinctive behaviour and of learning itself, Thorpe also suggests definitions for certain other terms like reflex, kinesis, and taxis which are necessary for the full description of behaviour. The following is a summary of Thorpe's main conclusions.

Habituation is considered to be, in many respects, the simplest type of learning, and is one which is almost universal in animals. It is shown to be of vital importance in the process of adapting behaviour to generalized environmental stimuli (for example, sudden sounds, shadows and movements) which may be precursors of danger, but which experience has, in fact, shown to be harmless or of no significance. Habituation is thus caused by some stimulus or situation which puts the animal into a given mood but fails to lead to the release of a particular consummatory act. The more closely linked a stimulus situation (sign stimulus) is with a specific instinctive act, the less likely it is to be the subject of habituation.

The classical conditioned reflex is shown to be an artificially isolated part of a whole learning process and is only intelligible biologically as part of such a process. As with habituation, it is primarily one of the methods by which innate receptory correlates of the less specific kinds are elaborated to fit the environmental situation more exactly.

Trial-and-error learning incorporates an active appetitive behaviour which constitutes the process of trial and is characterized by the retroactive action of the influence exerted by the reward. Trial-and-error learning is shown to be of immense importance in the development of bird behaviour, particularly on the effector side, in the acquisition of skill involved in the perfection of elaborate behaviour patterns, such as flight, nest-building and escaping from enemies. On the receptor side of such behaviour the conditioning element in trial-and-error learning leads to modification of the configuration of stimuli to which the animal is responding. Trial-and-error learning also serves to account for many examples of learning with puzzle-boxes and mazes. The learning function of play in improving skill is considered as a phase and is more prevalent in young birds than is usually thought. The danger of confusing maturation of an innate behaviour pattern with improvement due to trial-and-error learning is stressed.

Under this head of insight learning, Thorpe discusses the type of exploratory learning now known as latent learning, and its significance in the establishment of territory; tool using and detour behaviour are also possible examples of insight learning. In an analysis of recent work on the number concept in birds, Thorpe suggests that Kohler's conclusions that certain birds show two pre-linguistic faculties, (1) simultaneous and (2) successive, *unnamed* number sense, little, if at all, inferior to that of man, must be accepted as proved. The essential difference, therefore, between the number concept of animals and men is that only the latter have, in addition, the ability to deal with 'named' numbers. The significance of visual illusion experiments for the theory of insight learning is also considered, as are some other learning abilities suggestive of insight.

Analysis of the imitative abilities of birds suggests that a distinction must be made between social facilitation, local enhancement and true imitation. The first two play an important part in bird life, but the evidence for true imitation is at present very slender; vocal 'imitation' is not considered necessarily to involve imitation in the true sense.

Discussing imprinting as an innate disposition to learn in a particular direction and in a particular restricted period, it is believed that, once accomplished, this type of learning is particularly difficult to eradicate and is significant in understanding the theory of instinctive behaviour, and especially of the innate releasive mechanism. The important evidence supplied by pathological imperfections in imprinting is examined while the perceptory side of song learning is considered as a special case of imprinting.

Some learning abilities are of doubtful significance, the most important of these being the ability to recognize individuals. The subject of tameness is also discussed, and, in Thorpe's view, genetic tameness and wildness are undoubted realities. No evidence is found for an inherited recognition of man as an enemy, but it is shown that a tendency to general wariness readily becomes attached to man, but can be overcome by a variety of learning processes.

The memory powers of birds are also considered; instances of memory for individuals extending for periods of a year or more are well authenticated; and it is possible that memory for territory is often still more enduring.

MANAGEMENT PROBLEMS AND LOCAL GOVERNMENT

IN the most recent occasional paper of the British Institute of Management, Mr. J. E. MacColl suggests that, though latent for many years, there is a crisis in local government which has been made more acute by the stresses of post-war reconstruction.

Because of this stress, there has been a trend of functions from small authorities to large, and from large authorities to the central government. From a purely administrative point of view "large local authorities are more likely to be effective instruments than small ones. For many purposes the central government may be the most effective of the lot." But in our desire to produce maximum administrative effectiveness, care must be taken not to overthrow democracy itself. Mr. MacColl states that highly efficient local government departments are not necessarily satisfactory, and humanity, imagination and sensitiveness to local feeling are no less important than costs per head. People should not feel that their communal services are supplied from above regardless of their likes and dislikes, the ultimate test in a local democracy being whether the citizens find their town a pleasant place to live in and whether they feel responsible for what is done in their name.

Nevertheless, local government must be assessed by efficient criteria, and, in the first place, it must be acknowledged that much inefficiency has nothing at all to do with the limitations set by democratic control. In the second place, it is desirable to know what, in fact, are the costs of democracy. It is dangerously easy for councillors to ask for this return or that without any idea of what it really means in terms of extra cost. Mr. MacColl also discusses the lack of any adequate check on the number of staff in local government services. Although local government officers and especially senior officers work hard, much of their work could either be avoided or lightened. Each extension of intensification of activity leads to a demand for more staff, who really are needed unless or until somebody starts at the beginning to recast the whole administrative scheme.

As the amount of work a local authority is called upon to do increases, more and more staff are employed, extra office space taken over and a rich variety of forms designed. There is pressure from committees to speed up output of houses or to open new branches of the public library, pressure occasionally punctuated by panic when increases of rates threaten. The process goes on without anyone asking whether the load could be carried more efficiently or shared more evenly; perhaps without anyone having a clear idea how to set about finding this out. These difficulties are accentuated by excessive departmentalization and the absence of a general manager. Although it may be disturbing to those with orthodox views of British local government, there may be need for a hybrid political administrator to make the kind of contribution of the burgomaster or the American mayor.

Mr. MacColl also discusses the kind of men and women who are needed in local government service, and the relationships which should exist between the paid officers and the lay councillors. One of the crucial issues to be decided is whether it is more important to have highly trained and expensive administrators, or men and women who understand the peculiarities and idiosyncrasies of their own locality.

T. H. HAWKINS

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Blue Sun and Moon

ALTHOUGH the blue sun and moon are noteworthy phenomena, the physical origin of the colour does not appear to be well known. While, therefore, the following explanation is presumably neither novel nor complete, it may interest those who wish for "the vivid colouring of a physical illustration".

The cause of the sun appearing red has long been known to be due to the preferential scattering of blue light relative to red by dust particles and to small-scale fluctuations in refractive index in the atmosphere. Rayleigh showed that for particles of any given size much smaller than the wave-length, the scattering of radiation is inversely proportional to the fourth power of the wave-length; thus, for particles of less than 0·1 micron in diameter, light of wave-length 4000 A. would be scattered nine times more effectively than light of wave-length 7000 A. For the sun to appear blue, the relative magnitudes of scattering must be opposite to those which the Rayleigh theory predicts. This opposite condition can arise when the particles do not obey Rayleigh's criterion of being small compared with the wave-length.

The theory of scattering of electromagnetic radiation by spherical particles above the Rayleigh limit was first worked out by Mie[1], and extensive computations have since been made, by several workers, of the scattering under different conditions. Fig. 1 shows, for example, a curve derived by a method due to van de Hulst[2] of the variation with wave-length of the 'extinction' produced by a dielectric sphere. 'Extinction' is defined as the ratio of the effective cross-section over which radiation is stopped or diverted by a body to the geometrical cross-section which the body presents to the incident radiation.

A qualitative explanation of the main features of the curve can be given without going into detailed theory, and for this purpose the curve may be divided into three regions. The first (*A*) is the Rayleigh region, where the particle radius *r* is small compared with the wave-length λ, and the curve from the origin obeys the fourth-power law. The third region (*C*) is where the sphere is much larger than the wave-length; here it can be shown that not only does the sphere divert by refraction or reflexion all the radiation that falls upon it, but that it also diverts an equal amount by diffraction in the region around its edges. This fact, of which Walton[3], for example, gives a simple explanation, produces an extinction value of 2 instead of 1; this value is constant for all wave-lengths small compared with the sphere.

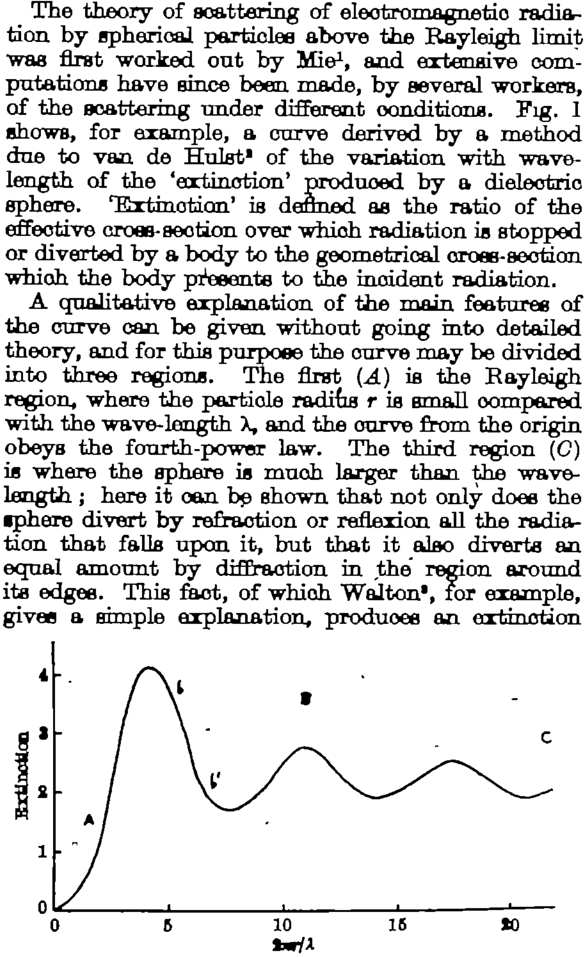

Fig. 1. Theoretical extinction of radiation of wave-length λ produced by a dielectric sphere of radius *r*, and refractive index 1·5

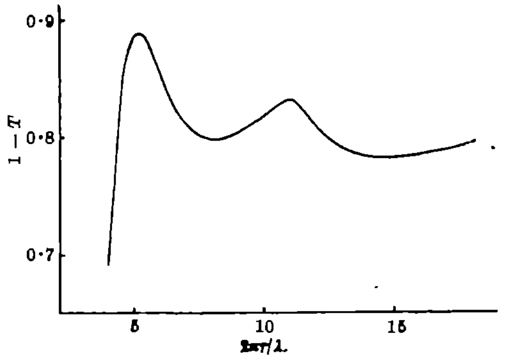

Fig. 2. Observed variation of (1 − transmission) with $2\pi r/\lambda$ for glass spheres of radius 3·5 microns and refractive index 1·5

In the intermediate region *B*, the Mie theory shows several peaks. These again could be expected qualitatively, since the particle size is here comparable with the wave-length, and resonances might occur, the fundamental being presumably the strongest. It is well known that in resonance the resonator effectively absorbs and re-emits radiation from a cross-section which may be several times its geometrical cross-section, and since the re-emission occurs in all directions, nearly all this radiation is effectively diverted from its original direction. The effective cross-section might therefore be expected to reach maxima at a series of values corresponding to the resonances, giving the form of curve predicted by the Mie theory. This form of curve is confirmed by observations on the scattering of infra-red radiation by small glass spheres[4]. Fig. 2 shows a typical observed curve for glass spheres of diameter 7 microns. The transmission of a screen consisting of a monolayer of many separate particles was actually observed; and (1 — transmission), which should be directly proportional to the extinction produced by a single particle, was plotted against $2\pi r/\lambda$.

The form of the intermediate region in Fig. 1 will account for the blue sun. Wherever the extinction curve is rising, light of longer wave-length will be scattered less than that of shorter wave-length, as in Rayleigh scattering; but wherever the extinction curve is falling, the opposite will be true. In order, therefore, for red light from the sun to be scattered more than blue light, the atmosphere must contain a large number of particles of greater size than usual, and those particles must be grouped in a narrow size-range, corresponding to such a region as *bb'*. A typical diameter would be 1·7 microns for particles of refractive index 1·3, and 1 micron for refractive index 1·5. Such conditions occur only rarely and require either a large-scale liberation of uniform particles of suitable size into the atmosphere, or (more probably) the separation by some atmospheric process of particles in the suitable size-range from a cloud of particles of random size. A corollary to the blue sun is that the sky might at the same time appear pink instead of blue.

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Department of Natural Philosophy,
University of Aberdeen. July 30. [See also p. 545.]

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An Accurate Determination of the Positions of Four Radio Stars

The use of an interferometer aerial system on a wave-length of 3·7 m. to measure the positions of a number of radio stars has already been described[1]. The present communication contains the results of recent more accurate determinations of the positions of four intense radio stars with this interferometer, together with results for the same stars obtained by using another interferometer the individual aerials of which employ parabolic reflectors. This latter interferometer has been used at wave-lengths of 3·7 m. and 1·4 m.

With the new interferometer, it is possible to determine the 'collimation error' either by the interchange of the individual interferometer aerial elements, or by observations of both upper and lower culmination of the circumpolar star 23·01 [1]. In addition, the electrical centres of the aerials are defined more precisely than those of the broadside arrays originally used at 3·7 m.

Declination has been determined from the periodicity of the record, as in the previous observations, and also by two new independent methods. In the first method the times of transit of the star across two 'collimation planes' displaced on either side of the axial plane of the interferometer are determined: the interval between these times is related to the declination. These displaced collimation planes are produced by increasing the electrical path to one or other of the aerials. In the second method, the time-interval between the transits at the upper and lower culminations of a circumpolar star provides a measure of the declination, since the axis of the interferometer is inclined at a considerable angle to the east–west line. The collimation error must here be determined by interchanging the interferometer aerials. A more detailed account of these and other methods of position-finding will be published elsewhere.

Table 1 gives the positions of the four stars, with their probable errors, as determined from the time of transit and the periodicity of the record obtained with the three interferometer systems. It also shows results obtained by the two new methods, which have been used at 1·4 m. Allowance has been made for atmospheric refraction. The co-ordinates refer to the epoch of 1950.

It has been pointed out[1] that, in addition to the instrumental errors, the position may be in error due to the radiation from other nearby weaker stars. It can be shown that, in the present observations, this factor is unlikely to cause an error greater than ½ sec. in the R.A. of the stars 19·01 and 23·01, or greater than about 2 sec. in the R.A. of the less-intense stars 05·01 and 12·01.

Table 1

Star	Constellation	Wave-length and method	Right Ascension	Declination
			h. m. s.	
05·01	Taurus	3·7 m., broadside	05 31 35 ±5	22° 05′ ±40′
		3·7 m., paraboloid	05 31 35 ±5	22° 11′ ±20′
		1·4 m., paraboloid	05 31 34·5 ±2	22° 09′ ±5′
		1·4 m., displaced collimation plane	— — —	22° 01′ ±3′
12·01	Virgo	3·7 m., broadside	12 28 17 ±5	12° 50′ ±1°
		3·7 m., paraboloid	12 28 18 ±5	12° 46′ ±20′
		1·4 m., paraboloid	12 28 18·8 ±2	12° 33′ ±15′
		1·4 m., displaced collimation plane	— — —	12° 31′ ±15′
19·01	Cygnus	3·7 m., broadside	19 57 45 ±5	40° 37′ ±5′
		3·7 m., paraboloid	19 57 45 ±5	40° 32′ ±5′
		1·4 m., paraboloid	19 57 45·3 ±1	40° 34·5 ±1′
		1·4 m., displaced collimation plane	— — —	40° 35·3′ ±0·7′
23·01	Cassiopeia	3·7 m., broadside	23 21 13 ±5	58° 30′ ±3′
		3·7 m., paraboloid	23 21 12 ±3	58° 32′ ±2′
		1·4 m., paraboloid	23 21 12·0 ±1	58° 32·1′ ±0·7′
		1·4 m., displaced collimation plane	— — —	58° 32·9′ ±0·5′
		1·4 m., double transit	— — —	58° 30′ ±3′

The final positions are given in Table 2.

Table 2

Star	Constellation	Right Ascension	Declination
		h. m. s.	
05·01	Taurus	05 31 34·5 ±3	22° 04′ ±5′
12·01	Virgo	12 28 18 ±3	12° 37′ ±10′
19·01	Cygnus	19 57 45·3 ±1	40° 35·0′ ±1′
23·01	Cassiopeia	23 21 12·0 ±1	58° 32·1′ ±0·7′

This work was carried out at the Cavendish Laboratory as part of a programme of radio research supported by the Department of Scientific and Industrial Research. Thanks are due to Mr. M. Ryle for his most valuable advice and help, and to Mr. J. E. Jackson of the Department of Geography for assistance in surveying the positions of the aerials of the new interferometer.

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Aug. 6.

[1] Ryle, M., Smith, F. G., and Elsmore, B., *Mon. Not. Roy. Astro. Soc.*, 110, 508 (1950).

A Search for Long-Period Variations in the Intensity of Radio Stars

Certain classes of visible star are characterized by well-marked variations of intensity; the period of these variations may be as short as a few hours, or as long as several hundred days. In this communication an account is given of an investigation which has been made to determine whether any of the known radio stars exhibit similar variations of intensity.

The present observations were made on a wave-length of 3·7 m. with an interferometer aerial which has already been described[1]. This system employs two fixed aerials, each of which has a large aperture in an east–west direction and a small aperture in a north–south direction; the interferometer is therefore receptive in a narrow strip which extends along the meridian from about declination + 10° to declination + 80°. Daily observations can therefore be made of radio stars situated throughout most of the northern hemisphere. The number of radio stars which can be distinguished is limited by confusion between the traces produced by adjacent stars and not by the random fluctuations on the record. Thus, although it is only possible to locate about fifty of the most intense radio stars, other sections of the record show well-defined periodic traces due to the simultaneous reception of the radiation from two or three weaker stars. It is not possible to deduce the absolute intensity or the accurate positions of these weaker sources; but by making a detailed comparison of the records obtained each day, it is possible to detect small variations in their intensity.

Observations have been made with this system nearly every day for more than eighteen months, although records representing about 15 per cent of the total observing time have had to be rejected from the present analysis owing to the occurrence of severe 'scintillation' caused by diffraction in ionospheric irregularities[2]. It was found that, of approximately a hundred radio stars examined, none showed any variation of intensity greater than 10 per cent; a more detailed analysis of some of the more intense ones suggested that their intensity was, in fact, constant to better than 5 per cent; but it is difficult, at this wave-length, to eliminate the effects of residual ionospheric irregularities for variations smaller than this.

It is therefore concluded that none of the radio stars observed varies by more than 0·1 magnitude with any period shorter than about 1,000 days; observations of the more intense stars suggest that their intensities may, in fact, be constant to within 0·05 magnitude.

This result is of interest not only for comparison with the behaviour of visible stars, but also in contrast to the marked day-to-day variations in the intensity of the metre-wave radiation from the sun.

This work forms part of a programme of research which is supported at the Cavendish Laboratory by the Department of Scientific and Industrial Research.

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Aug. 8.

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Nuclear Spin of Rubidium-86

THE nuclear spin I of rubidium-86 has been measured by the atomic beam method using magnetic resonance; a mass spectrometer was employed to select the correct isotope[1]. A pronounced resonance was obtained at a frequency of 2·36 Mc./sec. in a magnetic field of 4·22 gauss, which gives $I = 2$. This value is in agreement with the observed shape of the β-spectrum[2]. The hyperfine structure separation was found to be 3,900 ± 100 Mc./sec., which means a magnetic moment of 1·66 ± 0·4 nuclear magnetons. The results suggest that the magnetic moment is probably negative and it would then have a value of − 1·68 ± 0·01 nuclear magnetons. It is planned to extend the measurements to obtain a more accurate value of the magnetic moment and definitely establish its sign.

The rubidium-86 was prepared by the ^{88}Sr (d,α) ^{86}Rb reaction. I wish to thank the Physics Department of the University of Birmingham for carrying out this bombardment, and Dr. A. G. Maddock, of the Radiochemistry Laboratory, Cambridge, for the chemical separation of the rubidium-86.

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[2] Zaffarano, Kern and Mitchell, *Phys. Rev.*, 74, 682 (1948).

Scattering of 146-MeV. Protons by Deuterons

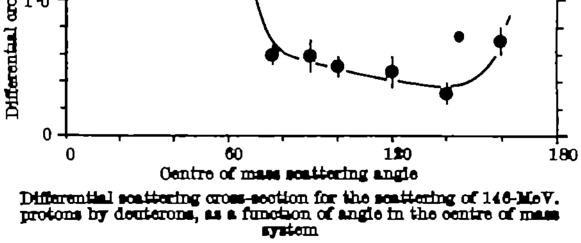
THE proton beam and the counting apparatus described in an earlier communication[1] have now been used for a study of elastic proton–deuteron scattering. The results are shown in the accompanying graph.

The scatterer was a rectangular strip of heavy water contained in a capsule made of thin aluminium sheet. Elastic proton–deuteron collisions were observed by detecting in coincidence both the scattered protons and the corresponding recoil deuterons. When the angle of scattering was less than 67° or greater than 85°, the geometry of the arrangement left no doubt as to which counter was detecting the protons in these events. Between these two angles it was not practicable to determine the cross-section except at 76°, where the recoil angles of the two particles are actually equal.

Various background effects were subtracted with the help of a second scatterer filled with normal water. Proton–proton collisions in the hydrogen content of the normal water were not counted, again because of the geometry of the arrangement. All background effects should have been unchanged by the substitution of normal for heavy water, with the exception of that due to inelastic proton–deuteron scattering followed by the detection of both protons. There are three final particles involved in this process, so that the recoil angles of the two protons are not uniquely connected. A consideration of the solid angle subtended by the counters suggested that this source of background could be neglected, and this conclusion was supported by an experiment in which the geometry of the detectors was varied.

The uncertainties shown in the graph are the statistical errors in the determination of the relative values at different angles; it is considered that systematic errors were small in comparison with these. The absolute cross-section was fixed by observing proton–proton scattering with the same apparatus, the cross-section for that process being taken[1] as 4·99 ± 0·31 millibarns. The absolute calibration of the proton–deuteron experiment is subject to an overall standard deviation of 7·8 per cent.

It is hoped to improve the accuracy of these results and later to obtain some information about neutron–deuteron scattering at the same energy. A



Differential scattering cross-section for the scattering of 146-MeV. protons by deuterons, as a function of angle in the centre of mass system comparison of the two effects should show whether, apart from the Coulomb repulsion, the proton-proton and the neutron–neutron interactions are the same at high energies. The recently published results of Stern and Bloom[2] on the scattering of 190-MeV. deuterons by protons (equivalent to the scattering of protons of approximately 95 MeV. by deuterons) are of great interest from this point of view. If their results are integrated over all angles, an elastic cross-section of roughly 24 millibarns is found. W. M. Powell[3], on the other hand, has observed an elastic neutron–deuteron cross-section of 48 millibarns at 90 MeV. neutron energy.

The experiment reported here was greatly assisted by the co-operation of Mr. A. O. Edmunds and the cyclotron crew. One of us (G. H. S.) is a member of the staff of the South African Council for Scientific and Industrial Research.

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G. H. Stafford
T. G. Pickavance
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August 24.

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Raman and Infra-Red Spectra of Germanium Tetrafluoride

The Raman spectrum of gaseous germanium tetrafluoride at 1·8 atm. has been investigated with mercury arc excitation, and two lines have been observed. One is excited by λ 4358 and the other by λ 4046 A., the measured Δν-values being 737·1 and 738·4 cm.$^{-1}$ respectively. This shift may with confidence be identified with the symmetrical breathing frequency of the tetrahedral GeF$_4$ molecule, to which we assign the value $\nu_1 = 738 \pm 2$ cm.$^{-1}$.

We have also observed the infra-red absorption spectrum of gaseous germanium tetrafluoride. This shows several bands, the most intense of which lies at 800 cm.$^{-1}$ and probably corresponds to ν_3.

Further details of the spectra will be published later.

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Runs in a Sequence of Observations

In previous communications[1-4] one of us (P. V. K. I.) has discussed a number of distributions arising from m observations belonging to k groups arranged at random on a line. When all the observations are different, m is equal to k, and for this case Kermack and McKendrick[5], and Levene and Wolfowitz[6] have considered the distribution of the number of runs 'up' and 'down'. A run 'up' or 'down' is a succession of observations in ascending or descending order. Kendall[7] has dealt with the same problem by considering the number of 'troughs' and 'peaks'. When m is greater than k, the sequence of observations will have three kinds of runs, namely, ascending, descending and stationary. This note gives the difference equation satisfied by the probability generating function and the first two moments for the distribution of the total number of *junctions* for a sequence of m observations with fixed probabilities $p_1, p_2 \ldots p_k$, a junction being the meeting point between two runs 'up', 'down' or stationary. It may be noted that the total number of runs is equal to the total number of junctions increased by unity.

The difference equation reduces to a $k \times k$ determinant as shown below:

$$\begin{vmatrix} \theta_1 & \psi_{10} & \psi_{11} & \psi_{12} & \cdot & \psi_{1,k-2} \\ \lambda_{20} & \theta_2 & \psi_{20} & \psi_{21} & \cdot & \psi_{2,k-3} \\ \lambda_{31} & \lambda_{30} & \theta_3 & \psi_{30} & \cdot & \psi_{3,k-4} \\ \lambda_{42} & \lambda_{41} & \lambda_{40} & \theta_4 & \cdot & \psi_{4,k-5} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \lambda_{k,k-2} & \lambda_{k,k-3} & \lambda_{k,k-4} & \lambda_{k,k-5} & \cdot & \theta_k \end{vmatrix} \varphi(m-2) = 0$$

where $\theta_r = E^2 - p_r(p_r + q_r t)$; $\psi_{rs} = -p_r[p_{r+1} + p_{r+2} + \ldots + p_{r+s} + (1 - p_{r+1} - p_{r+2} - \ldots - p_{r+s})t]$ $\lambda_{rs} = -p_r[p_{r-1} + p_{r-2} + \ldots + p_{r-s} + (1 - p_{r-1} - p_{r-2} - \ldots - p_{r-s})t]$; $p_r + q_r = 1$; E is the usual operator in finite difference and

$$\varphi(m) = p(m,0) + p(m,1)\,t + p(m,2)\,t^2 + \ldots,$$

$p(m,r)$ being the probability for r junctions in m observations.

The first two moments are:

$$\mu'_1 = (n-2)\,\{4\Sigma p_r p_s p_t + 3\Sigma p_r p_s(p_r+p_s)\} = (n-2)\,P_1(3),$$

$$\mu_2 = \mu'_1 + 2\,(n-3)\,\{10\Sigma p_r p_s p_t p_u + 8\Sigma p_r p_s p_t\,(p_r + p_s + p_t) + 6\Sigma p_r^2 p_s^2 + 2\Sigma p_r p_s\,(p_r^2+p_s^2)\} + 2(n-4)\{54\Sigma p_r p_s p_t p_u p_v + 34\Sigma p_r p_s p_t p_u(p_r+p_s+p_t+p_u) + 2\Sigma p_r p_s p_t p_u(p_s+p_t) + 22\Sigma p_r p_s p_t(p_r p_s+p_s p_t+p_r p_t) + \Sigma p_r p_s p_t(p_r p_s+p_s p_t) + 12\Sigma p_r p_s p_t(p_r^2+p_s^2+p_t^2) + 2\Sigma p_r p_s p_t(p_r^2+p_t^2) + 8\Sigma p_r^2 p_s^2(p_r + p_s) + \Sigma p_r p_s(p_r^3 + p_s^3)\} - (5m - 16)\,[P_1(3)]^2,$$

$$r > s > t > u > v.$$

The moments for the case when $n_1, n_2, \ldots n_k$ observations belong to k different groups are obtained by substituting

$$\frac{n_r^{(\alpha)}\, n_s^{(\beta)}\, n_t^{(\gamma)} \ldots}{n^{(\alpha+\beta+\gamma \cdots)}} \text{ for } p_r^\alpha\; p_s^\beta\; p_t^\gamma \ldots$$

in the moments about the *origin* for fixed p's.

The above moments have been obtained by extending the methods developed by one of us[3,4], by forming the frequencies for three, four and five observations for all possible combinations of equal and unequal observations.

It can be established from the difference equation that all the cumulants of the distribution are linear functions in m, and hence the distribution tends to the normal form as $m \to \infty$. Full details of this work will be published in the *Journal of the Indian Society of Agricultural Statistics*.

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Metallic Oxides with the Structure of High-speed Steel Carbide

OXIDES isomorphous with the high-speed steel carbide Fe_3W_3C have been found to exist with the ideal composition Me_3Ti_3O, where Me is one of the transition metals manganese, iron, cobalt, nickel or copper (but *not* vanadium, chromium or zinc).

The best agreement between calculated and observed $p \mid F \mid^2$ values for powder photograph reflexions and the best space distribution in the cubic unit cell is obtained if the 112 atoms are placed in the following positions of the space group $O_h^7 - Fd3m$:

16 O in 16 : (*c*) 1/8, 1/8, 1/8 ;
16 *Me* in 16 : (*d*) 5/8, 5/8, 5/8 ;
32 *Me* in 32 : (*e*) *x*, *x*, *x* ; ($x = -0{\cdot}165$)
48 Ti in 48 : (*f*) *x*, 0, 0 ; ($x = 0{\cdot}185$)

Analysis of powder photographs taken with oxides of different compositions gives the probable lower and upper phase limits for the titanium content as Me_3Ti_3O and Me_2Ti_4O respectively. At the latter composition 16 titanium atoms and 16 *Me* atoms are randomly distributed in 32 : (*e*). In comparison, 16 iron atoms take up the positions of 16 tungsten atoms in 48 : (*f*) in high-speed steel carbide of the composition Fe_4W_2C. The following values for the length of the unit cube edge have been found:

Me	Titanium-poor limit	Titanium-rich limit
Mn	11·10 A.	11·28 A.
Fe	11·14	11·31
Co	11·16	11·32
Ni	11·18	11·37
Cu	11·24	11·44

All the new oxides have metallic properties. It is of interest that the titanium atoms, independent of the composition, are surrounded octahedrally by six oxygen atoms.

A detailed report will appear shortly elsewhere.

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Source of Moulting Hormone in *Rhodnius*

THE immediate source of the hormone which induces moulting in the larvæ and pupæ of Lepidoptera is the prothoracic gland[1]. But this gland is itself activated by a secretion from neuro-secretory cells in the dorsum of the brain[2]. It has seemed probable for some time that a similar two-stage control of moulting might exist in other insects[3]; and recently it has been found by Possompès[4] that the lateral cells of the ring gland in the larvæ of Diptera are induced to secrete the pupation hormone by a factor liberated from the brain.

It has now been shown that the same sequence of events occurs in *Rhodnius*. Fourth-stage larvæ of *Rhodnius* decapitated at 24 hr. after feeding can be induced to moult by implanting into the abdomen the dorsal region of the brain from larvæ that have just passed the 'critical period'[5]. In the present series, this experiment succeeded in 80 per cent of cases. But if the recently fed larva is ligatured behind the mesothorax and the same implants are made into the isolated abdomen, this fails to moult. There were no positive results in twenty-three experiments.

Search in the thorax has revealed the presence of two strands of large cells, with enormous lobulated nuclei, deeply imbedded in the fat body and extending throughout the prothorax and mesothorax. These cells are abundantly supplied with tracheoles. They undergo a cycle of development in each moult, increasing greatly in size at the 'critical period', becoming small again at the end of the moulting stage. They break down and disappear in the adult within forty-eight hours after moulting.

If these cells are removed from a larva that has just passed the critical period and are implanted into the abdomen of a larva decapitated at 24 hr. after feeding, this is caused to moult (six positive in eighteen experiments). If they are implanted into recently fed larvæ ligatured through the metathorax, the isolated abdomen is likewise caused to moult (seven positive among thirteen survivors).

Similarly, the adult *Rhodnius* is not caused to moult by implantation of the brain; but moulting is induced if the thoracic gland from the moulting fifth-stage larva is implanted.

A corresponding gland has been found also in *Nepa*, where it likewise disappears in the adult insect.

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July 28.

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Activation and the Correlation between Male and Female Elements in Fertilization

IN the course of investigations on the process of fertilization, immature rats, which had been allowed to mate, were killed shortly after induced ovulation. Thirty-six animals yielded 477 eggs in the early phase of fertilization. The correlation in the stages shown by the male and female elements in the living eggs was carefully examined with the aid of the phase-contrast microscope. The stages were classified as follows: for the male element, (*a*) sperm present in the perivitelline space, (*b*) sperm in the vitellus but with head unchanged, (*c*) sperm head changing, (*d*) male pronucleus forming; for the female element, (*a*) chromosomes in metaphase of second maturation division, (*b*) in anaphase, (*c*) in telophase, (*d*) polar body abstricted, (*e*) female pronucleus forming. The numbers of eggs showing these stages are recorded in the accompanying table.

Of the 108 eggs which contained sperms only in the perivitelline space, the great majority (103) displayed chromosomes arranged in metaphase. In the

CORRELATION BETWEEN MALE AND FEMALE ELEMENTS DURING EARLY STAGES OF FERTILIZATION IN 477 RAT EGGS

Female / Male	Chromosomes in metaphase	Chromosomes in anaphase	Chromosomes in telophase	Polar body formed	Pronucleus forming
Sperm in perivitelline space	103	1	1	3	
Sperm in vitellus, unchanged	4	8	6	1	
Sperm in vitellus, head changing		5	47	173	1
Pronucleus forming				47	77

remaining five eggs, however, the mitosis had proceeded and in three of them the polar body had been formed. These five eggs thus exhibited signs of activation although no sperm had yet entered the vitellus.

Only nineteen eggs were observed in which there was an unchanged sperm within the vitellus. The infrequency of the observations connotes the brevity of this state. Most (fifteen) of these eggs showed signs of activation, including one in which the second polar body was visible. In the remaining four eggs sperm entry probably occurred just before the eggs were obtained for study; but some delay of activation is here indicated.

In 226 eggs the head of the penetrating sperm showed distinct changes, and in the majority (173) the second polar body had been formed. Some eggs (47), however, had chromosomes still in the telophase condition. In this series also there were indications both of early activation (one egg) and delayed activation (five eggs).

Finally, 124 eggs were observed showing the early stages of formation of the male pronucleus. The larger proportion (77) of these showed also the early female pronucleus; but the remainder (47) carried egg chromosomes still in the form seen after polar body formation.

Another group of immature rats was killed at a later stage, between 16 and 26 hr. after ovulation. Among these were 57 animals which yielded 228 eggs showing the various stages involved in the reappearance of the chromosomes and the formation and division of the first segmentation spindle. In none of these eggs was there any indication of a lack of correspondence between the male and female elements.

From these observations the following conclusions are drawn. There is a fairly close correlation between the male and female elements in the early phase of fertilization of the rat's egg. While the sperm is in the perivitelline space, the egg chromosomes are nearly always in metaphase. After the sperm has entered the vitellus, but before it has undergone perceptible change, the egg chromosomes are mostly seen in anaphase or telophase. The mitosis evidently proceeds very shortly after sperm entry. Soon the sperm head shows changes in form, and by the time these have become distinct the polar body is abstricted. Nearly always the early form of the male pronucleus appears before the female (47 eggs had only the male pronucleus; only one egg had solely the female pronucleus).

Activation of the egg may occur before the sperm has entered the vitellus, though the sperm head may possibly have broken the continuity of the vitelline surface. On the other hand, activation may occasionally be a little delayed. For these reasons the correlation seen in the early stage of fertilization is incomplete. Later, however, a closer correspondence is observed and is especially evident at the stages immediately preceding segmentation. Apparently a co-ordinating influence in the egg becomes effective in the course of fertilization.

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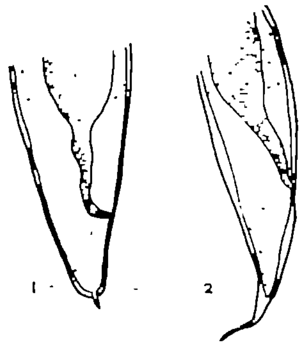
A New Species of *Nematodirus* in Sheep

Outbreaks of parasitic disease in lambs have occurred in the north of England during June and July 1951. Deaths have been associated with the presence of large numbers of nematodes of the genus *Nematodirus*. We are grateful to Mr. W. Lyle Stewart, who sent us the contents of the intestines of five lambs which had been sent to him for examination. About two million worms were received, and the collection was remarkable not only because of the large numbers but also because more than 90 per cent of the worms belonged to the genus *Nematodirus*. Examination showed that there were no *N. spathiger*, a large number of *N. filicollis* and a large number of a third species of *Nematodirus*. This last species cannot be referred to any known member of the genus, and it is proposed to name it *Nematodirus battus*. The description is as follows.

Nematodirus battus n.sp. Body attenuated anteriorly. Mouth surrounded by six papillæ. Cephalic cuticle dilated. *Male*: Length 10–13 mm., maximum diameter 0·12–0·13 mm. Bursa with two large lateral lobes; dorsal lobe small. Ventroventral and latero-ventral close and parallel; laterals arise from a common trunk, diverging in the distal half; postero-lateral and medio-lateral not parallel; externo-dorsal arises close to the base of the dorsal ray, which is doubled and has bidigitate extremities. Spicules filiform, 0·85–0·95 mm. long; tips united by a membrane; end bluntly pointed. Gubernaculum absent. *Female*: Length 17–22 mm., maximum diameter 0·16–0·22 mm.; vulva in the posterior third of the body. Tail pointed. Eggs large, 195 μ × 95 μ. Host: *Ovis aries*. Location: small intestine.

This species can be distinguished from others of the genus by the fact that the tail of the female is not truncate but finely pointed, and that the bursa of the male has the medio- and postero-laterals divergent and not parallel.



(1) *N. filicollis*, tail of female; (2) *N battus*, tail of female

A more detailed description will be given elsewhere; but the above description is provided to enable observations to be made during the present outbreak. This species can be most rapidly separated from *N. filicollis* and *N. spathiger* by examination of the tails of female worms (see Figs. 1 and 2), and it is hoped that other workers may contribute information on the distribution and biology of this worm.

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Mytilicola intestinalis, Steuer, in the European Flat Oyster (*Ostrea edulis*)

While examining a sample of ninety-six two- and three-year-old oysters taken from the Penryn River, Cornwall, on June 20 to assess the incidence of Dutch shell disease[1], *Mytilicola intestinalis* was found in three of the oysters. As the main initial interest of the sample lay in the shells, the meats were being discarded without examination. About thirty oysters had been opened and the meats discarded when a slip of the knife resulted in the cutting of the visceral mass; *Mytilicola* was then observed. The remaining sixty-six oyster meats were examined as the oysters were opened; two were found to be infected, but small parasites may have been overlooked.

A further sample of fifty similar oysters was procured from Penryn on June 26. Two *Mytilicola* were found in one oyster. The percentage infection would thus appear to be of the order of 3 per cent.

The infestation was light, the largest number of parasites found in one host being three. The ten parasites found comprised eight females and two males. Two females carried external egg-sacs, another had well-developed internal gonads, and the remainder were immature.

Mussels in the district are heavily infected with *Mytilicola*; but they are not abundant on the grounds from which the oysters were taken.

On July 7 a similar sample of two and three year-old native oysters taken from Tollesbury North Channel, on the north side of the River Blackwater, Essex, was also found to be infected. It was not possible to examine the oysters with the care necessary to detect small parasites; but six oysters out of 111 yielded a total of seven large *Mytilicola*, including two females with external egg-sacs. The parasites lay in the excurrent limb of the intestine, some distance forward from the anus, and could not be seen until the visceral mass was cut. Mussels in the River Blackwater are known to be infected with *Mytilicola*, and the parasite has been established in the vicinity for several years.

So far as is known, these are the first records of the occurrence of this parasite in oysters, but *Mytilicola orientalis*, Mori, has been recorded from *Ostrea lurida* on the Pacific coast of America[2].

It has been shown[3] that heavy infestation with *Mytilicola* is associated with serious loss of condition in mussels. There is the possibility, therefore, that a similar loss of condition may occur in infected oysters. The very light infestation in areas where *Mytilicola* is well established suggests that the infection of oysters requires a special set of conditions which does not occur very frequently in Nature. It is to be noted, however, that the gonads of several of the parasites were mature, and the possibility that *Mytilicola intestinalis* may become adapted to life in oysters cannot be excluded.

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The Leaf Scar as an Avenue of Infection for the Cherry Bacterial Canker Organism, *Pseudomonas mors-prunorum* Wormald

The development of branch cankers from previously infected fruiting spurs was noted by Wormald[1] in his original etiological study of the bacterial canker disease of cherry (*Ps. mors-prunorum*), and later by Webb[2], who concluded that most branch cankers originated in this way. Records made over the past two years during field observations on 5–12 year old cherries of several varieties have confirmed this view. Between 90 and 100 per cent of branch cankers examined, depending on the age and variety of the tree, were around the base of a dead spur. This association, together with the frequent occurrence of dead spurs with incipient cankers at the base and dead spurs without basal cankers, clearly indicated the sequence of infection.

As the fruiting spurs are thus primarily concerned in the initiation of the branch cankers, the mode of entrance of the pathogen into them is therefore highly relevant to the formulation of control measures. Most of the foliage is borne on these spurs, and Montgomery and Moore[3], who effected some control of the canker phase by the autumnal application of Bordeaux mixture sprays, suggested that the spurs become infected through the leaf scars during the autumnal leaf-fall period. This is the only time in the annual cycle of the disease when the condition of winter susceptibility of the stem and branch tissues coincides with the presence of a copious inoculum from the over-summered leaf-spot stage of the disease, and it is therefore the most likely period for infection.

More direct evidence that the leaf scar is an important avenue of infection has now been obtained by experimental inoculation of leaf scars in the autumn. The laminæ of the leaves on selected fruiting spurs were excised in October, thus inducing abscission in the petioles, which were then readily detached after ten days. Spurs with the leaf scars thus exposed were inoculated immediately, and at varying intervals afterwards. No wounds were made, and the inoculum, an aqueous suspension of a 48-hr. culture of *Ps. mors-prunorum*, was applied to the scars with a loop. The results of one experiment, recorded the following May, are summarized in the accompanying table.

Interval between exposure of scar and inoculation	No. of spurs inoculated	No of spurs killed	No. of killed spurs developing branch cankers
0 days	103	101	40
3 days	102	70	37
8 days	96	32	14
Uninoculated controls	100	0	0

These results are an aggregate for two varieties of cherry, one comparatively resistant and one susceptible to this disease. Approximately the same number of spurs was killed in each; but in the resistant variety only 11 per cent of these led to the formation of branch cankers compared with 63 per cent in the susceptible one. In view of the difficulty frequently encountered of reproducing cankers comparable with natural ones by inoculation through an artificial wound directly into the branch tissues, it is noteworthy that the cankers following inoculations of the leaf scars were indistinguishable in form and severity from those occurring naturally. On the six trees of the susceptible variety, nineteen of the twenty-four branches bearing inoculated spurs died from cankers which had girdled them by the following May.

Preliminary observation and histological studies suggest that the bacteria enter the spur via the vascular traces of the leaf scar.

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Kent. May 22.

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Fusaria Isolated from South Indian Soils

IN connexion with work on *Fusarium* wilt of cotton in South India, I took up in 1947 a detailed study of *Fusarium* floras of certain South Indian soils, particularly 'wilt-sick' black cotton soils. Wide occurrence of *Fusaria* in soils has been reported from a number of countries, though no such detailed survey has been undertaken in India. The present work was directed towards determining the different species of *Fusarium* that occur in 'wilt-sick' black cotton soils around Udamalpet (Coimbatore District, Madras State), mainly following the techniques of the traditional *Fusarium* investigations of Wollenweber, Reinking and others[1,2,3].

In the isolation of *Fusaria* from soils, the 'root burial' technique[4] was largely used, supplemented by the dilution-plate technique. In general the former gave a much better picture of the *Fusarium* flora than the latter, since *Fusaria* seldom appeared on dilution plates but could be easily recovered from bits of root initially buried in soils and later removed and plated out on suitable media. The following species of *Fusarium* were isolated from Udamalpet soils

1. ***Fusarium avenaceum*** (Fr.) Sacc.
2. ***F. chlamydosporum*** Wr et Rg.
3. ***F. culmorum*** (W.G.Sm.) Sacc.
4. ***F. equiseti*** (Cda.) Sacc.
5. ***F. javanicum*** Koord
6. ***F. javanicum*** Koord. v. ***radicicola*** Wr.
7. ***F. oxysporum*** Schlecht.
8. ***F. poae*** (Peck) Wr
9. ***F. scirpi*** Lamb. et Fautr.
10. ***F. scirpi*** Lamb. et Fautr. v. ***acuminatum*** (Ell. et Ev.) Wr.
11. ***F. solani*** (Mart.pr.p.) App. et Wr.
12. ***F. solani*** (Mart.) v. ***Martii*** (App. et Wr.) Wr.
13. ***F. solani*** (Mart) App. et Wr. v. ***minus*** Wr.
14. ***F. solani*** (Mart.) App. et Wr. v. ***striatum*** (Sherb.) Wr.
15. ***F. vasinfectum*** Atk.

The importance, from the point of view of plant disease, of the occurrence of different species of *Fusarium* in 'wilt-sick' soils will become obvious when it is realized that considerable evidence has accrued in recent years indicating that some wilts and root rots of crop plants are caused by complex infections by more than one species of *Fusarium*. Details of the present work will be published elsewhere.

I am grateful to Prof. T. S. Sadasivan for much guidance and criticism during the course of the present work. My thanks are due to the National Institute of Sciences of India for the award of an I.C.I. Fellowship, during the tenure of which the major part of the work was carried out.

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May 12.

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Myxobacteria Mistaken for Nitrifying Bacteria

IN connexion with the communication under this title by Miss Joyce B. Grace, published in *Nature* of July 21, p. 117, a careful re-reading of Winogradsky's papers on the subject[1] leads me to believe that he has described two quite different species under the name of *Nitrosocystis*. In the first place, there is the organism isolated by Romell[2] from forest soil by Winogradsky's later technique of placing grains of soil on the surface of silica gel plates. Imsenecki repeated this work, and obtained *Nitrosomonas*, and a non-nitrifying myxobacterium, *Sorangium symbioticum*[3]. In the second place, there is the zooglœa-forming species, isolated by Winogradsky from Zurich soil by the enrichment culture technique, originally described in 1892 as a *Nitrosomonas*, and reclassified by Winogradsky in 1933 as a *Nitrosocystis*. This species forms the 'hard colonies' mentioned by Kingma Boltjes[4], whose work Miss Grace dismisses with the statement that there was "no evidence that the cultures were pure" ; the cultures in question, however, were single-cell isolations. As regards hard colonies, I have seen them formed by my own pure cultures of an ammonia-oxidizing bacterium, which I have every reason to believe is a *Nitrosomonas*[5]. I think that the formation of hard or soft colonies depends on the density of the silica gel in the plate, and also on whether the colony is buried or superficial ; Kingma Boltjes observed both types on his plates made from pure cultures of *Nitrosomonas*.

I would be inclined to think that the first "*Nitrosocystis*" may be a myxobacterium, but that the second is a true nitrifier, so that the genus *Nitrosocystis* is still valid in this sense, unless further work should show it to be identical with *Nitrosomonas*. I do not feel qualified to express an opinion on the genera *Nitrocystis* and *Nitrosogloea*.

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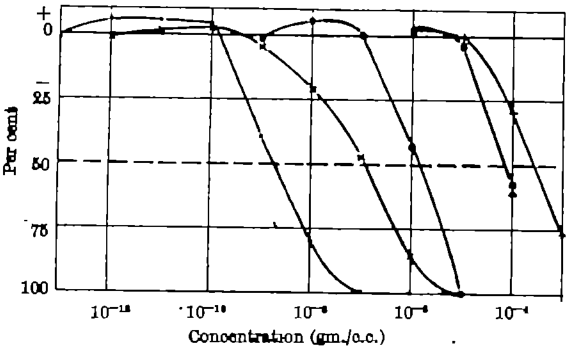
Effect of *cis*-Cinnamic Acid and some Isomeric Compounds on the Germination of Zygotes of *Chlamydomonas*

THE effect of a number of organic acids as inhibitors of germination has been tested on the zygotes of the *blastikos* race of *Chlamydomonas eugametos*[1]. It was observed that *trans*-cinnamic acid inhibits germination to about 50 per cent even at a dilution of 10^{-7} gm./c.c. The experiment has now been extended to the three different allotropic modifications of *cis*-cinnamic acid and a few isomeric compounds. The percentage of inhibition of germination with respect to that of control is shown in the accompanying graph. The experimental method and evaluation have been described in greater detail elsewhere[2]. The percentage germination of the control (in *Volvox* solution) is $85 \cdot 92 \pm 0 \cdot 429$ per cent ($n = 1,186$ zygotes). The activity of cinnamic aldehyde is very small, since at 10^{-4} gm./c.c. the germination remains unaffected. A similar effect is also



Percentage inhibition of germination with respect to control (0-line) cinnamic aldehyde, △—△ . *o*-coumaric acid, □—□; *β-d*-glucosido-*o*-coumaric acid, +—+ ; coumarin, ○—○ ; *trans*-cinnamic acid, ×—× , *cis*-cinnamic acid, ●—●, tested on the zygotes of the *blastitos* of *Chlamydomonas eugametos*. The concentrations for 50 per cent inhibition can be read from the broken line. + is promotion (above the 0-line)

found in the case of *trans*-2-oxy-cinnamic acid (*o*-coumaric acid). β-*d*-Glucosido-*o*-coumaric acid is less active than the aglucone. Coumarin is a hundred times more active; even at a dilution of 10^{-8} gm./c.c. a statistically significant promotion of germination can be definitely observed. Still more active is *trans*-cinnamic acid as has been already reported[1]; though in very dilute solution (10^{-10} to 10^{-12} gm./c.c.) no statistically significant promotion of germination was recorded. The range of activity of *cis*-cinnamic acid is fifty to eighty times more than that of the *trans* form, since even at a dilution of 10^{-11} to 10^{-12} gm./c.c. a significant promotion of germination could be observed. The three allotropic modifications of *cis*-cinnamic acid (42° C., 58° C., 68° C.) have the same activity[2].

The strong activity of coumarin can be ascribed to the opening of the lactone ring and the formation of *cis*-2-oxy-cinnamic acid (coumarinic acid). As the compound is unstable, its effect could not be tested on zygotes of *Chlamydomonas*. It may be assumed that the activity of *trans*-cinnamic acid is due to the formation of *cis*-cinnamic acid during the germination of zygotes, which takes place only in the presence of light[3]. Then it would be expected that, with a sufficiently large number of zygotes, at a dilution of 10^{-10} to 10^{-11} gm./c.c. of *trans*-cinnamic acid, promotion of germination will be observed. The question of the isolation of natural germination inhibitors from zygotes of *Chlamydomonas* remains still open.

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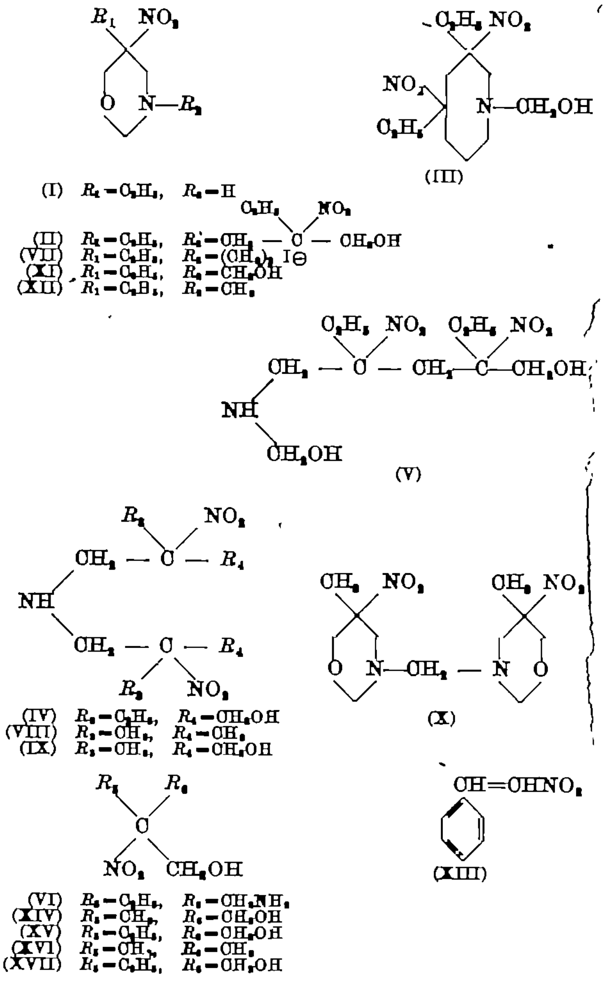
New Derivatives of Nitroparaffins and their Antitubercular and Antirickettsial Properties

As I have indicated earlier, the reaction of nitroparaffins with formaldehyde and ammonia or amines may lead to the formation of polymers[1]. Further experiments have shown[2] that a number of new ring compounds of 1 : 3-tetrahydro-oxazine (I and II) and 1-oxa-3-aza-*cyclo*octane (III) type are formed by the interaction of 1-nitropropane with formaldehyde and ammonia. The products can be transformed into hydrochlorides of the open-chain amines (IV), (V), (VI) or methiodide (VII). 2-Nitropropane yields the amine (VIII)[3] with formaldehyde and ammonia.

Recently, my co-workers and I isolated the compounds (IX) and (X) from nitroethane[4] and the compound (XI) from phenylnitromethane[5], formaldehyde and ammonia reaction products. Also, an oxazine (XII) was prepared from 1-nitropropane, formaldehyde and methylamine[6].


R_1 NO_2
O N—R_2
C_2H_5 NO_2
NO_2
C_2H_5
N—CH_2OH
(III)
(I) $R_1 = C_2H_5$, $R_2 = H$
C_2H_5 NO_2
(II) $R_1 = C_2H_5$, $R_2 = CH_2$ — C — CH_2OH
(VII) $R_1 = C_2H_5$, $R_2 = (CH_3)_2$ I⊖
(XI) $R_1 = C_6H_5$, $R_2 = CH_2OH$
(XII) $R_1 = C_2H_5$, $R_2 = CH_3$
C_2H_5 NO_2 C_2H_5 NO_2
CH_2 — C — CH_2—C—CH_2OH
NH
CH_2OH
(V)
R_3 NO_2
CH_2 — C — R_4
NH
CH_2 — C — R_4
R_3 NO_2
(IV) $R_3 = C_2H_5$, $R_4 = CH_2OH$
(VIII) $R_3 = CH_3$, $R_4 = CH_3$
(IX) $R_3 = CH_3$, $R_4 = CH_2OH$
CH_3 NO_2 CH_3 NO_2
O N—CH_2 — N O
(X)
R_5 R_6
C
NO_2 CH_2OH
(VI) $R_5 = C_2H_5$, $R_6 = CH_2NH_2$
(XIV) $R_5 = CH_3$, $R_6 = CH_2OH$
(XV) $R_5 = C_2H_5$, $R_6 = CH_2OH$
(XVI) $R_5 = CH_3$, $R_6 = CH_3$
(XVII) $R_5 = C_6H_5$, $R_6 = CH_2OH$
CH=CHNO$_2$
(XIII)

All these substances and ω-nitrostyrene (XIII) representing nitroaralkenes and a series of nitro-alcohols deriving from nitroparaffins (XIV), (XV), (XVI) and (XVII) were tested against saprophytic mycobacteria (six strains) *in vitro* in Youman's medium and *in vivo* against *Mycobacterium tuberculosis* ($H_{37}Rv$ strain) in white mice inoculated intravenously. They were also tested *in vivo* against *Rickettsia prowazeki*.

Some of the results of bacteriostatic concentrations *in vitro* are shown in Table 1.

All compounds except (IV) and (XIII) possess a relatively low toxicity. The lethal dose of some of them in rats is given in Table 2[6].

On the basis of these experiments, a few compounds were selected for testing *in vivo* in white mice. The results are shown in Table 3.

Table 1[7]

Substance	I	IV	V	VI	VIII	IX	XII	XIII	XIV	XV	XVII
Bacteriostatic concentrations (mgm. per 100 ml.)	7 5–125	7·5–60	7 5–60	30–60	15–125	15–30	7·5–30	5–15	30–125	30–60	30–60

(The wide range of concentrations was produced by examining the action on different strains.) Substances (VII) and (XVI) were found to be inactive.

Table 2

Substance	Lethal dose (gm. per kgm. of body-weight of rats) Intravenous	Subcutaneous	*per os*
I	0·6	1·5	
II	—	2·6 (in oil)	c. 3·0
III	—	—	c. 3·0
IV	0 2	—	
V	0·7	2 0	
VI	1·1	—	
VIII	0·3	—	
IX	0·8	1 2	
X	—	—	c. 3 0
XII	0·6	1 8	
XIII	—	0·15 (in oil)	0 6
XIV	—	3 5	
XV	—	1 0	
XVII	0·3	—	

After 35 days, all survivors were killed and the extent of tuberculous involvement was noted and rated. Experiments with the substances (I), (V), (VI), (X) and (XIV) are being continued.

Substances (XII) and (XV) were also examined as to their action *in vivo* against *Rickettsia prowazeki*. They proved to be more efficient than *p*-aminobenzoic acid[9]. Inoculated white mice treated with (XII) or (XV) lived for nine days; those treated with *p*-aminobenzoic acid survived four to six days; controls died after three to four days.

Table 3[7]

Substance	No. of animals	Daily dose (mgm.) per mouse	Administration	Number of days of administration	Mortality after 35 days	Average tuberc. index	Average survival time
Streptomycin	15	10	subcut.	30	0	22	35
I	15	10	*per os*	30	6 6%	44	32 5
II	15	10	,,	30	60·0%	80	31 3
III	15	10	,,	30	53 3%	72	30 2
V	15	10	,,	20	28·5%	75	32 3
X	15	10	,,	30	40·0%	71	32 0
XII	15	10	,,	28	57·4%	83	31 1
XIV	15	10	,,	30	33·3%	77	31 2
XV	15	10	,,	30	80 0%	94	31 9
Control	15	—	—	—	73·3%	100	28 6

I am much indebted to Prof. S. Ślopek, of the Silesian Medical Academy, for carrying out the *in vitro* and *in vivo* experiments, and Dr. J. Venulet, of the Medical Academy, Warsaw, for examining the toxicity of the substances.

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April 10.

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Identification of a Heparin as a Main Component of the 'Third Factor' involved in the Virulence-enhancing Action of Hog Gastric Mucin

PREVIOUS work[1–4] has shown that the virulence-enhancing action of hog gastric mucin is due to a synergic action between two non-specific factors (a viscous medium and particulate residue), and a more specific soluble third factor. Partial purification of the latter[3] yielded a heterogeneous product which was predominantly peptide in nature, but which contained 5–10 per cent of carbohydrate residues. Further purification, using a revised assay[4] in which the two non-specific factors are maintained constant, has shown that the carbohydrate moiety is responsible for the activity.

After much preliminary fractionation of the crude mucin from fresh hog gastric mucosæ, this moiety was separated into two active fractions by using the different solubilities of their barium salts in water and in aqueous alcohol. Fraction *A* is precipitated from aqueous solution by adding 3 per cent barium acetate at *p*H 7 and standing at 0° for several days. It has been obtained as an amorphous sodium salt, and examination at *p*H 4·5 and *p*H 8·0 by ultracentrifugation and electrophoresis indicates a single homogeneous substance. A typical batch has an activity of 3·9 (2·9–5·1) virulence-enhancing units[4]. Fraction *B* is soluble in aqueous solution containing 3 per cent barium acetate and is precipitated by adding alcohol to 50 per cent v/v. It contains no ester sulphate or hexuronic acid detectable by the Dische carbazole reaction[5], and is still impure, but it is predominantly carbohydrate, containing a high proportion of hexosamine. A typical batch has an activity of 1·1 (0·7–1·8) virulence-enhancing units[4]. Purification of this compound is being continued.

Active heparins are mucoitin sulphuric esters in which the number of sulphate groups can vary considerably[6]. Chemical analysis of the essentially homogeneous fraction *A* clearly indicates that it is a heparin. This has been further confirmed by comparing the anticoagulation activity of fraction *A* with that of three different, highly active, samples of authentic heparin which were also assayed for virulence-enhancing activity. In addition, my colleague Dr. H. P. Lambert had found that fraction *A* inhibits

Table 1. ANALYTICAL FIGURES ON FRACTION *A* ON THE NEUTRAL SODIUM SALT OF HEPARIN AND THOSE CALCULATED FOR A MUCOITIN DISULPHURIC ESTER

	Fraction *A*	Heparin			Calc. for mucoitin disulphuric ester	
		Reinert and Winterstein (ref. 8)	Wolfrom *et al.* (ref. 9)			
	Mixture of neutral and acid sodium salt	Neutral sodium salt ex. crystalline barium salt	'Roche' heparin neutral sodium salt	Neutral sodium salt ex. crystalline barium salt	Neutral salt $C_{12}H_{16}O_{16}NS_2Na_3$	Acid salt $C_{12}H_{17}O_{16}NS_2Na_2$
C	25·3	23·4	—	—	25·6	26·6
H	3·7	3·5	—	—	2·84	3·16
N	2·49(*D*) 2·75(*K_J*)	2·6	2·6	—	2·49	2·59
S	11·7	11·9	11·7	—	11·3	11·8
Na (from sulphated ash)	10·5	11·6	12·0	12·4	12·2	8·5
P	Nil	Nil	0·1	—	Nil	Nil
Anhydrohexosamine					28·5	29·7
(1) Elson and Morgan (ref. 11) after 3*N* or 4*N* HCl hydrolysis	22·7	—	22·2	21·4		
(2) Van Slyke after 3*N* HCl hydrolysis	27·0	—	—	—		
Anhydrohexuronic acid					31·2	32·5
(*a*) Lefèvre and Tollens	24·1	—	22·2	—		
(*b*) Dische (ref. 5)	31·4	—	—	—		
α (20–25° *C*.; L in water)	+ 53° (*C* = 1)	+ 45° (*C* = 1 corrected for 6·9 per cent water)	+ 42° (*C* = 2)	+ 55° (*C* = 2)		

Table 2. ANTI-COAGULATION TEST ON THE FRACTION *A* AND THREE DIFFERENT HEPARIN SAMPLES

Strength % w/v of anticoagulant solution	Mgm. anticoagulant per 100 ml. blood	Time for complete coagulation in hours							
		Fraction *A*		Boots heparin		Evans heparin		Roche heparin	
		Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2
0·0156	1·25	No clot	96	84	84	24	86	48	36
0·0125	1·0	No clot	48	24	36	18	36	48	36
0·00625	0·5	4	5	5	4	2·5	5	9	4
0·00318	0·25	2	2	1·25	1·25	1·25	1·25	2	1·5
0·00156	0·125	1	1	0·5	0·5	0·5	0·5	0·75	1·25
Nil	Nil (saline control)	0·25		0·25		0·3		0·3	

sheep-cell hæmolysis, and that this effect is due to an anti-complementary action. Heparin has already been shown to be anti-complementary[7].

Table 1 shows the more important analytical figures for fraction *A*, the slightly acid reaction (*p*H 5·5–6·0) of which indicates that the final dialysis, to remove sodium sulphate after decomposition of the barium salt at *p*H 7, has resulted in a loss of sodium ions and produced a mixture of acid and neutral salts. Figures published by Reinert and Winterstein[8], and Wolfrom *et al.*[9] for the neutral sodium salt of heparin, are included in the table, together with those calculated for an average polymer unit composed of a mucoitin disulphuric ester. Other relevant experimental data for fraction *A* which have already been found true for heparin are the absence of acetyl groups detectable by *p*-toluene sulphonic acid hydrolysis[9,10], a Van Slyke amino-nitrogen figure which increases with reaction time[9], the wide discrepancy between the Dische and Tollens–Lefèvre methods of estimating hexuronic acid[9], the presence of *d*-glucosamine[9] as detected by paper chromatography, the presence of a free carboxyl group[9], and the crystallization of an acid barium salt in micro-sheaves[9].

Table 2 shows a comparison of the anticoagulation activity of fraction *A* with that of three different, highly active samples of heparin from Boots Pure Drug Co., Ltd. (102 I.U. per mgm.), Evans, Lescher and Webb (93 I.U. per mgm.) and Roche Products, Ltd. (120 I.U. per mgm.). Fresh ox blood (3·75 ml.) was mixed with solutions (0·3 ml.) of different strengths of the samples under test, and the time for complete coagulation was noted using the technique described by Jorpes[12,13]. These results show that fraction *A* has a slightly greater activity than that of the three authentic heparin samples. Corresponding virulence-enhancing activities, when determined by the assay used for the third factor involved in virulence enhancement, are, in the usual units: fraction *A* 3·9 (2·9–5·1); Boots heparin, 3·2 (2·1–4·8); Evans, Lescher and Webb heparin, 2·2 (1·4–3·3); Roche heparin, 3·5 (2·3–5·1). Adequate controls ruled out any possible toxicity of these samples at the concentrations used for the test.

Full details of this work will be published elsewhere. Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

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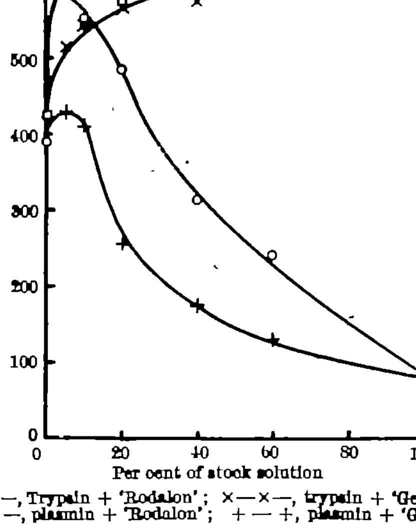
Quaternary Detergents and the Activity of Trypsin and Plasmin

DURING investigations on antiproteolytic substances an interesting action of two quaternary surface-active agents, namely, cetylpyridinium chloride ('Germidin', Bionova, Ltd., Copenhagen) and lauryl-benzyldimethylammonium chloride ('Rodalon', Ferrosan, Ltd., Copenhagen), was observed.

Mixtures of the quaternary compounds with trypsin (Armour, crystalline, containing not more than 50 per cent magnesium sulphate) and plasmin (human, streptokinase-activated) were tested for fibrinolytic activity by means of the plate method[1,2]. The results are presented in the accompanying graph.



□—□—, Trypsin + 'Rodalon'; ×—×—, trypsin + 'Germidin'; ○—○—, plasmin + 'Rodalon'; +—+, plasmin + 'Germidin'

Action of cetylpyridinium chloride ('Germidin', 1 per cent stock solution) and lauryl-benzyldimethylammonium chloride ('Rodalon', 1 per cent stock solution) on the fibrinolytic activity of equal volumes of enzyme solution. *Abscissa*: Concentration of quaternary compound added in per cent of stock solution. *Ordinate*: Fibrinolytic activity recorded as the product of two diameters of the lysed zones

It is seen that the fibrinolytic activity of trypsin is increased considerably by the addition of the quaternary compounds. Plasmin shows an increase in activity in the presence of very small concentrations of the compounds, while larger amounts inhibit. These results stress the difference between trypsin and plasmin as proteolytic enzymes. Chymotrypsin (Armour, crystalline, 50 per cent magnesium sulphate) was slightly inhibited. An *Aspergillus* protease[3] (courtesy of Dr. W. G. Crewther, Melbourne) was activated slightly.

Our experiments have shown that proteolytic enzymes may be characterized and grouped according to the influence of a number of antiproteolytic substances. These investigations will be published in detail elsewhere.

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Effect of Temperature on the R_F Values of the Amino-acids during Paper Chromatography with Solvents completely Miscible with Water

CONSDEN *et al.*[1] observed that in the case of phenol saturated with water as the developing solvent, R_F values of amino-acids increase with increase of temperature, since the water-content of phenol varies directly with temperature within the range studied. The reverse is the case with collidine, the water-content of which decreases with increase of temperature. The water-content of solvents which are completely miscible with water can be suitably adjusted, the phase-composition remaining unaffected by temperature. If the change in phase-composition of the developing solvent is the only cause of alterations of R_F values with temperature, they should be independent of temperature in case of miscible solvents. That this is not so will be clear from the following.

The miscible solvents employed were pyridine, acetone and *iso*propyl alcohol. Since these solvents are highly volatile, the ascending method[2] of paper chromatography was followed, using throughout Whatman No. 1 filter paper. The positions of the amino-acids on the chromatogram were, as usual, indicated with ninhydrin. The range of variation in temperature during a particular experiment did not exceed half a degree. The accompanying table records the R_F values at different temperatures of four amino-acids out of a large number I have investigated.

Developing solvent	Amino-acids	R_F values at 10° C.	15° C.	20° C.	25° C.	30° C.
Acetone–water (7 : 3 by vol.)	Aspartic acid	0·23	0·31	0·38	0·63	0·58
	Glycine	0·26	0·34	0·36	0·51	0·51
	Proline	0·46	0·49	0·51	0·65	0·69
	Phenylalanine	0·53	0·63	0·64	0·72	0·72
Pyridine–water (7 : 3 by vol.)	Aspartic acid	0·25	0·27	0·33	0·25	0·32
	Glycine	0·34	0·35	0·38	0·36	0·36
	Proline	0·51	0·56	0·60	0·55	0·52
	Phenylalanine	0·68	0·70	0·71	0·72	0·68
*Iso*propyl alcohol–water (7 : 3 by vol.)	Aspartic acid	0·12	0·13	0·17	0·28	0·17
	Glycine	0·20	0·23	0·27	0·30	0·26
	Proline	0·32	0·40	0·45	0·47	0·44
	Phenylalanine	0·47	0·51	0·56	0·57	0·55
*Iso*propyl alcohol–water (9 : 1 by vol.)	Aspartic acid	0	0	0	0	0
	Glycine	0·02	0·02	0·03	0·04	0·05
	Proline	0·10	0·11	0·11	0·13	0·15
	Phenylalanine	0·17	0·18	0·19	0·20	0·25

These results indicate that in most cases the R_F values increase with rise of temperature, except in the case of pyridine–water at 25° C. and *iso*propyl alcohol–water (7 : 3) at 30° C. At these two temperatures the R_F values show a decrease instead of an increase compared with those at preceding temperatures. A decrease of the partition coefficient at higher temperatures would partly explain an increase of R_F, assuming a constant value for the ratio of areas of cross-section of the mobile and immobile phases.

The decrease in R_F values in the case of pyridine–water at 25° C. and *iso*propyl alcohol–water (7 : 3) at 30° C. is contrary to what one expects from the above reasoning. It is perhaps necessary to take into account a large number of factors involved in paper chromatography which are likely to be influenced by temperature. They include water-adsorption by cellulose, compositions of the phases, affinity of the solvent and solute molecules for cellulose and the solvating power of the liquids employed. A detailed study for evaluating the most likely factors is in progress.

Thanks are due to Dr. J. K. Chowdhury, head of the Department of Chemistry, and Dr. B. Banerjee, senior research fellow, Bose Research Institute, Calcutta, for their encouragement and suggestions during this work. My thanks are also due to Dr. S. K. Mukherjee, University College of Science and Technology, Calcutta, for his criticism and suggestions.

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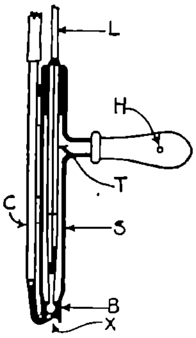
A Convenient 'Hanging-drop' Glass Electrode Unit

A glass electrode unit developed in this laboratory has proved so generally useful that its brief description may be helpful to others. It combines the advantages of providing a robust and convenient assembly for general purposes, and of permitting precise measurement of *p*H with as little as 0·15 ml. of available solution if need be. The form of the unit (which incorporates an effective stirring device) makes it suitable for electrometric titrations on volumes of solution as small as 0·4 ml.



The construction of the electrode assembly is shown in the diagram. The glass membrane is the bulb *B*, about 4·8–5·0 mm. diameter, blown on the end of the drawn-out tube *T* which contains a sealed-in *N* hydrochloric acid/silver chloride half-cell. It is a great advantage that the membrane consists of a type of glass permitting determinations of *p*H in alkaline as well as acid solution.

The electrode is mounted within a glass sleeve *S*, of which the main upper portion is 8 mm. internal diameter, and the short bottom portion about 6·2 mm. A side tube near the top is fitted with a rubber teat; this is perforated by a small hole *H* normally closed by the thumb on compressing. This provides a means of filling, washing, and also of stirring when the electrode is dipped into a small volume of liquid.

The bottom of the sleeve is open. A small notch ground in its bottom edge receives the bent tip of the potassium chloride bridge *C*, which is bound to the sleeve by rubber bands. The tip of *C*, including the bend, consists of a capillary with a sealed-in thread of asbestos fibres which terminates the salt bridge. The tube *C* is connected above to a reservoir (not shown) of potassium chloride into which a small calomel half-cell is dipped, the connexion being made through a length of about 12 cm. of flexible plastic tubing.

The potassium chloride reservoir, and the electrical lead *L*, are clamped on a suitable stand and the electrode assembly is allowed to dangle at a convenient height above bench-level.

The test solution *X* surrounds the glass electrode *B* and is held in place merely by capillarity. It is in contact with the tip of the potassium chloride bridge.

The general method of operation will be clear to any user, but the following may be mentioned: (1) pointed pieces of filter paper may be used to drain the space around the electrode, for example, during washing; (2) to fill when minimal liquid is available, a drop placed at the bend in *C* will enter the space around the electrode.

I wish to acknowledge the helpful co-operation of Messrs. Doran Instrument Co., Ltd., Stroud, Glos, who assisted by developing an appropriate glass electrode for this unit.

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A Gravimetric Estimation of the Carboxylic Acid Group in Cellulose

The electrochemical and ion exchange properties of cellulose and other insoluble polysaccharides are largely determined by the content of —COOH groups, so that their precise estimation becomes a matter of some importance. Davidson[1] has recently re-examined the various methods available for their determination, which are based either upon some form of acid–alkali titration, or upon the absorption of the basic dye methylene blue.

We consider most of the defects of these earlier methods are absent in the new method we now describe. The material is soaked in a saturated solution of uranium acetate in water (*c.* 0·01 *M*, *p*H 6·5) over-night, very thoroughly washed, oven-dried and weighed, ashed at 700° C. and the ash weighed as U_3O_8. This procedure applied to commercial 'Cellophane' gave the following results:

mgm. Ash/1 gm. 'Cellophane'	13·56	13·86	13·97
Acid-washed blank	0·1	0·1	0·1

Mean COOH content milliequiv./100 gm. = 4·00.

One of us (G. R. W.) has also estimated the uranium content by weighing in water before and after soaking in uranium acetate, using a hydrostatic balance. An average result of 4·71 milliequiv. COOH/100 gm. was obtained.

The same material gave the following results by other methods:

Neale and Stringfellow's method (ref. 2)	4·76
Methylene blue absorption (ref. 1)	4·806
Pacsu's method (ref. 3)	5·02

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William Nicol and Henry Clifton Sorby

In her short article on William Nicol and H. C. Sorby, Mrs. Eyles states[1] that Nicol "seems to have confined himself to making sections of fossil wood, and did not make rock sections". Nicol stated in 1834[2], however, that when he came to prepare sections of fossil plants he "had recourse to a process I had practised upwards of fifteen years ago, in preparing thin slices of the most fragile substances, as calcareous spar, in order to examine their effects on polarized light". The lapidary G. Sanderson had made thin sections after fixing the specimen to a block of wood with lapidary's cement; Nicol's process was essentially to substitute glass for wood and Canada balsam for the cement.

Nicol's collection in the British Museum (Natural History) contains, in addition to petrified plants, a few sections of flint and other pebbles, as well as of coal, cannel and lignite. Alexander Bryson's largely contemporary collection, also in the British Museum, includes sections of various minerals and rocks, and of corals and other fossil animals. There are incidental references to thin slices of minerals in some of Brewster's papers, and the technique had evidently been employed in Edinburgh on a wide range of minerals, rocks and fossils for many years before Sorby came on the scene, even if its applications were not pursued very far, except in the case of petrified plants.

Sorby's 1851 paper dealt with certain sedimentary rocks; but W. C. Williamson, from whom Sorby learnt the technique of preparing thin sections, had already in his classic memoir on "Microscopic Objects in the Mud of the Levant" (1848)[3] examined "thin sections of oolitic limestones from Bristol, Durdham Down, Yorkshire and Skerry". Williamson's interests were primarily biological; but his pioneering efforts are worthy of remembrance in any account of the early history of the microscopic study of rocks.

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MY article on Nicol and Sorby was intended to direct attention to two centenaries of especial interest in the history of microscopic petrography, that is, the examination of thin sections of *rocks*, which are, in most cases, mineral aggregates. It is generally recognized that the initial impetus to the development of this most important branch of geology was given by Sorby in the papers to which reference is made in my article; and also that the polarizing prism invented by Nicol and used by Sorby played an essential part in the development of the new science.

Nicol's statement, quoted by Mr. Edwards, certainly shows that he had made thin sections of *minerals*, but so had other and earlier workers. Prof. W. T. Gordon gave a short account of the history of the examination of stony material by means of thin sections to the British Association in 1926[1]. He mentioned there that Brewster made slices of amethyst one-fiftieth of an inch thick as early as 1817. In fact, Brewster made use of thin slices or plates of minerals for his optical studies several years earlier[2].

I am indebted to Mr. Edwards for directing my attention to the paper published by W. C. Williamson in 1848 in which he refers to examining thin sections of oolitic limestone from several localities. Williamson's paper was read in November 1845, and it is worth noting that in August of the same year John Phillips read a paper to a Yorkshire society in which he also refers to the examination of calcareous rocks in transparent sections[3] (a fact unknown to me when I prepared my article). It therefore seems that the advantages of this technique were becoming known in the eighteen-forties, especially in northern England.

That many of the sections made by Nicol and Bryson are preserved in the British Museum (Natural History) has escaped the notice of previous writers on Nicol, and indeed seems to have been unknown even to C. D. Sherborn, in his "Where is the — Collection ?" (Cambridge, 1940). Sherborn noted only that the Nicol and Bryson collections were sold in 1868, and not that they were acquired by the British Museum. An account of these and any similar collections would be useful and interesting, and might provide a clue to the relative priority of Sorby, Williamson, Phillips, and possibly others in this field.

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Could an Arms-Race End Without Fighting?

THERE have been only three great arms-races. The first two of them ended in wars in 1914 and 1939: the third is still going on. From so few events we cannot hope to draw any reliable conclusions by statistics. Let us instead see whether an analysis of motives throws any light on the problem. Arms, in peace-time, are intended to overawe possible enemies; therefore the motive of submission must come into the picture. Arms, in peace-time, in fact provoke possible enemies to prepare to defend themselves; so defensiveness must be taken into account. There is also considerable grumbling about the cost of rearmament. The behaviour of large groups of people is more regular and less capricious than the behaviour of individuals. It is instructive to regard large groups as deterministic, and to represent their behaviour by differential equations, provided that we remember that such a treatment is a caricature. The following simultaneous pair of equations were published[1] for that purpose in 1939.

$$dx/dt = ky\,\{1 - \sigma(y - x)\} - \alpha x + g, \qquad (1)$$
$$dy/dt = lx\,\{1 - \rho(x - y)\} - \beta y + h. \qquad (2)$$

Here t is time, x and y are the war-like preparations of the opposing sides, and the other letters are constants. Of these, k and l are positive 'defence coefficients', σ and ρ are positive measures of 'submissiveness', α and β are positive measures of the objection to the cost of rearmament; but g and h, which represent feelings, not about arms but about the treaty-situation, may have either sign. The names of the opposing nations do not appear, because the motives are supposed to be common to mankind; but the numerical values of the constants may differ from nation to nation.

The validity of these equations was reconsidered in more detail, and by comparison with more historical evidence, in a microfilm[2] published in 1947. The equations were found to be a tolerably good representation of what had happened. Better measures of x and y were introduced under the name of 'warfinpersal', which means the annual 'defence' expenditure divided by the annual earnings of a semi-skilled engineer. By the time that an arms-race had grown to alarming proportions, it was found to be difficult to distinguish the effects of α, β, g or h, for they were swamped by the effects of k and l. The ratio of k to l was reasonably regarded as equal to the ratio of the 'sizes' of their two respective groups as measured by population and industrial development.

The coefficients σ and ρ were originally introduced to represent the well-known fact that great Powers have sometimes suppressed very much smaller Powers without any fighting. The present note is about a comparatively subtle question, namely, the effects of submissiveness between two Powers that are in some sense equal. It will now be shown that the above equations (1) and (2) indicate the possibility that an arms-race might end without any fighting. I first noticed this theoretical possibility in April 1951. A preliminary note about it has been sent to Prof. C. C. Lienau of Columbia University for his book on "Measures of Organization".

The present world-tension between the devotees of communism and of private enterprise is between two groups sufficiently nearly equal to be alarmed about each other. For the sake of mathematical simplicity, let us represent this approximate equality by setting $k = l$, $\alpha = \beta$, $\sigma = \rho$; and let us neglect g and h. Equations (1) and (2) then become

$$\mathrm{d}x/\mathrm{d}t = ky - k\sigma y^2 + k\sigma xy - \alpha x, \qquad (3)$$

$$\mathrm{d}y/\mathrm{d}t = kx - k\sigma x^2 + k\sigma xy - \alpha y. \qquad (4)$$

It happens to be easier to discuss $(x + y)$ and $(x - y)$ rather than x and y separately. From (3) and (4) by addition and subtraction it follows that:

$$\mathrm{d}(x + y)/\mathrm{d}t = (k - \alpha)\,(x + y) - k\sigma(x - y)^2, \qquad (5)$$

$$\mathrm{d}(x - y)/\mathrm{d}t = -(k+\alpha)\,(x-y) + k\sigma(x^2-y^2). \qquad (6)$$

The relations are further clarified by dividing (5) and (6) respectively by $(x + y)$ and $(x - y)$; for then

$$\mathrm{d}\log(x + y)/\mathrm{d}t = (k - \alpha) - k\sigma(x - y)^2/(x + y), \qquad (7)$$

$$\mathrm{d}\log|\,x-y\,|/\mathrm{d}t = -(k + \alpha) + k\sigma(x + y). \qquad (8)$$

There was a time, during 1945 or 1946, before the present arms-race began to be mentioned. It may, nevertheless, have existed in embryo unnoticed, on one hand in Russia's tardy demobilization, and on the other in the United States' secrecy about the atomic bomb.

For mathematical simplicity it is convenient to contemplate an origin of time, say t_0, at which x and y were positive but both so near to zero that the last terms in (7) and (8) were negligible, leaving approximately:

$$\mathrm{d}\log(x + y)/\mathrm{d}t = k - \alpha, \qquad (9)$$

$$\mathrm{d}\log|\,x - y\,|/\mathrm{d}t = -(k + \alpha). \qquad (10)$$

The second member of (10) is negative, so that $\log|\,x - y\,|$ was tending towards minus infinity, and therefore x was tending to equal y. This is the equality of power, which many people rashly regard as a security. The second member of (9) is positive, so that $\log(x + y)$ was increasing. This is the arms-race beginning slowly and inconspicuously.

Next let us contemplate various later times at which $(x - y)$ is practically zero, but $(x + y)$ has grown enough to make the arms-race noticeable. In this stage the last term in (7) is more negligible than it was at t_0, because after t_0 its numerator has decreased, while its denominator has increased. So, in accordance with (9), the sum $(x + y)$ continues to increase exponentially. Therefore, a critical time, t_1 say, arrives after which $k\sigma(x + y)$ becomes greater than $k + \alpha$, thus making $\mathrm{d}\log|\,x - y\,|/\mathrm{d}t$ become positive. But because $\mathrm{d}|\,x - y\,|/\mathrm{d}t = |\,x - y\,|\,.\,\mathrm{d}\log|\,x - y\,|/\mathrm{d}t$, and because $(x - y)$ is practically zero at t_1, there may be a long lingering after t_1 before $(x - y)$ deviates notably from zero. In other words, $(x - y)$ has been in equilibrium at zero, and at t_1 this equilibrium becomes unstable, so that a chance disturbance may cause either x to exceed y, or y to exceed x. The national politicians would be chiefly interested in which of these two ways the change began; but to that question the answer given by the equations would be untrustworthy, because of chance. The cosmopolitans and the non-politicals might have more cause to remember the subsequent changes described in the next paragraph.

Equation (7) shows that immediately after t_1 the sum $(x + y)$ goes on increasing. Yet, when $(x - y)$ has deviated sufficiently from zero, there will come a second critical time, t_2 say, after which $k\sigma(x - y)^2/(x + y)$ will become greater than $(k - \alpha)$, thus making $\mathrm{d}\log(x + y)/\mathrm{d}t$ negative. But because $\mathrm{d}(x + y)/\mathrm{d}t = (x + y).\mathrm{d}\log(x + y)/\mathrm{d}t$, and because $(x + y)$ is large and positive, the change in $(x + y)$ after t_2 will come on without delay. The contrast between these two reversals may be expressed by saying that $(x - y)$ was in equilibrium at t_1, but $(x + y)$ was far from equilibrium at t_2. The decrease of $(x + y)$ would be obvious as the end of the arms-race.

Both these theoretical reversals are consequences of submissiveness, for they would not occur if σ were zero in (7) and (8).

So say the equations (3) and (4). But could events really happen thus? As far as I know, they never yet have done so. Nevertheless, as the more general theory (1) and (2) has been verified in several other cases, it seems desirable that the topical case (3) and (4) should be published for discussion before the actual event becomes known.

The foregoing description is likely to be received with general incredulity, because it asserts, after the manner of Bertrand Russell's 1914 pamphlet called "War the Offspring of Fear", that the motives in the present arms-race are mutual; whereas the reader, whether he believes the capitalist or the communist propaganda, has been told that the arms-race is all due to the aggressiveness of the other side. I can scarcely hope to dispel a prejudice that is so natural anyway, and is daily reinforced by broadcasts and newspapers. Some evidence about present mutuality has been brought back from the U.S.S.R. by Prof. Kathleen Lonsdale.

There may be among the learned another quite minor cause of incredulity, namely, that the above simple argument is mainly about maxima and minima, and does not give a fully quantitative solution of the differential equations (3) and (4). These do not belong to any of the simple types treated in the text-books. Indeed, it seems remarkable that one can obtain considerable insight by a discussion of maxima and minima. The equations have, however, been integrated numerically in a particular case, and some approximate formulæ have been found. The constants have been roughly determined thus: $\alpha = 2$ year^{-1}, $k = 4$ year^{-1}, and perhaps $\sigma > 0{\cdot}4$ per million people. But an account of these doings might easily double the length of this article.

L. F. RICHARDSON

Hillside House, Kilmun,
Argyll.
Aug. 29.

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[1] Richardson, L. F., *Brit. J. Psychol., Mon. Supp.* No. 23, p. 23, equations (31) and (32) (1939).

[2] Richardson, L. F., "Arms and Insecurity", a book in 35-mm. micro-film (published by the author, 1947 and 1949).

FORTHCOMING EVENTS

Monday, October 1

Society of Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. S. F. Smith: "The Application of Electronic Instruments to Industry".

Tuesday, October 2

Institution of Post Office Electrical Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Dr. J. Swaffield and Mr. D. L. Richards. "Transmission Performance of the Telephone Network—a Survey of some Basic Problems".

Wednesday, October 3

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Prof. F. H. Garner: "The Training of a Technologist" (Redwood Lecture).

Society of Public Analysts and Other Analytical Chemists (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

Thursday, October 4

Textile Institute, Lancashire Section (at 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. G. K. Lake: "Developments of the New Synthetic Fibres in the U.S.A.".

Friday, October 5

Royal Statistical Society, Industrial Applications Section, London Group (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. L. S. Vallance: "An Experiment on the Accuracy of Time Studies".

British Institution of Radio Engineers, Scottish Section (at the Institution of Engineers and Shipbuilders, Elmbank Crescent, Glasgow), at 7 p.m.—Dr. E. G. Richardson. "Acoustics in Relation to Radio Engineering."

Friday, October 5—Saturday, October 6

Physical Society (in the Physics Department of the Royal Cancer Hospital, Fulham Road, London, S.W.3).—Meeting to be held on the occasion of the Centenary of the Royal Cancer Hospital, 1851–1951: "Applications of Physics in the Diagnosis and Treatment of Cancer".

Friday, October 5.—At 2.30 p.m.

Saturday, October 6.—At 10 a.m.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer (Grade III) and a **Lecturer** (Grade II) **in the Department of Botany**—The Secretary, The University, Edmund Street, Birmingham 3 (October 6).

Chemists, Metallurgists and Physicists (Scientific Officer grade) at a Ministry of Supply research establishment near London, and (for one of the posts under Ref. F.582/51/A) the Royal Aircraft Establishment, South Farnborough, Hants: (Ref. F.582/51/A) **Physical Metallurgists** (3) with research experience in metallography, electron microscopy or X-ray or electron diffraction techniques, for the determination of thermal and physical properties of metals and alloys; (Ref. F.583/51/A) **Physical Chemist or Physicist**, with an interest in metallurgy or ceramics, for research investigations connected with the preparation of novel ceramic materials; (Ref. F.584/51/A) **Physical Chemist or Physicist**, with experience of electron diffraction techniques or of electrochemistry, for work on surface phenomena and for research investigations into the properties of metallic films and coatings—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (October 6).

Research Assistant (graduate in chemistry, with biological interests) for work in connexion with an investigation into silicosis—The Registrar, The University, Reading (October 6).

Secretary to the College—The Secretary, King's College, Strand, London, W.C.2 (October 8).

Lecturer in Physics (preference will be given to candidates interested in mathematical physics)—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London S.W.3 (October 12).

Research Appointment (physics graduate) in Microwave Spectroscopy—The Secretary and Registrar, University College, Southampton (October 15).

Research Fellow (with at least two years postgraduate experience in Theoretical Physics, Applied Mathematics, or Metal Physics) to **work in the Department of Metallurgy** on theoretical problems concerning the structure and properties of metals—The Secretary, The University, Edmund Street, Birmingham 3 (October 15).

Lecturer in Production Engineering subjects, including workshop technology up to Higher National Certificate standard, at Denbighshire Technical College, Wrexham—The Director of Education, Education Offices, Ruthin (October 20).

Senior Research Officer (with a university degree with honours in chemical or mechanical engineering, or equivalent qualifications, and with experience in the construction and operation of industrial plant) to undertake the planning and supervision of the design, construction and operation of pilot scale complete gasification plants, in the Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organization, Fishermen's Bend, Melbourne—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3508 (October 20).

Veterinary Research Officers (who must be members of the Royal College of Veterinary Surgeons, or hold a degree in Veterinary Science of an approved university involving a five-year course) in the Research Branch of the Department of Veterinary Service, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (October 31).

Lecturer (with university degree or diploma either in engineering or agriculture) **in Agricultural Engineering** at Canterbury Agricultural College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 12).

Chair of Applied Physics at New South Wales University of Technology—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (November 30).

Assistant (Grade B) **in the Department of Metallurgy and Chemistry** at Rotherham Technical College—The Director of Education, Education Offices, Domine Lane, Rotherham.

Botanist or Plant Pathologist for the Research Division of the Ministry of Agriculture in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Botanist/Plant Pathologist 4/403'.

Chemists (Principal Scientific Officer grade) at a Ministry of Supply research and development establishment in Buckinghamshire, to work on problems of combustion in solid and liquid propellant rocket motors—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.650/51/A.

Demonstrator in Chemistry—The Registrar, The University, Nottingham.

Head of the Building Department (Grade I) at Burton-on-Trent Technical College—The Director of Education, Education Offices, Guild Street, Burton-on-Trent.

Instrument Engineer (with an honours degree in engineering, corporate membership of one of the Institutions of Mechanical or Electrical Engineers, or equivalent qualifications, and with at least three years practical experience of instrument manufacture) to undertake the design, provision and maintenance of instruments used for the measurement of radioactivity and for the control and recording of pressures, temperatures and the flow of liquids and gases, using electronic and other methods, at the Division of Atomic Energy (Production), Risley—The Ministry of Supply, D.At.En.(P.), Risley, Warrington, Lancs.

Lecturer in the Department of Engineering at the County Technical College, Wednesbury—The Director of Education and Clerk to the Governors, Dept. F.E., County Education Offices, Stafford.

Mathematician (Senior Experimental Officer or Experimental Officer grade) to take charge of, organize and build up a small computing section, and a **Mathematician** (Experimental Officer or Assistant Experimental Officer grade) with interest in applied mathematics or numerical analysis, for a Ministry of Supply research and development establishment south-east of London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.251/51/A.

Prehistorian (with a good honours degree in archæology) for the Department of Geological Survey, Uganda—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27079/57/51.

Research Officer (**Biochemist**, with science degree of United Kingdom University and at least two years postgraduate biochemistry experience) for service in Kenya, Tanganyika and Uganda—The Under-Secretary of State, Research Department, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Senior Lecturer qualified to teach some of the following subjects: Theory and Design of Structures, Surveying and Levelling, Building Science, Strength of Materials up to Higher National Certificate standard in building and civil engineering, and a **Lecturer in the Mechanical Engineering Department** to teach Production Engineering up to at least Higher National Certificate standard—The Secretary, South-East London Technical College, Lewisham Way, London, S.E.4.

Senior Research Officer (with membership of the Royal College of Veterinary Surgeons or equivalent, and a university degree, preferably in Veterinary Science, and at least six years experience in veterinary research work), and a **Research Officer** (with membership of the Royal College of Veterinary Surgeons or equivalent, and a university degree, preferably in Veterinary Science), in the Sudan Veterinary Service—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, marking envelope 'Research Officer 4/220'

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Colonial Office. Colonial Research 1950–1951: Reports of the Colonial Research Council, Colonial Products Research Council, Colonial Social Science Research Council, Colonial Medical Research Committee, Committee for Colonial Agricultural, Animal Health and Forestry Research, Colonial Insecticides Committee, Tsetse Fly and Trypanosomiasis Research Committee, Colonial Fisheries Advisory Committee, Director, Anti-Locust Research Centre. (Cmd. 8303.) Pp. 243. (London: H.M. Stationery Office, 1951.) 6s. 6d. net. [78

Fifth Column Psychology. By Vivian U. M. Thompson. Pp. 16. (Lightwater, Surrey: The Author, Ratawi, 1951.) 2s. [78

Annual Reports on the Progress of Chemistry. Cumulative Index, Vols. 1–46, 1904–1949. Pp. 286. (London: Chemical Society, 1951.) 25s. [78

Question. Vol. 3, No. 3: People at Work. By H. W. Hughes, R. W. Latham and Winifred Raphael. Pp. 185–256. (London: Hammond, Hammond and Co., Ltd., 1951.) 2s. 6d. [78

University of Bristol. Annual Report of the Agricultural and Horticultural Research Station (the National Fruit and Cider Institute), Long Ashton, Bristol, 1950. Pp. 217. (Bristol: The University, 1951.) [78

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research, Road Note No. 9: Recommendations for Plastic White Line Markings. Pp. 8. (London: H.M. Stationery Office, 1951.) 6d. net. [98

Rothamsted Experimental Station. Report for 1950. Pp. 184. (Harpenden: Rothamsted Experimental Station, 1951.) 7s. 6d. [138

Council for the Preservation of Rural England. Annual Report, 1950–51. Pp. 42. (London: Council for the Preservation of Rural England, 1951.) [138

The Unified Field: an Extension of the General Theory of Relativity to Date. By Dr. Donald C. Thornton. (International Science Monographs.) Pp. 24. (Hemel Hempstead: The Author, 6 Mountfield Road, 1951.) [138

Bulletin of the British Museum (Natural History). Geology, Vol. 1, No. 5: Cretaceous and Eocene Peduncles of the Cirripede *Euscalpellum*. By T. H. Withers. Pp. 147–170+plates 11–14. 5s. Geology, Vol. 1, No. 6: Some Jurassic and Cretaceous Crabs (Prosoponidae). By T. H. Withers. Pp. 171–192+plates 15–17. 5s. (London: British Museum (Natural History), 1951.) [138

Ministry of Agriculture and Fisheries. Fishery Investigations, Series 2, Vol. 17, No. 5: The Fecundity of the Plaice. By A. C. Simpson. Pp. 28. (London: H.M. Stationery Office, 1951.) 2s. net [148

Experimental and Research Station, Cheshunt. Annual Report (Thirty-sixth Year) 1950. Pp. 72+6 plates. (Cheshunt: Nursery and Market Garden Industries' Development Society, Ltd., 1951.) [158

Symbols, Signs and Abbreviations recommended for British Scientific Publications. A Report by the Symbols Committee of the Royal Society, representing the Royal Society, the Chemical Society, the Faraday Society, the Physical Society. Pp. 20. (London: Royal Society, 1951.) 9d.; 12s for 25. [168

British Intelligence Objectives Sub-Committee Surveys. Report No. 30: The Acetylene Industry and Acetylene Chemistry in Germany during the Period 1939–1945. Part 1: Industrial Production and Use of Acetylene, by Dr. R. Owens; Part 2: Acetylene Chemistry, by Dr. A. W. Johnson. Pp. 157. (London: H.M. Stationery Office, 1951.) 3s. 6d. net. [208

Scottish Education Department. Report for the Year 1950 on the Royal Scottish Museum. By Dr. Douglas A. Allan. Pp. 15. (Edinburgh: Royal Scottish Museum, 1951.) [208

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 871, Vol. 243: The Analysis of the Geomagnetic Secular Variation. By F. J. Lowes and S. K. Runcorn. Pp. 525–546. 5s. No. 872, Vol. 243: Photoconductivity in the Infra-red Region of the Spectrum. Part 1: The Preparation and Properties of Photoconductive Films of Lead Telluride, by O. Simpson and G. B. B. M. Sutherland; Part 2: The Mechanism of Photoconductivity in Lead Telluride, by O. Simpson. Pp. 547–584. 9s. (London: Cambridge University Press, 1951.) [208

Forestry Commission. Report on Forest Research for the Year ending March 1950. Pp. vi+126. 3s. 6d. net. Forest Record No. 11: General Volume Tables for Corsican Pine in Great Britain. By F. C. Hummel, T. W. Irvine and J. Jeffers. Pp. 26. 1s. 6d. net. (London: H.M. Stationery Office, 1951.) [218

Annual Report of the Oundle School Natural History Society for the 1950 Season. Pp. 16. (Oundle: Oundle School, 1951.) 2s. [218

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines for the Year 1950. North Western Division. Report by G. Hoyle. Pp. ii+26+4 plates. 1s. 6d. net. Scottish Division. Report by H. R. Houston. Pp. ii+25+4 plates. 1s. 6d. net. South Western Division. Report by T. A. Rogers. Pp. ii+23. 1s. 3d. net. Northern Division. Report by T. A. Jones. Pp. ii+24. 1s. 3d. net. East Midland Division. Report by W. B. Brown. Pp. iii+31+5 plates. 1s. 6d. net. North Eastern Division. Report by C. W. Scott. Pp. ii+24+7 plates. 1s. 6d. net. (London: H.M. Stationery Office, 1951.) [218

Other Countries

Ministry of Public Works, Egypt. Physical Department Paper No. 49: The Nile Basin. First Supplement to Vol. 6. By Dr. H. E. Hurst and R. P. Black. Monthly and Annual Rainfall Totals and Number of Rainy Days at Stations in and near the Nile Basin for the Period 1938–1942. Pp. vii+228+4 plates. P.T. 50; 10s. Physical Department Paper No. 55: The Nile Basin, Vol. 7, The Hydrology of the Sobat and White Nile and the Topography of the Blue Nile and Atbara. By Dr. H. E. Hurst. Pp. xiii+141+115 plates. P.T. 100; 20s. (Cairo: Government Press, 1950.) [28

University of Minnesota: Minnesota Geological Survey. Bulletin 34: Bibliography of Minnesota Geology. By Theodora G. Melone and Leonard W. Weis. Pp. xii+124. (Minneapolis: University of Minnesota Press; London: Oxford University Press, 1951.) 8s. net. [28

List of Scientific Papers published in the Middle East (including Cyprus, Egypt, Iran, Iraq, Israel, Lebanon, Pakistan, Sudan, Syria and Turkey) received by this Office between 1st March 1950 and 1st November 1950. (No. 6.) Pp. 76. (Cairo: Unesco Middle East Science Co-operation Office, 1950.) [28

Jamaica. Annual Report of the Department of Agriculture for the Year ended 31st March 1949. Pp. 18. 1s. 3d. Annual Report of the Department of Agriculture for the Year ended 31st March 1950. Pp. 18. 1s. (Kingston, Jamaica: Government Printer, 1950–1951.) [28

Fieldiana. Zoology, Vol. 31, No. 46: Remarks on and Descriptions of South American Non-Marine Shells. By Fritz Haas. Pp. 503–546. 1 dollar. Zoology, Vol. 31, No. 47: Mammals from British Honduras, Mexico, Jamaica and Haiti. By Philip Hershkovitz. Pp. 547–570. 30 cents. Zoology, Vol. 31, No. 48: Birds of Negros Island. By Austin L. Rand. Pp. 571–596. 30 cents. Zoology, Vol. 31, No. 49: Review of the subspecies of the Sunbird, *Nectarinia jugularis*. By Austin L. Rand. Pp. 597–608. 20 cents. (Chicago: Chicago Natural History Museum, 1951.) [78

National Research Corporation. Semi-Annual Report to Stockholders, 1951. Pp. 12. (Cambridge, Mass.: National Research Corporation, 1951.) [78

Canada: Department of Mines and Technical Surveys: Geological Survey of Canada. Bulletin 20: Precambrian Correlation and Nomenclature, and Problems of the Kisseynew Gneisses, in Manitoba. By J. M. Harrison. Pp. v+53. 25 cents. Memoir 259: Geology of North-eastern British Columbia. By F. H. McLearn and E. D. Kindle. Pp. ix+236 (8 plates). 1.25 dollars. (Ottawa: King's Printer, 1950–1951.) [78

United States Department of Agriculture. Technical Bulletin No. 1030: Dissemination of the Beet Leafhopper in California. By Francis R. Lawson, Joseph C. Chamberlin and George T. York. Pp. 59. (Washington, D.C.: Government Printing Office, 1951.) 25 cents. [78

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 106, No. 2: Breeding and other Notes from Nyasaland and the Lundazi District of Northern Rhodesia. By C. W. Benson. Pp. 67–114. Vol. 106, No. 3: Mammals in the Highlands of Southern Peru. By Oliver P. Pearson. Pp. 115–174+8 plates. Vol. 106, No. 4: On Reptiles and Amphibians from Tanganyika Territory collected by C. J. P. Ionides. By Arthur Loveridge. Pp. 175–204. (Cambridge, Mass.: Harvard College, 1951.) [78

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 29, Part 10: Studies in the Bromeliaceae, 16. By Lyman B. Smith. Pp. viii+429–520. (Washington, D.C.: Government Printing Office, 1951.) 50 cents. [78

World Health Organization. Annual Epidemiological and Vital Statistics, 1939–1946. Part 1: Vital Statistics and Causes of Death. Pp. 124. (Geneva: World Health Organization; London: H.M. Stationery Office, 1951.) 16 francs; 20s. [88

Rikets allmänna kartverk. Meddelande Nr. 11: The Swedish Solar Eclipse Expeditions to West Africa and Brazil in 1947. Pp. 93. (Stockholm: Rikets allmänna kartverk, 1951.) [88

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procès-verbaux des réunions. Vol. 129: 1ère partie, Procès-verbaux (Octobre 1950); 2ème partie, Rapport administratif (1949). Pp. 60+40. 14 kr. Bulletin statistique des pêches maritimes des pays du nord et de l'ouest de l'Europe. Vol. 32, pour l'année 1947. Rédigé par Nils Rosén. Pp. x+40. 8 kr. (Copenhague: Andr. Fred. Høst et fils, 1951.) [88

Second Annual Report of the Commonwealth Scientific and Industrial Research Organization for the Year ending 30th June, 1950. Pp. 157. (Canberra: Commonwealth Government Printer, 1950.) 9s. [88

Commonwealth Scientific and Industrial Research Organization. Bulletin No. 248: The Potato Moth *Gnorimoschema operculella* (Zell.) and its Control in Australia. By G. A. H. Helson. Pp. 27. (Melbourne: Government Printer, 1949.) [88

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Série scientifique, No. 50: Microbiologie des sols latéritiques de l'Uele. Par H. Laudelout et H. Du Bois. Pp. 36. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1951.) 30 francs. [98

The Rabbit Problem: a Survey of Research Needs and Possibilities. Pp. 17. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1951.) [98

Research Council of Alberta. Report No. 59: Geology of Carbondale River Area, Alberta. By W. H. A. Clow and M. B. B. Crockford. Pp. 75. 50 cents. Report No. 61: Clay Deposits of Elkwater Lake Area, Alberta. By M. B. B. Crockford. Pp. 102. 50 cents. (Edmonton: King's Printer, 1951.) [138

Report on General Survey of Somaliland Protectorate (British Somaliland), 1949. Pp. 42. (Burao: Survey Department, 1950.) 6s. [138

International Office for the Protection of Nature. Report for the Years 1949 and 1950. Pp. 16. (Bruxelles: International Office for the Protection of Nature, 1951.) [138

Ceylon. Part 4: Education, Science and Art (E). Administration Report of the Director of National Museums for 1950. By P. E. P. Deraniyagala. Pp. E21. (Colombo: Government Publications Bureau, 1951.) 45 cents. [138

Austenitic Grain-Size Control of Steel. By B. B. Nijhawan and A. B. Chatterjea. Pp. 58. (New Delhi: Council for Scientific and Industrial Research, n.d.) 3 rupees. [138

The Way of Perfections: a Tract on the Fourth Way of St. Thomas Aquinas. By the Rev. J. B. Freeman. Pp. ix+134. (Mysore: The Author, St. Philomena's College, 1951.) 3 rupees. [138

Annual Report of the Indian Council of Agricultural Research for 1949–50. Pp. vii+81. (Delhi: Manager of Publications, 1951.) 1.6 rupees; 2s. [138

World Health Organization. Monograph Series No. 4: Experiment in Dental Care; Results of New Zealand's Use of School Dental Nurses. By Dr. John T. Fulton. Pp. 87. (Geneva: World Health Organization; London: H.M. Stationery Office, 1951.) 4 francs; 5s.; 1 dollar. [158

Deccan College Monograph Series 6: Stone Age and Pleistocene Chronology in Gujarat. By Prof. Frederick E. Zeuner. Pp. vii+46. (Poona: Deccan College, 1950.) 8 rupees. [168

Thirty-fourth Annual Report of the National Research Council of Canada, 1950–51. (N.R.C. No. 2463.) Pp. 43. (Ottawa: King's Printer, 1951.) [208

Thomas Baker, Alice Baker and Eleanor Shaw Medical Research Institute, Alfred Hospital, Prahran. Twenty-fourth Annual Report, 1950. Pp. 16. (Prahran, Vic.: Alfred Hospital, 1951.) [208

Catalogues

Catalogue of Seeds, Plants, Flowers. Pp. 54. (Calcutta: The Globe Nursery, 10 Lindsay Street, 1951.)

Military History: Books on the Armies of the World and their Equipment. (Catalogue 716.) Pp. 80. (London: Francis Edwards, Ltd., 1951.)

A New Paraffin Section Mounting Bath. Pp. 2. (London: George T. Gurr, 136 New King's Road, S.W.6, 1951.)

Mastery of Measurement: Electronic Instruments selected from the Extensive Range designed and made in England by Marconi Instruments, Ltd. Pp. 72. (St. Albans: Marconi Instruments, Ltd., 1951.)

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LEADERSHIP IN THE MODERN STATE

ON at least three occasions in recent months, Government action in Britain has raised the question of the appropriateness of our existing organization of central government. The establishment of the Ministry of Local Government and Planning, with the re-distribution of functions between the new Ministry and the Ministry of Health, raised fundamental issues that did not receive adequate discussion at the time. Similar issues were involved in the subsequent creation of the Ministry of Materials, while the question of the means of control of the nationalized industries is perpetually being raised, sometimes on Government initiative, sometimes by critics of Government policy. Particular and more limited aspects of the general question have also been discussed from time to time as, for example, in a debate in the House of Lords on the most appropriate means for administering the atomic energy project, and in comments in reports of the Select Committee on Estimates on Treasury control.

Full discussion, free from political bias, of the principles involved is of the first importance. It is the great merit of such lectures as the Romanes Lecture on "The Science and Art of Government" which Lord Hankey delivered at Oxford on June 7, and which has now been published[*], that they enable us to judge the soundness of decisions or proposals in the light of rules or principles of statecraft which are frequently forgotten in the press of business. Lord Hankey postulated, as the main objects of government, peace abroad and contentment at home without too much encroachment on liberty; and in pursuance of the first, which to day is more important than ever, he discussed at some length the reasons for the failure of the Allied Governments to achieve that first object of victory, and the obstacles to their success.

Even here, however, when Lord Hankey traces the real weakness of the United Nations to the fact that it is required to combine the roles of arbiter and belligerent, and thus to become judge in its own cause, his observations have a profound significance for much that is happening in our domestic affairs to-day, and indicate the roots of difficulties there also. Permanent peace cannot be compelled by force, and the important work of the United Nations in the economic, social, cultural and spiritual fields requires supporting by some great and sustained spiritual initiative. Nor has fortune favoured the realization of the second object, "contentment at home without too much encroachment on liberty"; and in considering what could be done to increase contentment Lord Hankey turned largely to the political maxims of the Greeks. First of these, he commends that of avoiding extremes, and refers to criticism of post-war governments of Britain for driving political theories like nationalization to extremes and for wasting public money on untested schemes of Colonial development. The latter lesson would appear to have been learned at last but at great cost, and it is further emphasized in a passage in the last report from the Advisory Council on Scientific Policy.

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[*] The Science and Art of Government. By the Rt Hon. Lord Hankey. (The Romanes Lecture delivered in the Sheldonian Theatre, 7 June 1951.) Pp. 34. (Oxford: Clarendon Press; London: Oxford University Press, 1951.) 3s. 6d. net.

As regards nationalization, less confidence can be felt, particularly in view of statements about the engineering and the chemical industries. Here, as Lord Hankey proceeds to show, the maxim attributed to Pittacus of Mytilene, "Know thy opportunity", is equally pertinent. He raises the question whether advantages could not have been won from the austerities of to-day by concentrating on overdue reforms that will increase our strength without making demands on financial or other resources needed for rearmament. The timing of action is indeed the key to success, and although Lord Hankey does not discuss particular instances of bad timing that have been responsible for our present difficulties, he makes one important suggestion. It is not nationalization alone, carried out with insufficient regard to the administrative and other resources available for implementing a policy, and too much in subservience to a political doctrine, that is responsible for the strain of overwork on ministers, Parliament and public servants and is already endangering the country's constitution, for all its strength. Lord Hankey rightly observes that the burden of government has been enormously increased by the new and sometimes unnecessary functions imposed by the work of the United Nations and its satellite bodies, the Atlantic Treaty Organization and other developments. This in itself has led to proliferation of commissions, boards, councils and committees at least as much as internal policy. When Lord Hankey's comment is endorsed by the dignified warning about overstrain and illness contained in a note "The Price of Administration", commenting in a recent issue of the *Journal of Public Administration* on the tragic and premature death of Sir Arthur Street, and this is accompanied by the loss of senior Civil Servants from Whitehall to industry, the situation is clearly serious. We are in truth desperately short of experienced administrators in the service of the State, and some of the superhuman load of administrative responsibility must be taken off the shoulders that now bear it.

Something might perhaps be done to check the tendency by making the upper ranks of the Civil Service less financially disparate with those of industry. But a drastic and immediate overhaul of the whole task of administration is desirable, and might also offer surprising economies. Besides avoiding the initiation of measures for the implementation of which trained and experienced staff is not available, it is imperative that there should be a rigorous pruning of all the petty controls and responsibilities which cannot be clearly shown to be necessary in the public interest. Not the least is this necessary in those departments such as the Board of Trade, which, already structurally weak and carrying an absurd load of duties, has recently lost its permanent secretary, Sir John Woods, who has gone to the English Electric Co. There is little hope of rapidly increasing the number of trained senior Civil Servants, and practically the only hope of relief is to prune, wherever possible, the activities of Government.

Lord Hankey made a second practical suggestion—that the whole population should be instructed how to obtain adequate nutrition from austerity rations, by correctly balancing proteins, carbohydrates, fats, vitamins and mineral salts and by other measures which would greatly improve national health, avoid dental decay and effect important economies. Science, as he points out, has already given the lead here, and to achieve success the wholehearted co-operation of the medical profession, nurses and scientific workers from many fields would be required. It is a matter involving not the expenditure of great sums on nutrition but a great deal of education, and here the wider connotation of Lord Hankey's suggestion is important.

Nearly fifty years ago, in the last speech of his South African tour, Mr. Joseph Chamberlain observed: "Everything depends, in administration and in high politics, upon the extent to which those who govern and those who are governed are able, to some extent at any rate, to put themselves in each other's places". Failure to do so, to observe what is from one point of view in national affairs the Solon maxim, "Know thyself", has been a main cause of many difficulties in which Great Britain now finds itself. With it, however, has gone disregard of the maxim of Thales—"Suretyship is the forerunner of ruin"; and there is no more searching passage in Lord Hankey's lecture than that in which he shows how neglect of this precept is inherent in the conception of the Welfare State and, if not watched, can bring all to ruin.

Lord Hankey concludes that while there is no ground for complacency, until rearmament has made further progress, there is no reason for pessimism. Nevertheless, we must avoid waste and dissipation of our scientific and other resources. With that latter problem Lord Hankey was concerned more particularly in a subsequent lecture on technical and scientific man-power given on August 29. This lecture was the fourth in a series of Centenary Lectures on "The Worker in Industry", arranged by the Ministry of Labour and National Service (now issued by the Ministry), and in it Lord Hankey referred to the large groups of workers in science and technology, grouped sometimes by professions, sometimes geographically, sometimes in government service, sometimes in private industry or groups of industries, whose higher direction and co-ordination call for a special type of scientific and technological administrator who is not easy to find. There is in science and technology, he said, the same need as in the Services for a cadre of persons qualified for such directorate and co-ordinating responsibilities at the highest level.

It is suggested by Lord Hankey that aspirants to such posts should have some establishment comparable to the Imperial Staff College, where they would gain a more intimate knowledge of sciences and technologies other than their own, and would meet people with totally different experience in various branches of government and administration, finance, economics, humanities and international affairs. This appears to be advocating a scientific and technological staff college on the model of the Imperial Defence College. It was never the intention, however, that scientific men and technologists with administrative gifts and destined for administrative responsibilities should be excluded from the Administrative Staff College already established at Henley. In such a college they would assuredly more readily correct the deficiencies of specialization and broaden their outlook than in a separate scientific staff college, and in doing so would help to diffuse a much-needed understanding of science into government, the humanities and other spheres of national life.

It will not, of course, be easy as yet to find scientific men and technologists with the general knowledge and administrative ability required to organize and lead the mixed teams of large-scale scientific and industrial enterprise. Measures of reform in secondary as well as in scientific and technological education are necessary, as well as a greater readiness in government and in industrial circles to admit to administrative responsibility the scientific worker or technologist who shows evidence of such gifts. It may even be necessary to encourage him to use them; but although the men with whom we are here concerned will always be relatively few, there must be no attempt to increase the number of administrative positions. That must always be kept at the minimum consistent with efficiency: the present proliferation, as Lord Hankey remarked in his Romanes Lecture, is partly a consequence of so overburdening our administrators that they are unable to cope with the perennial task of reviewing organization.

In his later lecture, Lord Hankey touched on a question of government that is to some extent new, though of growing importance. Government, he emphasized, is concerned primarily with human beings, and accordingly human relations and human personality are dominating considerations. That applies equally to the question of technical and scientific man-power: without a large and adequate number of human beings highly trained for research, development and manufacture, science would decline, progress would be arrested and degeneracy result. In his Romanes Lecture, however, Lord Hankey's major concern appeared to be lest in the Welfare State we should sap, especially in the young, the sterling qualities which have made Britain great. Disaster could easily follow a policy of safety first, a decline in the spirit of public service or of adventure. In industry, as well as in maritime life, enterprise, a readiness to accept responsibility and run risks and to make ventures are as essential as in science or any other creative activity. There are elements in our society to day which threaten this spirit and discourage the adventurous, and of these Lord Beveridge gave plain warning in presenting his reports on 'social insurance' and on 'voluntary action'. It should be a first canon of statesmanship to avoid all measures which threaten the growing-points of science, art or industry, and to encourage as far as administrative action can the individuality and the spirit of enterprise which are the roots of national greatness.

Misgivings on this score are the real reason for the concern manifested, for example, in the House of Lords debate on the administration of the atomic energy project. It is vital to the future of Great Britain that conditions of service should be such as to attract the right type of men and women into the scientific and technological departments of the State, and encourage their most fruitful and creative use. Even now, despite the observations of the Barlow Report on scientific staff and the comments of the Select Committee on Estimates in 1947, the position is not entirely satisfactory. The right use of the scientific and technical expert and the proper relation between science and technology demand more attention than might appear from Lord Hankey's lecture; but none the less he indicates the principles which should determine that use and relation. Equally, his principles might be applied to the consideration of the measures affecting the organization of government and its efficiency. Treasury control of expenditure, although necessary to avoid waste, is a relatively minor matter. Suggestions of the Committee on Public Accounts for strengthening that control, including the appointment of Treasury nominees on semi-independent bodies financed from public funds, and for defining and strengthening the link between the departmental accounting officers and the Treasury, while valuable in themselves, become trivial unless the general policy of the central government is encouraging the initiative and enterprise on which Lord Hankey lays such stress.

That much is strongly contended, for example, in a recent memorandum from the Federation of British Industries, and apart altogether from party politics there is reason for doubting whether the whole basis of taxation policy is now in keeping with the country's long-term interests, and the need for encouraging research and development. An impartial examination of this issue is the more desirable since the ability of the private trust or corporation, such as the Nuffield Foundation, to continue to sustain the growing-points of science by voluntary effort is in doubt. Furthermore, the work of government rests to a large extent not only on the Civil Service but also on the services of an immense number of voluntary workers, in borough councils and magistrates' courts, hospital management committees, governing bodies of schools, and the like. Without this voluntary service the task of government, particularly of local government, could not be carried on. Quite apart from the continuance of that spirit of public service to which Lord Hankey referred, it is important that men and women of the right type should be forthcoming for such work in sufficient numbers. There are changes in social and economic conditions which are tending to check the supply, and on that ground alone an early review of local government is desirable. But Lord Hankey's lecture indicates clearly that the first need is some clear thinking on the whole field of central and local government organization, and an honest attempt to apply firmly and courageously the principles the soundness of which has been attested by more than two thousand years of human experience.

FORECASTING THE WEATHER

Neue Methoden der Wetteranalyse und Wetterprognose

Von Dr. Richard Scherhag. Pp. xii+424. (Berlin, Göttingen und Heidelberg: Springer-Verlag, 1948.) 78 D. marks.

WITHIN the past twenty years the forecasting of to-morrow's weather has become a much more formidable task than it was in earlier years. This comes about not so much because more precision is expected, but because the forecaster is now required to analyse so many more reports and to apply so much recently acquired knowledge of the atmosphere before he can make a satisfactory assessment of the probabilities. Even then he can seldom do justice to his forecast, because of limitations of newspaper space and broadcasting time; but that is another matter.

Until the 1930's, the surface weather chart with its sea-level isobars was the forecaster's main tool; with it he achieved a measure of success which in retrospect is surprising. He always knew that there must be close links between the behaviour of the low- and high-pressure patterns on his surface charts and what was going on in the free atmosphere; but he had not enough information to study the mechanism. Then the application of radio and radar to the measurement of the meteorological elements in the atmosphere and improvement in the means of collecting reports from wide areas provided the forecaster with what he needed; but the new flood of information also brought new problems, not the least of which was the devising of practical and speedy means of analysing and assessing the great mass of surface and upper-air observations which poured on to his bench from the greater part of the hemisphere several times a day.

It is mainly with this problem, and with the summarizing of his long experience in applying upper-air analysis to day-to-day forecasting in Germany, that Dr. R. Scherhag's treatise is concerned, and its importance lies in the fact that it is written from the point of view of the practising forecaster. So many books have been written on meteorological theory and so few by experienced forecasters for forecasters. Dr. Scherhag has divided his book into five major parts dealing respectively with (1) the bases of synoptic meteorology, (2) the climatology of the upper atmosphere and its relation with weather, (3) three-dimensional analyses of weather situations, (4) forecasting procedure in Germany, and (5) long-period forecasting. The second, third and fourth parts are particularly valuable, not for any novel ideas they contain—the techniques described have already been adopted or developed and extended independently in other weather services—but for the emphasis on daily forecasting practice.

In Germany the procedure is to prepare contour charts for isobaric surfaces at five levels up to 41 millibars (70,000 ft.) for the standard times of observation each day. After assessing the changes in thickness of the layers between these surfaces which are likely to be brought about by horizontal and vertical movement and by radiation, the future deformations and positions of the upper isobaric surfaces are estimated, taking into account the probable disposition of the pressure patterns on the surface chart in order to keep the whole system mutually consistent. This is the framework which has then to be filled in with considerations of the changing characteristics, history, and movement of the air masses taking part, and of the regions of interaction between these masses, so leading finally to a forecast of the weather over a particular region at a particular time.

Most modern weather services now follow a similar procedure; but as the physics of no single stage is completely understood, either in Germany or elsewhere, varying degrees of empirical treatment necessarily enter, with emphasis on factors which differ from one country to another. To Dr. Scherhag the day-to-day changes in the stratosphere have important interrelations with weather: in some circumstances he may even select the regime at the 41-millibar level as giving the best guide to the future movements of the pressure field lower down. Without denying that the stratosphere may play an important part, forecasters in other services look to lower levels for the dominating factors, and instead of extending their analysis ever higher, as Germany's recent isolation seems to have driven Dr. Scherhag and his colleagues to do, they pay more attention to the hemispherical circulation pattern in the lower half of the atmosphere.

Almost all Dr. Scherhag's 400-page treatise is concerned with forecasting for periods up to 40 hours ahead, and the brief section of 15 pages on long-range forecasting is not encouraging. The author sees little prospect of extending modern synoptic procedures beyond three days, and though other methods, such as the study of weather singularities and periodicities and pressure waves, and the effects of sunspots and volcanic dust, may have their applications, Dr. Scherhag cannot yet foresee any technique for making useful forecasts for longer periods as a regular procedure.

The book is excellently illustrated with more than two hundred diagrams, and has a bibliography of nine hundred items. Dr. Scherhag and his publishers are to be congratulated on making a contribution of first class importance to the literature of weather forecasting.

J. M. STAGG

UNITY AMID COMPLEXITY

Aspects of Form

A Symposium on Form in Nature and Art. Edited by Lancelot Law Whyte. Pp. ix+249 (32 plates). (London: Percy Lund, Humphries and Co., Ltd., 1951.) 21s. net.

THIS is one of the most intriguing books of recent times. It is also one of the most symptomatic. A stage has clearly been reached when thinkers of several kinds, namely, physicists, biologists, psychologists and art-historians, have cast professional discretion aside, and asked what form is, and what—if anything—we know about it. The result is a symposium at once original and, in the best sense, speculative. The discussion hinges upon "the unity of spatial form in relation to complex processes". This cardinal concept is allowed to develop in an almost classical environment, while the details emerge in the modern synthetic manner. (It is as if, writing *S* for spatial form and *C* for complex process, one was invited to put *SRC* and to let the whole subject take shape within the calculus of relations.)

In particular, a crystallographer leads off by showing how visual configuration passes through 'occupation' and finishes with abstract organization. This, of course, is but one way of saying that material objects tend to obey the law of *pragnanz*, as in *Gestalt* theory. It is also a species of homopolar bond with Dr. Arnheim's paper later on, concerning artistic form. Meanwhile, an astronomer contributes a chapter full of interesting twentieth-century views upon that typically Greek theme, permanence *versus* change. Next come a couple of distinguished biological essays, and then one by Dr. H. B. Cott (of camouflage fame) dealing with the appearance of animals, this implying the existence of vision. The subtle point here is the over-riding influence of contrast, itself a variety of form. Later chapters describe brain patterns, and the functional substitute. The editor (Mr. L. L. Whyte) himself concludes with a chronology of form, and a bibliography.

Slight in bulk, this volume yet represents a prodigious effort, the magnitude of which the reader may not realize until he reaches the last few pages. Then he may discern something of the cost, in the hard labour of thought, which the composition and illustrations must have involved. Seldom can the yield have been more worth while. This said, it may not be too graceless to remark upon a few obvious omissions from the book-list; for example, Speiser's profound "Mathematische Denkweise", Beilby's "Aggregation and Flow of Solids", and E. S. Russell's "Directiveness of Organic Activities", all immediately concerned with the growth of pattern. Incidentally, Koehler's book (p. 246) deals with a multitude of facts, and its title needs an 's' accordingly. Naturally, it is fully recognized that the present volume has been produced in connexion with an exhibition of contemporary art, and that therefore its bias (in so far that it has one) is in that direction.

Nevertheless, there is at least an equal need for a corresponding treatment linked specifically with classical art, including humanist architecture. Some material already exists for such a venture, and even the people to undertake it. But by then, "Aspects of Form" will itself have become a classic.

F. I. G. Rawlins

SOUTH AMERICAN INDIANS

Handbook of South American Indians

Edited by Julian H. Steward. Vol. 6: Physical Anthropology, Linguistics and Cultural Geography of South American Indians. (Smithsonian Institution: Bureau of American Ethnology, Bulletin 143.) Pp. xiii+715+47 plates. (Washington, D.C.: Government Printing Office, 1950.) 5 dollars.

With volume 6, the "Handbook of South American Indians" is complete except for the index. As forecast in the review of vol. 5, the subjects treated are early man (Part 1), physical anthropology (Part 2), and languages (Part 3); but in addition there is a long section on geography and plant and animal resources (Part 4).

The main contribution to Part 1 is a devastating summary by T. D. McCown of previous work, in which he shows that there has been much writing and little progress in the past thirty-five years. Apart from the Argentine remains, none of which has been proved to be of great age, there are various discoveries in Brazil, Ecuador and Lower California which have been held to constitute a Lagoa Santa race. He shows that there are far too few skeletons to support the claim that they form a race, and throws considerable doubt on the antiquity of the Ecuadorian examples. He gives Bird's discoveries of cultural material in South Chile a kindly mention, but does not refer to the single skull, apparently comparable with those of Lagoa Santa, which he was able to reconstruct from a cremation.

The uneven distribution of the available information is particularly apparent in the part dealing with physical anthropology. There are four sections—on skeletal remains, the living Indian, the Mestizos and the physical anthropology of Chile. The last three do not confine themselves to anthropometry, pigmentation and hair, but include also brief general discussions of blood groups and basal metabolic rates, and an account of the physical anthropology of the internal organs of the non-Indian inhabitants of Chile.

The vast subject of linguistics is ably summarized by J. Alden Mason, who emphasizes the incompleteness of our knowledge and disclaims any sort of finality. The plan of this section is a general introduction, followed by notes on each group, with a bibliography. The languages are grouped in larger divisions where possible, but a great many still have to be regarded as independent. A most useful map, in a pocket at the end of the book, accompanies this section.

The final section is much more than mere background. It contains a great deal of information of ethnological and archæological importance, including discussions of the domestication of animals and the origins of cultivated plants; for example, very valuable summaries of recent work on maize and cotton. A recent paper on the Cucurbitaceæ found in the Pre-ceramic deposits of North Peru by T. W. Whitaker and J. B. Bird is not mentioned, but this is an indication, not of omission, but of the inevitable delay in the publication of this volume. Map 7, a relief map of South America, which appears in this section, is so much reduced as to be of little use.

It is impossible to finish this brief notice without expressing once more the immense debt owed by all students of South America to those responsible for the compilation and publication of this "Handbook".

G. H. S. Bushnell

AMERICAN FORAGE AND PASTURE CROPS

Forage and Pasture Crops

A Handbook of Information about the Grasses and Legumes grown for Forage in the United States. By W. A. Wheeler. (Prepared under the auspices of the Field Seed Institute of North America.) Pp. xi+752. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1950.) 60*s*. net.

As the United States turns to the grass, legume or other forage crop to restore lands, so Britain begins to approach the temporary ley scientifically as a fertility-building crop. Soil conservation may have more spectacular connotations than has the homely phrase, 'good husbandry', yet the aim of the agronomist in either country is to use pasture and forage as improving crops, whatever the starting point. In one sense the practice of leaving land in grass for long periods may be conservation of soil; but we must realize that fertility is fruitfulness rather than some latent quality. One conceives a level of fertility as the rate of all those soil cycles of growth and decomposition which stimulate soil production. In any country, pasture-breaking or forage-cropping accelerates these processes.

Agriculturists in the United States are not only conservation-conscious. As Mr. Wheeler indicates in his introduction, there has also recently developed a spirit of inquiry in the attitude towards range grazings, and the indigenous species are being zealously explored.

For the foregoing reasons we should be acquainted with developments in the United States, and it is from this point of view that we judge Mr. Wheeler's encyclopædic work.

The collation of agricultural experience is an arduous task. The scientific evidence is often meagre, and a host of advisory bulletins is largely compounded from general observation and more than a little speculation. Mr. Wheeler has devoted almost one-half of his book to an agronomic treatise based, with due acknowledgment, on this type of publication. Difficult though the task may be, the material needs more facts and much more winnowing before it is acceptable as a work of reference. Even in view of the enormous amount of material used, and the impressive list of references, it would not be unfair to criticize the disjointed and often repetitive reading which this section makes, because much of it is clearly intended for continuous reading.

The serious deficiency, however, is in basic facts. A chapter on inoculation of legumes contains numerous statistics but little scientific information. The sponsors of the work might have invited specialists to contribute directly to this and another section on fertilizers. Mr. Wheeler shows better acquaintance with seed authentication; but his chapter on plant improvement which begins to leaven the treatise with stimulating thoughts eventually disappoints the reader through lack of detail in describing breeding methods.

A chapter on pests, diseases, weeds and poisonous plants makes brief reference to a good range of these visitations. Shades of the advisory leaflet are cast by the frequent appearance of the magic symbols DDT and 2,4-D.

References are listed at the end of each chapter. This may be the only practical way in which they could be cited, owing to the indirect nature of much quotation. A complete bibliography is appended under author and geographical indexes. The subject index is thorough in itself, but relates to pages, and the reader must work his way through chapter references in order to identify authors with their work.

The description of species which forms the major part of the book is historical and agricultural, as distinct from botanical. There is much repetition of the information contained in the general part of the book. To the non-American student of forage and pasture plants, however, this descriptive portion remains the more informative. This is a relative term. A volume clearly offered as a reference book should be a comprehensive yet scrupulously distilled source of information. The present edition cannot be said to attain these standards, and is therefore disappointing. J. O. Green

ASPECTS OF X-RAY CRYSTALLOGRAPHY

Selected Topics in X-Ray Crystallography from the Delft X-Ray Institutes

Edited by J. Bouman. (Monographs on Theoretical and Applied Physics, Vol. 3.) Pp. xv+375. (Amsterdam: North-Holland Publishing Co., 1951.) 76s.

As its title implies, this book consists of a selection of articles by certain acknowledged experts in the field of X-ray crystallography, the common link being their proximity to each other in Delft. It is divided into eight sections ranging from purely general subjects such as structure analysis, distortion in crystals, and investigations in the biological field, to completely specialized ones such as the recrystallization of aluminium, investigations of photographic emulsions, and the degree of crystallinity in natural rubber. Certain types of apparatus, such as the reciprocal-lattice goniometer of de Jong and Bouman, the curved-crystal monochromator, and micro-cameras, are also dealt with in detail. It will be seen, therefore, that the range of interest is very wide, and opportunity is given for the various contributors to deal deeply and intimately with their own subjects. The book is well produced, and, despite occasional lapses in construction and spelling, the English is of a reasonable standard.

Yet the result is unsatisfactory. 'Selected topics' do not form a book, and the present volume has no general theme to give a sense of unity: the selection of contents appears to have been dictated rather by what the various contributors wished to write than by what the editors wished to include, and consequently the range is too wide to be of great value to specialists, and too casual to form a work of reference for the student.

Consider, for example, the first section—on structure analysis. This deals in great detail with the reciprocal lattice and its direct photography; but then there is a jump to the subject of termination errors in Fourier series. The main part of the subject—the determination of the relative phases of the structure factors—is completely omitted.

Moreover, it is difficult to see the justification for the placing of certain chapters. The section on structure analysis continues with chapters on the broadening of Debye–Scherrer lines and on stereographic pole figures. Still more surprising, in this same section there is mention of the Patterson function; but this turns out to be completely different from what is normally understood by that term, and is, in fact, concerned solely with diffraction by small crystals. Such departures from accepted nomenclature can be very misleading, and indicate a lack of contact with workers in other countries.

These faults could perhaps be tolerated if the various articles formed adequate reviews of the particular subjects. By this test, also, the book fails. The articles cover only the particular interests of the authors, and the lists of references are all quite short and far from comprehensive. (For example, although the biological field is included, the name of Bernal does not appear in the index.)

One must therefore regretfully conclude that the effort spent in producing this book has not been worth while. Despite the brilliance of some of the individual contributions, it is not a work that the specialist will feel he must have at his elbow, nor one to which the student can be referred. H. Lipson

The Pharmacopeia of the United States of America (the United States Pharmacopeia)

Fourteenth revision (U.S.P. 14) and the First U.S.P. 14 Supplement. By authority of the United States Pharmacopœial Convention, Inc., meeting at Washington, D.C., May 14 and 15, 1940. Prepared by the Committee of Revision and published by the Board of Trustees. Pp. lv+1068+4. (Easton, Pa.: Mack Publishing Co., 1950.) 9 dollars.

THE fourteenth revision of the United States Pharmacopeia became official on November 1, 1950, only three and a half years after its predecessor. This short period is a sign of the rapid advance of therapeutics and a testimony to the energy of the Committee of Revision. The new work is about 10 per cent longer than its predecessor and contains nearly two hundred new articles.

The drugs thus introduced include acetanilide, aureomycin, chloramphenicol, chloroguanide (proguanil AN), chlorophenothane (DDT), dimercaprol (BAL), diphenhydramine (Benadryl), folic acid, heparin sodium, naphazoline (Privine, but not Priscol), nikethamide, raspberry juice, streptomycin, trimethadone (Tridione), tripelennamine (Pyribenzamine, but not mepyramine), tubocurarine, tyrothricin, and vitamin B_{12}. The list of omissions includes neoarsphenamine, rhubarb, senna, strychnine, tannic acid and thyroxin. Suramin is omitted and then reintroduced in the first supplement, which becomes official on the same day as the Pharmacopeia (for which this simplified spelling is adopted). Most of these changes were inevitable, though it is perhaps surprising that acetanilide and raspberry juice are introduced now, and that nikethamide was not introduced sooner. It seems likely that thyroxine will be reintroduced before long.

The Committee is to be congratulated on this work, which is very up to date and will be much studied not only in the various American republics where it has official status, but also in other countries which are busy preparing new editions of their own pharmacopœias. It is hoped that before long the appearance of the international pharmacopœia will simplify the labours of the various national committees. In the meantime, there is evidence of collaboration between the British and American committees. Most of the new American names are the same as the new British names, although the Americans evidently could not go so far as to adopt the therapeutically suggestive name 'leptazol' to describe the drug which they now introduce as pentylenetetrazol.
J. H. G.

Physical Chemistry

By Prof. Walter J. Moore. (Prentice-Hall Chemistry Series.) Pp. ix+592. (New York: Prentice-Hall, Inc., 1950.) 6.65 dollars.

PROF. W. J. MOORE has written for university students who have acquired a knowledge of physics and of advanced mathematics. Indeed, the book affords a fine opportunity of testing a student's ability to apply his mathematical knowledge. As is to be expected, the author's approach to the subject is by the way of thermodynamics. The contents comprise: physicochemical systems, the laws of thermodynamics, chemical equilibrium, the kinetic theory, the structure of atoms and molecules, nuclear physics, particles and waves, chemical statistics, crystals, liquids, electrochemistry, surface chemistry, and chemical kinetics. Each chapter opens with a brief, scholarly written, historical account of the concept in question. This is followed by the formal treatment, which is precise, critical and thorough. The author does not make a gift of the mathematical expressions of the laws and relationships he discusses, but builds up his equations from first principles. Each chapter ends with abundance of questions, numerical problems and well-selected reading references. This is an excellent book, but suitable only for those whose mathematical equipment goes at least as far as partial differentiation.
G. F.

Transformation Calculus and Electrical Transients

By Prof. Stanford Goldman. Pp. xiv+439. (New York: Prentice-Hall, Inc.; London: Constable and Co., Ltd., 1949.) 30s. net.

IN the theory of electric transients, the technique of the Laplace transform is a convenient central topic from which Prof. S. Goldman surveys impedance operators, complex variables, partial differential equations, and special functions, particularly the Bessel functions. The Laplace technique is developed from the beginning, and the more advanced student of electrical engineering, at or near postgraduate level, should benefit from the careful interweaving of pure mathematics with electrical theory. Attention is given to rigorous demonstration, but where proofs are omitted, for reasons of length or difficulty, references are supplied. The reader is expected to have a sound knowledge of the calculus, and an acquaintance with the concept of complex numbers and with elementary differential equations. The Laplace transform itself is studied as a transformation relating $f(t)$ to $F(s)$ (the author uses s in place of the more usual p) by the equation

$$F(s) = \int_0^\infty e^{-st} f(t)\,dt.$$

This mode of presentation is often more easily grasped by the technical student than the equivalent 'operational' calculus of Heaviside. The electrical theory excludes the non-linear network, but the study of the linear network is fairly comprehensive and up to date, including, for example, a discussion of the stability of feed-back amplifiers.

The Colloid Chemistry of the Silicate Minerals

By Prof. C. Edmund Marshall. (Agronomy, a Series of Monographs prepared under the auspices of the American Society of Agronomy, Vol. 1.) Pp. ix+195. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1949.) 5.80 dollars.

THIS useful monograph assembles in logical fashion the various aspects of our present knowledge of colloidal systems involving silicate minerals. After a summary of the main types of silicate structures the author discusses the distinctive properties of the zeolites, notably the adsorption of vapours. The major part of the book, however, deals with the clay minerals. Prof. C. E. Marshall has done a real service in thus bringing together the diverse facts on the physics and chemistry of clay systems which have been revealed in recent years by a variety of techniques. Each chapter is documented with a good list of references and a nice balance has been struck. The reader will benefit from the author's wide and critical reading in being guided immediately to the more important papers in the field. There is much in this short book of value not only to workers in the field of soil science but also to mineralogists and to chemists interested in colloidal phenomena generally.

BRITAIN'S SCIENTIFIC SHRINES (7)

By Eng.-Captain EDGAR C. SMITH, O.B.E., R.N.

THE NORTH-EASTERN COUNTIES

AN itinerary through Yorkshire for a student of the history of science would take him from Sheffield in the south to Middlesbrough in the north, and from Whitby in the east, where stands the statue of Captain Cook (1728–79), to Settle in the west, the birthplace of Dr. George Birkbeck (1776–1841), who as the successor of Garnett at the Andersonian Institution, Glasgow, became imbued with the idea of furthering the education of the working classes. "Standing at the end of a long period of history, in which the fountains of learning had been enclosed for the benefit of a dominant caste [he] recaptured the tradition of the great medieval founders by taking knowledge to the people." A pioneer of mechanics' institutions, from 1804 onwards, as a London physician, he was always to be found in the ranks of the reformers. Birkbeck College, London, is but one of his monuments. He died on December 1, 1841, and was buried in Kensal Green Cemetery. Of Cook there are several memorials in Yorkshire. In Stewart Park, Marton, Middlesbrough, is a granite vase marking the site of the cottage in which he was born, and in the village of Great Ayton stands an obelisk built of stones from Cape Everard, close to Point Hicks, Victoria, Australia. The obelisk marks the site of a cottage occupied by his parents, but which in 1934 was taken down, transported to Melbourne and re-erected in Fitzroy Gardens.

Middlesbrough is a comparatively new town, for a century ago it was a mere village. It now has a population of some 144,000 and in it are to be seen the statues and memorials to the builders of its fortunes, Henry Bolckow (1806–78), John Vaughan (1799–1868), Joseph Pease (1799–1872), Sir Lothian Bell (1816–1904) and Sir Arthur Dorman. Sheffield, on the contrary, has been the home of the cutlery industry for centuries, and its Cutlers' Company was incorporated as long ago as 1624. One important event in its history was the introduction of the crucible process of making steel by Benjamin Huntsman (1704–76). A Quaker and watchmaker of Doncaster, Huntsman set out to produce a finer steel for his springs than he could buy. Removing from Doncaster to Handsworth, he there developed the crucible casting process and later on opened a workshop at Attercliffe, where the firm of B. Huntsman, Ltd., still produces high-class steels. In the Attercliffe old churchyard is its founder's tomb bearing the inscription "Benjamin Huntsman, died 21st June 1776 aged 72 years".

Among Sheffield's other famous men were John Roebuck (1718–94), the son of a Sheffield manufacturer; Mark Firth (1819–80), the steel maker who in 1879 founded Firth College, from which sprang the University of Sheffield; and Henry Clifton Sorby (1826–1908), the founder of metallography. The son of a tool-maker, and always a man of means, from the time he learnt how the Edinburgh investigator William Nicol (1768–1851) had devised a method of cutting thin sections of rocks for microscopical examination, Sorby devoted himself to the study of the structure of rocks and metals, writing some 240 memoirs. He was president in 1878–80 of the Geological Society, which on its centenary in 1907 sent an address to "The Father of Microscopical Petrography". Roebuck, unlike Firth and Sorby, saw little of Sheffield after his schooldays, for he was first a Birmingham physician, then a chemical manufacturer at Prestonpans, and in 1760 the founder of the famous Carron Ironworks, Falkirk. After a life of varying fortunes, he died at Bo'ness and was buried in the Carriden Cemetery. A low wall enclosed his grave and at the back was placed a well-designed marble tablet with a long inscription in Greek and Latin. In 1933 his descendants and the Carron Company carried out a complete restoration of both tomb and memorial.

From Sheffield it is only a few miles to the busy towns of Wakefield, Halifax, Bradford and Leeds, all of which demand notice. No scientific survey, however, would be complete without a visit to Sprotborough, near Doncaster, for here was Sprotborough Hall, the home of Sir Godfrey Copley, Bart. (d. 1709), who by his will left £100 to the Royal Society for "improving natural knowledge". He had been member of Parliament for Thirsk, had held public offices and from 1691 was greatly interested in the affairs of the Royal Society. He died in Red Lion Square, Holborn, London, but was buried in Sprotborough Church. His £100 was allowed to lie idle for some time, but awards were made in 1731, 1732 and 1736, and then the money was used to found the Copley Gold Medal, now the oldest and most famous of prizes in the world of science. Many of its recipients have been mentioned in the course of this survey, but it is of interest to recall that in the forty-six years 1749–95 inclusive, during which forty-one awards were made, no fewer than six of the recipients were Yorkshiremen. In 1749 the Medal was given to John Harrison, a native of Wragby, near Wakefield, for his "Curious Instruments invented and made by him for the exact Mensuration of Time"; in 1759 it was given to Smeaton for his "Curious Experiments concerning Water-wheels and Windmill-sails", and in 1773 Priestley received it for his "Many Curious and Useful Experiments on Different Kinds of Air". Three years later, Cook was awarded it for his "Paper containing the Method he had taken for Preserving the Health of the Crew of H.M.S. Resolution"; in 1783 it was given to the nineteen-year-old boy John Goodricke (1764–86) of York, for his "Discovery of the Period of the Variation of Light in the Star Algol"; and in 1795 to Jesse Ramsden (1735–1800), the son of an innkeeper at Salterhebble, near Halifax, for his "Various Inventions and Improvements in Philosophical Instruments". Harrison (whose wonderful chronometers, it will be remembered, were repaired and set going again by the late Lieutenant Commander Rupert Gould), like Copley, died in Red Lion Square, London, but was buried at Hampstead. Priestley's birthplace was Fieldhead, Birstall, near Leeds, and to Leeds he came from Warrington in 1767 at the age of thirty-four to be minister of the old Mill Hill Unitarian Chapel, a position he held for six years. In Leeds he found much congenial society, having among his friends the Rev. John Michell (1724–93), the rector of Thornhill, who had been Woodwardian professor at Cambridge. In his "Memoirs", Priestley wrote: "In writing the 'History of Discoveries Relating to

Vision', I was much assisted by Mr. Michell the discoverer of the method of making artificial magnets. Living at Thornhill not far from Leeds I frequently visited him and was very happy in his Society as I was also in that of Mr. Smeaton who lived still nearer to me." Smeaton's home was Austhorpe Lodge, Whitkirk, and he died there on October 28, 1792, and was buried in Whitkirk Church. His monument, surmounted by a representation of the Eddystone Lighthouse, was recently reconditioned by the joint efforts of the Smeatonian Society of Engineers and the Newcomen Society. There is no statue of Smeaton, but several of Priestley, one being in the centre of Leeds and another at Birstall. The town of Halifax also has other scientific associations, for here Herschel taught, played and conducted before going to Bath; while in the neighbourhood are Bradley, the birthplace of Sir Henry Savile (1549–1621), provost of Eton and warden of Merton College, Oxford, and Warleywood, the birthplace of Henry Briggs, whom Savile chose as the first Savilian professor of geometry. Two other scientific worthies who came from the same district were Dr. John Radcliffe (1650–1714), a native of Wakefield, whose name is perpetuated in Oxford by the Radcliffe Library, the Radcliffe Infirmary and the Radcliffe Observatory, the last of which has been removed from Oxford to South Africa, and Flamsteed's friend and collaborator, Abraham Sharp (1651–1742), who spent his earlier and later years at Little Horton, near Bradford, and who is buried in Bradford Church. Leeds, too, can claim other distinguished men of science, for Dr. Isaac Milner (1751–1820), who for many years was Lucasian professor and president of Queens' College, Cambridge, was the son of a weaver of the City, and the redoubtable and wealthy Richard Sheepshanks (1794–1855) was the son of a Leeds cloth manufacturer Parson, lawyer, mathematician, astronomer, a renovator of our weights and measures, known to Herschel, Babbage, Whewell, Airy, Baily and a crowd of others, Sheepshanks, whose bust is in Trinity College, Cambridge, was a rare fighter, and of something he wrote De Morgan said that it will "remain to illustrate the science of our century and will furnish ample material to the future collectors of our literary curiosities". From the time Sheepshanks left college, his sister lived with him, and as his heiress she presented £10,000 to Cambridge for research, and gave his instruments to the Royal Astronomical Society.

Before leaving the West Riding of Yorkshire, two other places are worthy of mention: Thurlestone, near Penistone, was the birthplace of Nicolas Saunderson (1682–1739) who, though like Gough of Westmorland blinded in infancy through smallpox, yet became the successor of Whiston as Lucasian professor at Cambridge; while at Sharow, near Ripon, lies Piazzi Smyth, buried beneath a pyramidal stone recalling his much-read book "Our Inheritance in the Great Pyramid". He had retired from the post of Astronomer Royal for Scotland in 1888, and it was at his Yorkshire home near Ripon he carried on his spectroscopic investigations.

To the north of Ripon, and in the North Riding, lie Richmond and Northallerton, the former being the birthplace of Sir Edward Banks, the builder of London Bridge, and of Henry Greathead (1757–1816), the pioneer of the lifeboat, and the latter recalling the work of Colonel William Lambton (1756–1823), who was born at Crosby Grange nearby. Though of humble parentage, by 1781 Lambton had become an ensign. After some active service in India, he was employed on surveying, and from his geodetical work sprang the Great Trigonometrical Survey of India, Sir George Everest (1790–1866) being his chief assistant. Travelling eastward from Northallerton across the Pickering Moors, near Pickering itself is found the village of Cropton, the birthplace of the whaler-captain and magnetician, William Scoresby (1789–1857), who lectured "to the assembly of beauty, fashion and philosophy" at York in 1831. Not long after this, he took holy orders and during 1839–47 was vicar of Wakefield. He died at Torquay. Still farther east and eight miles inland from Scarborough is Brompton Hall, the ancestral home of the Cayley family. The papers of Sir George Cayley (1773–1857), the sixth baronet, have recently been recovered, and they show him to have been a real pioneer in aeronautics. An exhibition of Cayley relics is now being held at Scarborough.

The historic city of York, standing at the junction of the three Ridings, with its splendid Minster, its Archbishop's Palace and its well-known Yorkshire Philosophical Society, brings to mind the two seventeenth-century mathematicians and astronomers, William Neile (1637–70) and William Gascoygne (1612 ?–44), both of whom died in their thirties. Neile was an archbishop's grandson and was born at Bishopthorpe. At Oxford and in London he became known to Wilkins, Seth Ward, Wren and others, was made a member of Council of the Royal Society and at his home in White Waltham, Berkshire, had an observatory. He died there on August 24, 1670, and there he is buried and has his monument. His contemporary, William Gascoygne, was the son of Henry Gascoygne, of Thorpe-on-the-Hill, in the parish of Rothwell, near Leeds. He was as much interested in astronomy as were Horrocks and Crabtree, corresponded with them, and to-day is known to have been the first inventor of the wire micrometer and its application to the telescope. It is considered that he was born not later than 1612, but it is known for certainty that he died at the Battle of Marston Moor, near York, on July 2, 1644, fighting on the side of the Royalists. York is the home of the firm of Cooke, Troughton and Simms, Ltd., which began in the shop opened in 1837 at 50 Stonegate by Thomas Cooke (1807–68). He proved a worthy successor to the instrument makers of the eighteenth century and has been called the 'English Fraunhofer'. He died while engaged on the famous 25-in. equatorial for the Gateshead engineer Robert Stirling Newall (1812–89), who gave it to Cambridge.

Durham and Northumberland, in common with other counties, have given birth to men who in one way and another made their mark in the world of science. Thus the records of the nineteenth century contain the names of such outstanding men as Lord Armstrong and Sir Joseph Wilson Swan. But looking back over the centuries, the year 1701 saw the birth of the somewhat eccentric mathematician William Emerson, a native of Hurworth, near Darlington. For a time he followed his father as a schoolmaster, but took to writing text-books. At the age of sixty-two he walked to London and there he died at the age of eighty-one. His books almost formed a mathematical encyclopædia. Edward Hussey Delaval (1729–1814) belonged to an ancient Northumbrian family. He became a Fellow of Pembroke Hall, Cambridge, in 1759. He was also elected a Fellow of the

Royal Society and in 1766 received the Copley Medal for his "Experiments on the Specific Gravities of the Several Metals". Afterwards he was much concerned in the lightning conductor controversy. Dr. Charles Hutton (1737–1823), the son of a Newcastle colliery worker, started with little education, but rose to be the professor of mathematics at the Royal Military Academy, Woolwich. He was the leading authority on gunnery, and a notable figure in the Royal Society. He retired in 1807 and was succeeded by Olinthus Gregory, but he lived another sixteen years. At his death he was buried at Charlton, Kent. His bust he bequeathed to the Newcastle upon Tyne Literary and Philosophical Society, which had been founded in 1793. Dr. George Peacock (1791–1858), of Thornton Hall, Denton, in Durham, another mathematician, belonged to a later generation. Entering Cambridge at the age of eighteen, he assisted in founding the Analytical Society, which, for the benefit of students, published a translation of the "Differential Calculus" of Lacroix. A man of great charm, in 1836 he became Lowndean professor of astronomy, and three years later also Dean of Ely, where he is buried. At his death, Airy wrote to his widow: "All my debts to other friends in the University added together are not comparable to what I owe to the late Dean . . .". Airy himself had associations with the North, for he was born at Alnwick, where his father was an excise officer.

Whatever interest, however, may be felt in the careers of these and other men of science, for many, the history of Durham and Northumberland is associated with their collieries, railroads, locomotives and ships. Of the leading pioneers of the locomotive, Matthew Murray (1765–1826) of Leeds, William Hedley (1779–1843), John Urpeth Rastrick (1780–1856), George Stephenson (1781–1848), Timothy Hackworth (1786–1850), Robert Stephenson (1803–59), and Sir Daniel Gooch (1816–89) were all born on the banks of the Tyne, and the construction of their historic locomotives "Puffing Billy", "Wylam Willy", "Blucher", "Locomotion" and "Rocket", of the Stockton and Darlington Railway, as also of the Liverpool and Manchester Railway, are landmarks in the history of land transport. There are many monuments to these north-country pioneers, and as recently as 1947 a tablet was placed on Hackworth's house at New Shildon, Durham, while two years later, through the action of the North-East Coast Institution of Engineers and Shipbuilders, the cottage at Wylam in which George Stephenson was born was transferred to the custody of the National Trust.

1951 POPULATION CENSUS OF ENGLAND AND WALES

THE detailed results of the fifteenth Census of Population of England and Wales, taken on April 8, 1951, will be eagerly awaited, as it is twenty years since the last census was taken, 1941 being the first break in the regular series of decennial censuses dating from 1801. It is, however, forty years since there last was a simultaneous count of the population of all the constituent areas of the United Kingdom and the Irish Republic. In 1951 the Census authorities of England and Wales, Scotland, Northern Ireland, the Channel Islands, the Isle of Man and the Irish Republic acted in concert, and a Census was taken on the same day in all these territories. It is to be hoped that this arrangement will continue in future, as the volume of migration between different parts of the British Isles is not inconsiderable and the territorial units which are of interest to students of population are generally larger than the unit covered by one Census authority. It would be of great assistance if definitions and tables in the full reports could be standardized, and summary tables relating to Great Britain, the United Kingdom, and the British Isles as a whole published.

A full appreciation of the results of the Census, which contained a number of new questions asked for the first time on this occasion, will have to await the publication of the detailed reports. The time-lag between Census day and publication will, however, be considerably shortened in England and Wales, for the Registrar General proposes to analyse a sample of 1 per cent of the Census schedules and to publish main tabulations relating to this sample within a year of enumeration.

The preliminary report*, which has recently been published, is, as is customary, based not on an analysis of the actual Census schedules but on a count made from summaries supplied by the local Census officers. Its purpose is restricted, and its main function is to give provisional figures for the total population, classified by sex, of all local-government areas in the country down to district level. For the social scientist its main importance lies in the information it gives on total numbers and on the geographical distribution of the population.

Table 1. TOTAL POPULATIONS AND RATES OF CHANGE IN THE BRITISH ISLES, 1921–51

	Population (thousands)			Rate of change per cent per decennium	
	1921	1931	1951		
England (excl. Monmouth)	35,230	37,359	41,148	+6·0	+4·9
Wales and Monmouth	2,656	2,593	2,597	−2·4	+0·1
England and Wales	37,887	39,952	43,745	+5·5	+4·6
Scotland	4,882	4,843	5,096	−0·8	+2·6
Great Britain	42,769	44,795	48,841	+4·7	+4·4
Northern Ireland	1,258*	1,243*	1,370	−1·2	+5·0
United Kingdom	44,027	46,038	50,210	+4·6	+4·4
Islands in the British Seas	151	143	158	−5·4	+5·3
Irish Republic	3,096*	2,933*	2,959	−5·3	+0·4
Grand total	47,274	49,114	53,327	+3·9	+4·2

* Estimated.

The total populations of the different constituent parts of the British Isles are shown in Table 1, together with their rates of change. To make for easier comparability the rates of change for the twenty years 1931–51 have been converted to average rates for decennia. The table shows that for the British Isles as a whole the population increased at a slightly higher rate between 1931 and 1951 than during the decennium 1921–31. In the United Kingdom, however, the rate of increase remained practically stationary at 4½ per cent for ten years. Within the United Kingdom, Wales, Scotland and Northern Ireland increased in population during 1931–51 after registering a decline in total numbers during 1921–31. This decline, however, was probably due to a negative balance of migration.

Confining our attention to England and Wales, two features of interest must be pointed out. In the first place, for the first time in the past century there has been a net gain of population due to migration. This gain is estimated at about half a million for the period 1931–51. It is due to the return of British subjects resident abroad, the demobilization of Allied and Dominion soldiers in Britain, and to a small part to the immigration of refugees and displaced persons. The net balance of migration from other parts of the United Kingdom can only be estimated since the introduction of the National Register in 1939, and it is believed that this factor accounts for an increase of between 250,000 and 300,000 since that time.

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* General Register Office. Census 1951, England and Wales. Preliminary Report. Pp. xxxii+52. (London: H.M. Stationery Office, 1951.) 5s.

The second feature that needs comment is that the decennial rate of increase is the lowest ever recorded, in spite of the net gain from migration to which reference has already been made. It is true that since 1931 there have occurred 360,000 deaths, estimated as being due to the War. But the losses of the First World War were much heavier, both absolutely and relatively, than those of the Second, and yet the rate of increase between 1911 and 1921 amounted to 4·9 per cent in spite of a net outward balance of migration. It is therefore difficult to accept the statement in the text that "there is no sign of any tapering away of the successive increments such as would normally be expected to herald the early approach of an ultimate population maximum". The Registrar General's technical advisers must be aware that figures of total population cannot provide any reliable guide to prospects of future development of population, and it would have been wiser to wait for the more detailed information on age distribution and fertility before committing oneself to this view on the future. Taking recent registration figures into account, it would be very surprising if the rate of increase between the present Census and the next will not be substantially lower than 4½ per cent per decennium.

The overall rate of increase for the country as a whole masks considerable variations in the rate of increase for different regions. The geographical distribution of the population has changed since 1931, and the proportionate importance and rates of increase of the different standard regions are shown in Table 2. It is clear from this table that the eastern and southern regions of the country continue to grow at the expense of the north and the north-west. But a new tendency has become evident since 1931. The rate of increase of London and the south-east, which was well above the national average during the previous decennium, has fallen spectacularly and the proportionate importance of that region has decreased. Conversely, the rates of increase of the Midland and south-western region have shot up. It will be interesting to analyse the changes in age, occupational and industrial distribution of the populations of those regions, but this will not be possible until the detailed tables are published.

Table 2. PROPORTIONATE POPULATIONS IN DIFFERENT REGIONS OF ENGLAND AND WALES, WITH DECENNIAL RATES OF CHANGE

Region	Population per cent total			Rate of change per decennium	
	1921	1931	1951	1921/31	1931/51
Eastern	5·8	6·1	7·1	+11·5	+12·8
Southern	5·1	5·3	6·1	+11·3	+11·4
Midland	9·4	9·4	10·1	+ 5·6	+ 8·7
South-western	6·6	6·5	6·9	+ 4·1	+ 7·5
North Midland	7·3	7·4	7·7	+ 6·4	+ 7·2
London and south-east	25·0	25·9	24·9	+ 9·2	+ 2·7
East and West Riding	9·9	9·8	9·4	+ 4·4	+ 2·1
North-western	16·0	15·5	14·7	+ 4·0	+ 2·0
Northern	8·0	7·6	7·2	+ 0·8	+ 1·6
Wales	7·0	6·5	5·9	− 2·4	+ 0·0
England and Wales	100·0	100·0	100·0	+ 5·5	+ 4·6

Some comments have been made on the change in the proportion of the urban population. It appears as though the percentage classified as urban has decreased slightly since 1931. The report shows that this decrease took place almost entirely after 1939. But, again, the figures must be interpreted with caution. There have been no changes in local-government boundaries since 1939, and it is possible that the slight increase in the rural population is merely a reflexion of the increasing tendency of city dwellers to move to the peripheral suburbs, some of which may be classed as rural districts. A detailed study of this question will have to await the publication of the report on place of residence and place of work.

The above remarks make it clear that only very provisional conclusions can be drawn from the preliminary report. New light will be thrown on many problems, however, when the final volumes begin to come out. The abnormally long interval between the past two censuses has been a great obstacle in the way of those who are interested in local or regional studies. It is to be hoped that there will never again be so long an interval between two censuses. Provision was made in the Census Act of 1920 for a census to be taken not more frequently than once every five years, and it is to be hoped that the provisions of the Act will be used and a new census taken in 1956.

E. GREBENIK

SOME EXPERIMENTAL WORK CARRIED OUT IN PHYSICS WITH THE LARGER HARWELL PILE

THIS article describes a few of the experiments which have been carried out in physics at Harwell with the larger atomic-energy pile known as BEPO.

Neutron Crystallography

A double-crystal neutron spectrometer, which utilizes a collimated beam of thermal neutrons from the *thermal column*, has been designed and made for work on neutron crystallography[1], and has been used, among other things, for checking theoretical predictions regarding the intensity of reflexion of monochromatic neutrons from single crystals, with a view to the ultimate use of such crystals in structure analysis. The use of single crystals is clearly desirable if adequate progress is to be made in neutron crystallography, but has been restricted by the appreciable extinction effects arising from the large crystals that have hitherto been employed. From a series of intensity measurements, made under carefully controlled conditions, it has been found that the theoretical intensity relationships worked out by Bacon and Thewlis[2], and Bacon and Lowde[3], according to which the integrated intensity of reflexion is dependent, for thick crystals, not on the structure factor but largely on the degree of mosaic spread, are in fact valid; further study[4], however, has led to the discovery that relatively large crystals can be used if they are of the right shape. For potassium bromide, a crystal typical of many in this field, a specimen 1 cm. long and 2 mm. square in cross-section, permits the proportionality between integrated intensity and structure factor to be retained.

Further, the permitted cross-section may be increased to 4 mm. square by immersing the crystal in liquid air and thus increasing the degree of mosaic spread.

The problem of using single crystals has been attacked on somewhat different lines by Lowde[5], who has constructed a small-scale neutron spectrometer in which crystals of dimensions of only 1 mm. or so are employed. To gain the necessary intensity, the incident radiation is not monochromatized but comes straight from the pile. A convergent beam is used, the crystals under investigation and a special multiple boron-foil ion chamber[6] being set up so that a given crystal plane can reflect into the ion chamber only neutrons of, or near, a particular (chosen) wave-length. The peak counting-rate of the crystal rocking curve then gives the integrated reflexion for the crystal plane in question. The weakness of the method is the inherently possible confusion of orders of a given reflexion, but in favourable cases the method is very encouraging. The peak-to-background ratio obtained with single crystals of naphthalene, for example, is high enough to encourage the hope that information about hydrogenous structures is within our reach, without the need for the substitution of hydrogen by deuterium.

Another way in which the double-crystal neutron spectrometer has been used is for the study of the electron distribution in graphite[7]. X-ray measurements have shown that the $10\bar{1}0$ reflexion relative to the $11\bar{2}0$ is about 85 per cent stronger than expected, and the $10\bar{1}1$ reflexion relative to the $11\bar{2}2$ is about 80 per cent stronger. This could arise if the atomic positions in graphite were other than those generally accepted, or alternatively the electronic configuration might be different from that usually assumed. If the explanation of the anomalous intensities is, in fact, concerned with electronic configuration and not with incorrect atomic positions, then the intensities of reflexion obtained by neutron diffraction should no longer be anomalous, since the neutron scattering is a nuclear phenomenon and no part is played by the electrons. In the event, the measured neutron intensities were found to agree with the theoretical intensities to within 5 per cent, showing that the accepted atomic positions are substantially correct, and that an asymmetric electron distribution probably occurs in graphite.

Irradiation Experiments

The effect of pile irradiation on a number of materials has been studied by X-ray diffraction methods and by electron microscopy. For example, it has been found that the strength of various polymers is seriously affected by such irradiation. Some polymers, for example cellulose and its derivatives and collagen, appear to break down to about the same extent in both the crystalline and non-crystalline parts, whereas others, such as nylon and keratin, first break down in the non-crystalline regions[8].

Some very interesting effects have been obtained by irradiating by slow neutrons in BEPO a copper-gold alloy containing 30 per cent (atomic) of gold, in its ordered state[9]. The first result of the irradiation appears to be an increase of order, as evidenced by a decrease in unit-cell dimensions, and the appearance of satellite reflexions on each side of certain superlattice reflexions, which may possibly arise from the existence of regularly arranged 'domains', although it is too early to be sure of this. The effect is accompanied by a decrease in electrical resistivity. At a later stage the resistivity increases and additional X-ray reflexions occur, the origin of which is not yet understood; but at no stage have the superlattice reflexions shown any loss of intensity. It is possible that further irradiation may produce such a loss, but this question must await further experiment.

In contrast with the above results, it is interesting to note that the irradiation of a similar alloy in a fast neutron flux produces the opposite effect, that is, the alloy becomes disordered[10].

Neutron Spectrometer Experiments

A beam of neutrons from a nuclear reactor will consist of a group of neutrons which have been in approximate thermal equilibrium with the moderator, and a group with energies lying between 2 MeV. and thermal energies. It is often useful to be able to select from this distribution those neutrons the energies of which lie in a narrow band. This may be done either by using the wave property of neutrons to reflect a certain wave-length with a crystal (as in neutron crystallography), or by artificially modulating the beam and then timing the neutrons over a measured path. Spectrometers working on each of these principles are in use with the Harwell pile. The crystal spectrometer is used to obtain a monochromatic neutron beam with an energy anywhere in the range 0·05–10 eV., and a mechanical time-of-flight spectrometer using a cadmium shutter to pulse the beam is used to select neutrons with energy anywhere between 0·001 and 0·10 eV.

These instruments have been used to measure the transmission of samples of several elements as a function of neutron energy. From the measured transmission the probability that a neutron will interact with a nucleus (that is, the cross-section) can be calculated. This cross-section will represent the sum of the probabilities for several different types of scattering and absorption processes. In some cases one process will predominate (for example, absorption in hafnium) and then it is possible to study it alone. In other cases it will be necessary to analyse the 'total' cross-section to find the cross-sections for several processes. The elements molybdenum, bromine, zirconium, hafnium and selenium have been studied in this way, and the results on the first four have been reported[11].

Filtered Neutrons

Neutron beams consisting solely of very low-energy neutrons are useful for certain experiments. It is possible to obtain such a beam by placing a block of polycrystalline material with a low absorption cross-section in the neutron beam, when those neutrons with wave-lengths greater than twice the maximum inter-planar spacing in the crystals will pass through almost unattenuated and neutrons with shorter wave-lengths will be scattered out.

The scattering of neutrons, with wave-lengths too great for Bragg reflexion, by crystalline materials is mainly due to the interaction of the neutrons with the thermal vibrations of the lattice. The scattering in this case will be inelastic, and the gain in energy by the neutron is a measure of the thermal vibration frequency. This phenomenon has been studied in polycrystalline samples of beryllium and iron with a beam of lead-filtered neutrons. The thermal vibration frequency of the C—H bond has also been measured by this method.

Angular Correlation Experiments

Measurements have been made of the angular correlation between the alpha-particles and gamma-rays emitted in the reaction $^{10}B(n,\alpha)^{7}Li(\gamma)^{7}Li$, and between fission fragments and gamma-rays in the slow-neutron fissions of uranium-235. In the boron experiment[12], the distribution was spherically symmetrical to 2 per cent; there was therefore no evidence from this experiment that the spin of lithium-7 is other than $\frac{3}{2}$. In the fission experiment, significant deviations from symmetry up to 20 per cent were observed, and in addition a delayed gamma-ray, of half-life between 10^{-8} and 10^{-7} sec., was observed.

Thin layers of the separated isotopes boron-10 and lithium-6 have been irradiated in a gridded ionization chamber filled with an argon – carbon dioxide mixture, and a 'kicksorter' is used to measure the ionization produced by the disintegration particles relative to that of polonium alpha-particles. The energy-loss to produce one ion pair is found to depend on the velocity of the ionizing fragment.

The gridded ion-chamber technique has also been used to study the alpha spectrum from the break-up of beryllium-8 following the beta-decay of lithium-8. A neutron beam passes through a rotating shutter with equal on and off times of 0·5 sec., and strikes a foil of natural lithium. The delayed alpha-particles are recorded in a thirty-channel 'kicksorter' when the shutter is closed. The alpha-spectrum was studied between 0·5 and 8 MeV., and only the broad excited level of beryllium-8 at 3 MeV. seems to be involved. From a comparison of the total number of delayed alpha-particles, with the number of prompt events from the $^{6}Li(n,\alpha)$ reaction, recorded with the shutter open, a value of 0·042 barn has been obtained for the capture cross-section of lithium-7.

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VERTEBRATE PALÆONTOLOGY AND EVOLUTION

A DISCUSSION on "Vertebrate Palæontology and Evolution" was held jointly by Sections C (Geology) and D (Zoology) of the British Association on August 10 at Edinburgh. Prof. T. S. Westoll (Newcastle upon Tyne) began by stressing that only a few selected parts of a very productive field of inquiry could be dealt with at the meeting. Palæontology, essentially a historical and observational discipline, must strive to correlate its findings with the potentially or actually experimental investigations of living organisms.

There is good evidence from the fossil record of evolutionary changes of different orders of magnitude—from phyletic ('micro-') evolution of slow change without extensive reorganization of structural pattern, to adaptive radiations involving the emergence of new structural patterns of divergent adaptive importance. Branches in an adaptive radiation may, after a comparatively short period of relatively rapid divergence, survive through a long period of little further essential change, in which phyletic evolution can often be traced. Adaptive radiations can occur at a great variety of systematic levels, from assemblages of orders (for example, Placoderms) or sub-orders (for example, Perissodactyls) through families (Percoidea) and genera and species (Darwin's finches), probably down to demes. The important question is whether mega-evolution, involving really striking modification of structural pattern, is different in nature.

Orthogenesis is a concept long applied to palæontological series. Closer investigation frequently shows greater complication than was at first thought. Furthermore, the more or less vitalistic or metaphysical language in which orthogenesis is so often befogged is found unnecessary by many recent workers. The imperfect geological record and incomplete fossil remains have contributed to an oversimplification in many evolutionary studies.

In cases of 'macro-' and 'mega-evolution' the fundamental problem is in the stability of structural pattern. Phyletic evolution involves the 'plastic' modification of the same pattern; in the other cases a presumed ancestral pattern has been modified beyond its limits of 'elasticity', so that great modifications and adjustments have been made and then stabilized. In such cases, because of limitations imposed by genetic constitution, development-mechanics and structural factors, independent parallel evolution is not infrequent (secondary palate in Theriodontia, cannon-bones in Artiodactyls, etc.); and the essentially *adaptive* nature of the process is shown by convergence in such cases as Equidæ and Litopterna. Organism and environment each exert 'pressure' on the other; and within the limitations of his field the palæontologist must appreciate this dynamic relationship.

Analysis of some selected case-histories was undertaken by Prof. Westoll, and he showed that the evolution of the horses was not orthogenetic, but that at least three succeeding adaptive offsets have taken place. Factors involved in the radiation of actinopterygian and placoderm fishes were discussed in relation to adaptive modification of pattern. A new analysis of the history of the Dipnoi (a remarkably clear and simple 'mega-evolution' at ordinal level) reveals an integration of finite steps of offset from the early stock, with more-or-less persistent groups settling down at certain stages until replaced by more fully adapted forms. The history of emergence of a major group must be very complex, but there is reason to believe that it took place also by the integration of successive offsets. It was noted that growth-studies are of great importance in this field.

Dr. W. E. Swinton (British Museum, Natural History) reviewed the geological history of dinosaurs, a group usually regarded as diphyletic. The two groups—the Saurischia (large herbivores and bipedal carnivores) and Ornithischia (bipedal and armoured quadrupedal herbivores)—both developed from small, bipedal Triassic Thecodonts. These last had only light armour of bony plates on the back. Though many dinosaurs attained very large size, this is not universal.

Giantism is well shown in the Saurischia. One line culminates in the late Cretaceous *Tyrannosaurus*. The Sauropoda, mainly of Jurassic age, reached some thirty tons in weight, partly compensated by their aquatic habit. The Ornithischia show greater adaptive diversity but less extreme growth in size. Bone-development is often striking. Thus, while the duck-billed *Anatosaurus* (*Trachodon*) has no special outgrowths, late Cretaceous relatives (*Corythosaurus*, *Lambeosaurus*, *Parasaurolophus*) developed remarkable outgrowths of the premaxillaries or nasals or both, which carry the nasal passages and may have served as air-storage tubes during diving. This is an allometric modification of existing bone. Other bipedal Ornithischia (*Troödon-Pachycephalosaurus*) show no excessive growth, but have massive thickening of the frontals and parietals. Brain-casts indicate enlarged pituitary bodies, suggesting acromegalic hyperostosis. The Ceratopsian skull has a characteristic frill of bone over the neck region, with variable development of nasal and supraorbital horns. These are developments of the skull-bones. Again, a large pituitary body is indicated by brain-casts. The relatives of *Stegosaurus* show no thickening of skull-bones, but remarkable plates are found on the body. The pituitary body, so far as known, is small.

It is suggested, continued Dr. Swinton, that very great body size or abnormal bone-development may be hormonally controlled, hereditary and without sex-linkage. Jurassic Saurischia show giantism but no hyperostoses; Cretaceous Ornithischia show hyperostoses but no real giantism. These developments correlate with two widespread Mesozoic temperature minima. This 'phylogenetic pituitarism' suggests that the diphyletic origin of the dinosaurs needs reconsideration.

The relationship between mammals and Synapsid reptiles were then examined by Mr. F. R. Parrington (Cambridge). The Permian and Triassic mammal-like reptiles, especially those of South Africa, first discovered about a century ago, have long been known to resemble Monotremes in their post-cranial skeleton and to develop mammal-like cranial and dental characters. There is general agreement that mammals originated from the later (Triassic) Theriodont members of the Synapsida, but precise origins are obscure. This is largely because of the paucity of fossil theriodonts and mammals from about the end of the middle Triassic through the Mesozoic.

Two upper Triassic skeletons described by Broom showed remarkably close approaches to mammalian conditions, and were placed in the new sub-order Ictidosauria. To this sub-order are now referred a few fragmentary fossils once regarded as advanced Cynodonts, and the remarkable *Tritylodon* and its allies, long regarded as mammals. ***Bienotherium***, a Chinese Tritylodontid, was described by Young, and shown by Watson to retain the reptilian jaw-articulation and to be probably a Cynodont derivative. Kühne has fully confirmed this by his study of the European relative *Oligokyphus* (Rhætic and Lower Lias of Somerset, etc.). The Ictidosauria so defined show a variety of tooth-crown structure.

Certain teeth from Rhætic-Lower Liassic deposits in Britain and Switzerland are still more mammalian in appearance, and suggest comparison both with Symmetrodonts and with Pantotheres, two orders of Mesozoic mammals, the rare remains of which have been fully monographed by Simpson. Two other orders—Triconodonts and Multituberculates—have been regarded as of unknown but separate Theriodont origin, but since then the Tritylodontids, earlier regarded as Multituberculates, have turned out to have reptilian jaw-articulations.

Since there is much diversity of form of the cheek-teeth both in Mesozoic mammals and in Ictidosaurs and other late Theriodonts, and since there is some parallelism, the question arises whether mammals form a true taxonomic unit, or are polyphyletic. The evidence is equivocal, and has been used to defend quite diverse views. But there can be no doubt that many 'mammalian' skeletal features had already been evolved by the Theriodonts. Only the jaw-articulation and middle-ear structures are clear points of distinction. Much of the argument turns on whether such structures are likely to be similarly modified by parallel evolution. The recent important discoveries give hope that palæontology may before long clarify this problem, and perhaps lead to a solution.

Dr. G. S. Carter (Cambridge) also discussed the problem of mammalian origins by focusing attention on the Monotremes, and by using the methods of comparative morphology. The Monotremes are in many respects remarkable structural intermediates between reptilian and mammalian patterns. The phylogenetic position of the Monotremes has been very diversely argued: at one extreme Brazier Howell, on the evidence of the shoulder-girdle, suggests that they evolved from an early reptilian stock quite distinct from that leading to other mammals; at the other, W. K. Gregory recently maintained that they are aberrant marsupials. The most generally accepted view is that they diverged from an early mammalian stock in Triassic or possibly Jurassic times.

The modern Monotremes are specialized: *Ornithorhynchus* is aquatic, and *Echidna* (=*Tachyglossus*) is believed to be descended from aquatic ancestors. Feeding habits are also specialized. Both Monotremes are mammalian in hair, diaphragm, lungs, breathing, heart and blood system, kidneys and most features of skull and jaws. The physiology, so far as is known, is mammalian except in a few characters. Even the small blood-corpuscles are mammalian in form, an adaptation allowing smaller capillaries and a higher metabolic rate. A few characters are worth special attention. Control of body-temperature is by increase of muscular activity when cold; control by sweating is probably absent or slight, and variation of body-temperature with external temperature is greater than in mammals, but less than in living reptiles. Four striking features of Monotremes were noted: the shoulder-girdle retains coracoids and interclavicles, and the fore-limb shows a reptilian posture—it is suggested that in the latter feature *Ornithorhynchus* is adaptively specialized to swimming by means of the fore-limbs, whereas *Echidna* is thought to have had aquatic ancestors; the female generative system is almost entirely reptilian, but mammal-like features are the relatively small yolk and a crude development of a follicular cavity; the monotreme eye is entirely reptilian except for two features, the chief being the superior oblique muscle which turns through a pulley and has moved its attachment area as in mammals; and finally, though facial musculation is developed in Monotremes, a difference from living reptiles, the pattern is different from that in placental mammals.

Monotremes and placental mammals probably diverged when many characters of the soft parts and physiology as well as the skeleton were mammalian, some still reptilian. Most of the monotreme characters are either completely mammalian or completely reptilian: few are intermediate. This implies a series of consecutive changes rather than a grand simultaneous transformation. Such a view is not opposed by the palæontological evidence.

In the ensuing general discussion Prof. Westoll noted that the Theriodonts show several features indicating the piecemeal acquisition of mammalian characters. If one bases classification solely on the presence or absence of the mammalian temporo-mandibular joint, then pouch-young of some marsupials and even an occasional lamb at birth are reptiles.

Lieut.-Colonel L. M. Davies spoke as one to whom evolution is a fact yet to be proved, and pointed out the enormous differences between a bird's feather and any reptilian dermal structures. He asked how such things could happen as a result of explosive evolution. It was pointed out that 'explosive' is a word implying comparative rather than absolute speed of evolution, and that in any case the history of the birds is very badly known. Other speakers discussed giantism in various aspects, and a case of genetically controlled hyperpituitarism was mentioned.

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SURVEYS OF UNDER-DEVELOPED AREAS

THE Duke of Edinburgh referred in his presidential address at the British Association to the various shortages which the world is now facing and which are "partly due to the huge inevitable waste of war and its consequences, and partly to the lack of any comprehensive survey of the world's resources and requirements". "It is only," the Duke continued, "by an accurate knowledge of the world's resources that we can foresee the scope and magnitude of the future problems which science and technology have to meet and which only they can solve." For a whole day, on August 14, an inter-section discussion was concerned with the need for the assessment of the resources of those areas that seem to the rest of the world to be undeveloped or under-developed and about which extravagant claims are often made. At the end of the day one of the speakers commented that, from the dozen or so papers read, one thing stood out most clearly—namely, that as scientific men, all recognized the need for more facts. Especially was there a need for the establishment of the facts by preliminary surveys. To make haste slowly was the speediest, as well as the surest, way of developing areas for the benefit both of their inhabitants and of mankind generally.

The importance accorded by scientific workers to the problems of the economic development of the under-developed parts of the world was shown by the number of Sections collaborating—E (Geography), C (Geology), D (Zoology), K (Botany), M (Agriculture) and F (Economics)—and by the size of the audience throughout the morning session. The problem of these areas has been posed by the politicians, notably by President Truman in Point Four of his address to Congress in 1949: "We must embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of under-developed areas". But it falls to scientific workers to show just how these benefits are to be brought to such regions, and the discussion made it clear that there are no short cuts and no easy solutions, and that a tremendous diversity of conditions must be encountered. Prof. L. Dudley Stamp, who opened the discussion, claimed that the huge losses incurred in the Tanganyikan groundnut and the Gambian poultry schemes showed convincingly that, apart from any possible political or financial mismanagement, there is at present inadequate knowledge on which to base development schemes in under-developed lands, especially in the tropics.

Prof. Stamp explained the purpose and organization of the World Land Use Survey, of which he is director of the Old World Division. He elaborated the aims of this fact-finding survey—to record the existing use of the land and to attempt to ascertain the reasons why the land is used as it is—along lines similar to those of his article in *Nature* of June 23, p. 1010. The need for objectivity, he said, is paramount: if subjective judgments are introduced, the value of such a Survey will be greatly reduced. For these and other reasons, the Survey recommends that any map prepared should be, like the one-inch map, 'survey accurate', even though the final product covering the whole world will be only on the scale of one to one million. The land-use classification drawn up by a Commission of the International Geographical Union is designed to cover as many different categories of land use as possible in regions as diverse and as distant from one another as Thailand, northern Canada and tropical Africa. An essential prerequisite of development anywhere in the world, whether well known and intensively used or unknown and undeveloped, must be a record of the present position and the causes that lie behind it: in Prof. Stamp's phrase, there must first of all be a "synoptic, objective view".

Fifteen years ago the prospects of such a world survey would have seemed meagre indeed, and even to-day the financial problems are large and as yet unsolved. But, as several speakers pointed out, the use of air photographs in mapping now makes possible the covering of much of the world, including many of the under-developed areas. In the absence of Brigadier M. Hotine, the director of Colonial Surveys, Lieut.-Colonel G. J. Humphries described the comprehensive and ever-increasing range of the activities of that Directorate since its establishment in 1946, and discussed some of the difficulties encountered both at headquarters and in the Colonial territories. He explained the adoption of the scale of 1/50,000 as being the one that most nearly meets the requirements of most users of the maps. Contouring remains the chief bottle-neck; hence the issue of 'preliminary plots' in black-and-white only, and with hachuring to indicate certain relief features; but fully coloured, contoured maps will be available later once the immediate and pressing demands of the development plans of all British Colonies have been met. Later in the discussion, Mr. T. D. Weatherhead, director and general manager of Hunting Aerosurveys, Ltd., gave illustrations of how his company's photographs have helped agricultural and planning authorities and guided geologists in undertaking their field-work. He believed that the problem of speedy contouring can be overcome by the wider use of aids such as the airborne profile-recorder.

Two geographers spoke of land-use surveys with which they had been associated and thus illustrated both the potentialities and the problems of so vast a project as a world survey of land use. Dr. J. Wreford Watson, head of the Geographical Branch, Department of Mines and Technical Surveys, Canada, showed how geographers are employed by the

Canadian Government "to survey conditions as they are, . . . geography being regarded as a factual not a remedial aid to government", and described the regional surveys made in different parts of Canada. He pointed out that the size of Canada makes a field-by-field survey impossible and compels the use of the sampling method, larger areas being interpreted by detailed studies of typical samples. In his view the success of the World Land Use Survey will depend on its inclusive categories and its generalized scale. Mr. R. M. Prothero, of University College, Ibadan, described some of the problems of land-use mapping in the forest areas of southern Nigeria, stressing the lack of map-cover in many tropical regions and the difficulties in interpreting air photographs—such as the problem of the identification of cacao, especially in a country with thousands of very small farms. Nevertheless, his preliminary investigations in an area north of Ibadan gave some interesting information that is so often impossible to come by in the tropics, namely, data concerning, for example, bush fallows and the amount of land available for cultivation.

Most of the fields of science concerned in the carrying out of surveys were represented in the discussion, though there was no forestry contribution — an unfortunate omission in view of the breadth of view so characteristic of forestry departments and of individual foresters in many under-developed areas. Prof. T. N. George, of Glasgow, spoke of the geologist's interest in the problems of development. He described how in the past a high proportion of the time of geological surveys was taken up by the investigation of mineral deposits of possible commercial significance, and showed how the question of development still turns largely upon the nature of the economic conditions prevalent at any particular time. The contribution of the soil scientist was emphasized by several speakers, and especially by Dr. Herbert Greene, adviser on tropical soils at Rothamsted Experimental Station. He recognized four factors that have made soil survey easier and more significant during the past twenty-five years: the use of air photography; the concept of soil associations fashioned in East Africa by the late Geoffrey Milne and his colleagues; the discovery of insecticides and drugs that make possible the occupation of vast areas, especially in tropical lowlands, that were not previously available; and the principle of what he termed 'beneficial use', whereby the communal interest and the sense of partnership were seen to matter more than any individual claims to rights in land or water. At the same time, he directed attention to the problems in certain under-developed areas where nationalism seeks the fruits of technology but rejects the foreign technician. He was convinced that the British are right in their policy of encouraging the nationals of such areas to take an active and responsible share in the work of development: thus, and only thus, will they appreciate that the limitations on development are imposed not by the whim of an alien power but by the natural conditions.

"A Zoological Contribution" was the title of Dr. E. B. Worthington's paper, read for him in his absence; but Dr. Worthington speaks as much more than a zoologist, because of his outstanding work for all the sciences in Africa and in virtue of his position as secretary-general of the Scientific Council for Africa South of the Sahara established last year. This Council, an international body, is, he suggested, rightly conceived, since science can know no frontiers, and it would take great notice of this discussion by British scientific men of the problems of under-developed areas. He pointed out how considerable is the scientific potential of Africa to-day, especially on the biological side, largely as a result of wise spending by the metropolitan and Colonial governments and through the establishment of the Colonial university colleges and research institutions in British and non-British territories. The tsetse fly has so far saved much of Africa from disorderly development—in contrast to parts of the Far East and south-east Asia—and in his view there is still time to bring science to bear upon African problems, though he foresaw serious difficulties arising from the rapid growth of population in certain areas.

Most time was not unnaturally devoted to the huge under-developed parts of Africa, but several speakers besides Dr. Watson directed attention to other areas. Miss A. G. Donnithorne spoke of a rather different type of survey, that of the economist. She dealt with the Far East, citing in particular the work done in China by the selection of samples by Prof. Buck and his associates. Dr. C. F. Hickling, fisheries adviser to the Secretary of State for the Colonies, discussed fisheries in all parts of the world and showed that fisheries often represent undeveloped food supplies even in countries that are otherwise well developed many tropical waters are not merely undeveloped but quite unexplored. The Colonial Office is establishing fisheries research stations and fisheries departments which will concentrate on the development of existing fisheries and the improvement of methods of catching and preserving. Care is being taken to avoid the heavily capitalized unit and to enlist, wherever possible, the co-operation of the local fisher-folk. Sir Geoffrey Evans, of the Royal Botanic Gardens, Kew, focused attention on the land settlement problems of those areas round the Caribbean that he knows so well, and where it is hoped that homes may be created in British Guiana and British Honduras for some of the growing populations of the West Indian islands. He stressed the need for preliminary surveys, especially of soils, before the possibility of rail or road construction (essential for any real development) can be entertained. One of the world's basic problems to-day is, in his opinion, that of food supplies in relation to a rapidly increasing population. Contrary to a commonly held view, there are not large areas of first-class land in the virgin tropics capable of producing food: there is, he claimed, far more second-class and marginal land.

It must be recognized, moreover, that not all the under-developed lands are uninhabited, and this in itself gives rise to a whole series of problems. Dr. Greene dealt with the difficulties of partnership, and the several references made by different speakers to human values and relationships made it clear that scientific workers fully recognize their great significance. No speaker put this better than Dr. A. S. Thomas, principal scientific officer of the Nature Conservancy, with a wide experience of tropical Africa. "Development," he said, "is not merely a matter of production and exports, or even of hospitals and schools, but of human development and human happiness. We must preserve this happiness of the people until we know more, not only about their crops, but about them also." Here Dr. Thomas was bringing together the concern of all the sciences. He showed, too, how false are many of the common generalizations about the tropics, and how misleading can be the experience of temperate lands when applied to tropical conditions. We are still grossly ignorant of the interaction of all the factors that control plant growth near the equator, and this information can, he claimed, be gathered in only one way—by the slow, careful, even laborious method of the preliminary, detailed survey. "The more revolutionary the cultural methods to be used," he warned, "the greater the need for pilot schemes and for working in small units."

Statements like these do not appeal to the politician or to the official who wants quick returns and speedy and convincing results. But they are typical of the caution and realism of the scientific worker and, significantly, were endorsed by all those taking part in the discussion. They are clearly the convictions of the organizers of the World Land Use Survey, which will provide an objective record of the existin facts of land use and which is intended as a foundation for schemes of improvement and developmen in all parts of the world. It is to be hoped that small part at least of the many millions at presen available for development and welfare schemes wil be directed towards this Survey in different countrie so that it may speedily be established on a permanen basis. Here is a project in which all the sciences ar interested and all men of science can, and should co-operate: and it cannot fail to make a real an substantial contribution to the scientific study o under-developed, as well as other, areas and also t the progress and happiness of those who are sometime termed the world's under-privileged peoples.

ROBERT W. STEEL

NEWS and VIEWS

Sir Arthur Fleming, C.B.E.

AFTER fifty years of distinguished service to the causes of industrial research and the education and training of industrial personnel, Sir Arthur Fleming has resigned his post as director of research and education to the Metropolitan-Vickers Electrical Co., Ltd., although he will remain a director of the firm; he has also agreed to assume general direction of research and education for the group of electrical firms known as A.E.I., Ltd. The Research Laboratories at Trafford Park, Manchester, which Sir Arthur was responsible for creating and developing, have produced outstanding contributions to scientific and technical knowledge and achievement over a very wide field, and have afforded unique opportunities to a long succession of investigators many of whom have attained eminence in their respective subjects. He will be most remembered, however, for the influence he has exerted on technical education in Great Britain. The number of apprentices and trainees of all grades for whom systematic training has been provided in the Metropolitan-Vickers works now totals more than ten thousand, and a glance through the register of them, published a short time ago, reveals the amazing extent to which these facilities have benefited the electrical industry as a whole, the government services and the educational institutions of the country; and have also provided trained personnel for almost every other country. The Metropolitan-Vickers training scheme acquired a world-wide reputation many years ago, and established a pattern which has been widely adopted.

Sir Arthur's activities have not been confined to Metropolitan-Vickers. His knowledge and experience have been placed unsparingly at the disposal of numerous societies, the universities and government establishments, and, in particular, he has held the positions of president of the Institution of Electrical Engineers and of both the Engineering and Education Sections of the British Association. He has been the recipient of many honours, including the Faraday Medal of the Institution of Electrical Engineers and the Hawksley Medal of the Institution of Mechanical Engineers; he was granted the degree of D.Eng. *honoris causa* by the University of Liverpool; was appointed O.B.E. in 1918 and C.B.E. in 1920 for his work on submarine detection, and in 1945 was knighted for his outstanding services to education. Sir Arthur retains remarkable physical and mental vitality, and it is to be hoped that he will lon continue to give industry and education the benefi of his far-sightedness and intense enthusiasm.

Dr. C. Dannatt, O.B.E

DR. C. DANNATT, who succeeds Sir Arthur Flemin at Manchester, has had some thirty years service wit the Metropolitan-Vickers Electrical Co. After militar service in the First World War, he graduated i electrical engineering from the University of Durha and went to Metropolitan-Vickers in 1921 as a colleg apprentice. He joined the Research Department i 1922 and over many years has built up a very clo association between the Research and Engineerin Departments of the Company on design and relate matters. He is the author of many papers an articles on electrical engineering subjects, and i 1936 was awarded the D.Sc. degree of Durham. I 1940 Dr. Dannatt was appointed to the chair o electrical engineering in the University of Birmingham; but due to war-time commitments he filled i only on a part-time basis. Before and during th Second World War he was actively associated wit the Admiralty in the application of remote contro to gunnery, being one of the original members of th Admiralty Remote Power Control Committee, an for this work he received the O.B.E. in 1943. I 1944 he vacated his university chair and rejoine Metropolitan-Vickers, this time on the electrica engineering side, and became in 1947 chief electrica engineer of the Company with a seat on the Board Dr. Dannatt therefore brings to his new post a ver broad understanding of the requirements of a larg manufacturing organization in industrial researc and also in the recruitment and training of technica staff. Coupled with his additional appointment a assistant managing director of the Company, there i every reason to believe that under his guidance th forward-looking policy of the Metropolitan-Vicker Co. in these vital activities will be fully maintained.

Institute of Biology: Mr. D. J. B. Copp

MR. D. J. B. COPP has been appointed secretary of the Institute of Biology as from October 1. Mr. Copp is a graduate of University College, Southampton, where his studies were interrupted by the War, when he was engaged on radar research at the Admiralty Signals Establishment (Extension), Witley. In 1947 he was appointed assistant secretary of the

British Association and in that capacity he has become well known to a large number of men of science who have greatly appreciated his unobtrusive but active and efficient work in connexion with the five post-war meetings of the Association and with the Association's publications, conferences, press relations, etc. He has taken a special interest in the student membership of the Association and in dealing with applications from school science societies and clubs for assistance in drawing up their programmes. The young Institute of Biology is fortunate to have obtained as its principal permanent official an energetic officer of proved administrative ability.

Physical Society Medal Awards: Dr. A. B. Wood

The Council of the Physical Society has awarded the Duddell Medal for 1951 to Dr. A. B. Wood for his work on the design of instruments for use in work on under-water acoustics. One of the main investigations which Dr. Wood has carried out is the echo depth-recorder, in which magnetostriction oscillators are used for transmitting powerful high-frequency sound signals and to receive weak returning signals. These depth recorders are fitted in many important ships throughout the world, and are adapted to give an automatic record of the contour of the sea-bed over a very large range of depths. The depth recorder was primarily designed for hydrographic surveying and is also used for navigation, the location of wrecks and shoals of fish, and to indicate the silting up of harbours. Dr. Wood was largely responsible for the development of the acoustic mine and for appreciating the difficulties which had to be overcome in ensuring that the explosion of one mine should not actuate the rest of the mine-field. The piezoelectric pressure gauge and cathode-ray oscillograph designed by Dr. Wood are used in investigations of the pressure-time curve of under-water explosions. The details of this work have formed the basis of a large volume of experimental and theoretical research on the damaging effect on ships of under-water explosions.

Dr. J. H. E. Griffiths

The Council of the Physical Society has awarded the Charles Vernon Boys Prize for 1951 to Dr. J. H. E. Griffiths, of the Department of Experimental Philosophy, University of Oxford, for his work on ferromagnetic resonance. In carrying out measurements on the permeability of ferromagnetic materials at centimetre wave-lengths, Dr. Griffiths found that the high-frequency resonance of the metal increased to a maximum with increasing magnetic field and then decreased. This suggested that the effect must be due to ferromagnetic resonance of a nature similar to nuclear resonance; since electron spins precess according to the combined effect of their internal and external fields, this ferromagnetic resonance is capable of becoming a new tool for the investigation of magnetic materials.

Nuffield Foundation Grant to the Royal Anthropological Institute

The symposium on Blood Groups and Anthropology on March 17, 1951, organized by the Royal Anthropological Institute (see *Nature*, May 5, p. 705), served to focus attention on the need for co-ordination of the work now being done in a relatively new field of research. Arising from this symposium, the Institute appointed a Blood Group Committee, and a grant of £14,000 has been made by the Nuffield Foundation to establish a research centre which will be known as the Nuffield Blood Group Centre of the Royal Anthropological Institute. The new Centre will classify the large and rapidly growing body of data on the distribution of the human blood groups throughout the world, assess it statistically and make the results available to anthropologists and other research workers. It will also carry out and stimulate work in Great Britain and abroad where this is desirable in order to follow important clues or to fill gaps in the world picture, and in particular will continue work now in progress on the classification of British blood donors. The centre will be at the Royal Anthropological Institute, 21 Bedford Square, W.C.1, and it is hoped that it will be in operation on January 1, 1952. It will greatly facilitate the work if persons publishing or having published papers on the frequencies of blood groups and other genetical factors in particular populations will send reprints to the Centre. Pending the appointment of a director, reprints will be acknowledged by the Secretary of the Institute.

New Forestry College for Cyprus

A new Forestry College for Cyprus was opened by the Acting Governor (Mr. John Fletcher-Cooke) on September 27. The College, which is situated at Prodhromos, 4,500 ft. up in the Troodos Mountains, is to provide training for forest guards and foresters. In addition to studies in the basic sciences, botany, geology, soil science, meteorology and ecology, the syllabus will include such subjects as sylviculture, crop mensuration, yield regulation, forest engineering and surveying, the utilization and preservation of timber, and protection of forests against disease. Each of the two courses for guards and foresters will last one year. Fifteen places out of a total of thirty-six are reserved for students from countries outside Cyprus, and it is expected that students from neighbouring countries will receive their training there. The director of the College is Mr. R. J. Streets, who was released by the Forestry Commission of Great Britain to take up the post; Mr. Streets was formerly in charge of the Forester Training School, Lindford Hall, Thetford, Norfolk.

Institute of Geodesy, Photogrammetry and Cartography, Columbus, Ohio

The recent establishment of an Institute of Geodesy, Photogrammetry and Cartography in the Ohio State University, Columbus, by the board of trustees, has recently been announced. This embraces an executive board and several committees dealing with research, professional development, etc. An advisory committee of international composition has been appointed by the University administration. In association with the Institute is offered an integrated programme of undergraduate and graduate instruction. The undergraduate curriculum, which covers four years and leads to a B.Sc. degree (with a 'major' in geo-sciences), comprises a broad range of subjects in well-chosen proportion. These, in order of magnitude, are mathematics (a necessary foundation), physics, geology, chemistry, astronomy, etc.; and in the fourth year, geodesy, photogrammetry and electronics. Languages and the humanities have a quarter share of the total programme. The course, indeed, can have a wide cultural value as well as providing a sure foundation for later special study. For this there are graduate courses of instruction suited to individual needs and capacities. Though geodesy is a most ancient science, its applications are much widened by present-century developments, peaceful and otherwise. The scientific surveyor of the second half of the twentieth century requires a wide basic training; and the problem of its provision awaits solution. The trustees of the Ohio State University deserve credit for their constructive effort, and the progress of the new Institute and school will be watched with much interest and may perhaps stimulate similar action elsewhere.

Memoranda of the Indian Science Congress Association

FOUR memoranda prepared by the Indian Science Congress Association, at the request of the United Nations Educational, Scientific and Cultural Organization, have been issued under the title " 'Scicong' Memoranda for Unesco" (pp. 59. Calcutta 16: the Association, 1951). The first of these is a review of the energy and power resources of India, prepared with reference to the Unesco discussion theme for 1950, "World Energy and Power Resources", to which a bibliography is appended. The second memorandum outlines the activities of some typical science clubs in India; these include the students' scientific societies in connexion with universities and like institutions, and some suggestions are made for the further development of such societies, including the use of educational and documentary scientific films and of exhibition boxes of scientific interest. The third memorandum, on the popularization of science through books, gives a fairly comprehensive picture of the position of publication and of science writing in India. Although a start has been made in the popularization of science in India in this way, science writing is unlikely to develop into a professional occupation for some years. The fourth memorandum, on international collaboration between existing associations for the advancement of science, reviews briefly the history of the Indian Science Congress Association and discusses the desirability of forming an international federation of associations for the advancement of science. One reason for advocating the formation of such a federation is that it might deal more satisfactorily with questions relating to freedom of scientific inquiry, and the dangers involved by secrecy in science, than the Committee of Social Relations of the International Council of Scientific Unions has done. The value of that Council for purely academic and scientific problems is fully recognized; but the Indian Science Congress Association would welcome the formation of a federation to encourage symposia and discussions of scientific problems of wide social and international import and the publication of an international journal covering such matters.

Survey of the Ticks of South Africa

THE *Onderstepoort Journal*, created in 1933 to replace and continue the annual reports of the director of veterinary services and animal industry of the Department of Agriculture, Union of South Africa, has earned a permanent place in all libraries that cater for readers interested in the welfare of domesticated animals, the diseases that afflict them and the organisms that cause these diseases. The papers it publishes reflect the wide scope of the work done at the Onderstepoort Veterinary Research Station, from which the *Journal* is published. A feature of this work has always been its broadly biological outlook. Typical of this is the survey of the ticks of South Africa, which has been undertaken as part of a zoological survey of the Union. Ticks collected all over the Union by government veterinary officers have been sent to the Onderstepoort Laboratory, and the material thus collected is being studied by Miss Gertrud Theiler. In Part 1 of her report (*Ond. J.*, 23, 217; 1948 [*sic*]) she comments on the difficulties created by the methods adopted for the collection of the ticks. She has, however, been able to draw certain conclusions from her studies. The species discussed by Miss Theiler are as follows: in Part 1, *Amblyomma hebraeum*, the vector of 'heart water'; in Parts 2–3 (*Ond. J.*, 22, 255; 1949 [*sic*]), *Boophilus decoloratus*, the blue tick, and *Rhipicephalus appendiculatus*, the brown tick; and in Parts 4–6 (*Ond. J.*, 24, 1; 1950), *Rhipicephalus capensis*, *R. evertsi*, and *Ixodes pilosus* and *I. rubicundus*. Each of the articles is accompanied by maps which show the localities in which each of the ticks discussed was present, together with information about the nature of the districts concerned and about the relevant climatic factors.

Prehistoric Sites on the North Cornish Coast

A VERY useful article entitled "Prehistoric Sites on the North Cornish Coast between Newquay and Perranporth", by Joan R. Harding (*Antiquaries J.*, 30, July–October 1950), deals with a coastal area of Cornwall which is a little more restricted than is indicated by the title and covers the coast from Kelsey Head to the Penhole Sands. At the former site Mesolithic and Iron Age finds have been made, and at the latter relics of the Mesolithic and Bronze Ages have been discovered. Judging from the illustrations, the Mesolithic finds recall those made farther north at Constantine Bay near Padstow. Culturally, the flint industries are undoubtedly Mesolithic, though in time they may well be later and even overlap with the early metal age. Miss Harding is to be congratulated on bringing forward some very interesting finds.

Scottish Postgraduate Agricultural Scholarships

THE Department of Agriculture for Scotland has recently awarded postgraduate agricultural scholarships, commencing this year, to the following. *Husbandry*, N. H. Cuthbert (Glasgow), dairy husbandry at the University of Reading; A. F. Gristwood (Edinburgh), poultry husbandry at the University of Edinburgh; P. C. Harper (Aberdeen), rural science at the University of Edinburgh; A. M. MacNair (Glasgow), agriculture at the University of Cambridge; I. S. Robertson (Edinburgh), agriculture at the University of Cambridge; T. Webster (Glasgow), agricultural science at the University College of Wales, Aberystwyth; *Agricultural Economics*, H. C. Currie (Edinburgh), agricultural economics at the Agricultural Economics Research Institute, Oxford. Three current awards have been extended for a further period of study as follows: *Husbandry*, A. O. Ballantyne (Glasgow), Ph.D. degree at the University of Edinburgh, H. G. Livingston (Aberdeen), dairy husbandry at the University of Minnesota; *Statistics*, St. C. S. Taylor (Edinburgh), Ph.D. degree at the University of Edinburgh.

ERRATUM.—In the article "Britain's Scientific Shrines (6)" in *Nature* of September 15, p. 443, column 2, for "Dr. William Browning" read "Dr. William Brownrig".

SLOW-NEUTRON TERNARY FISSION OF URANIUM-235

By PROF. E. W. TITTERTON
Australian National University

THE liquid-drop model of the fission process[1] was used by Present[2] in 1941 to predict that fission into three charged fragments is dynamically possible. A mode of fission involving three charged fragments was observed by Alvarez in 1943 in the case of the slow-neutron fission of uranium-235. Since that date, there has been a considerable body of work on the subject[3].

Experiments using photographic plates have been made by Wollan *et al.*[4], Demers[5], Green and Livesey[6], Tsien *et al.*[7] and Marshall[8]. They indicate that in about one-third per cent of the cases the slow-neutron fission of uranium-235 gives rise, in addition to the two heavy fragments, to a long-range α-particle which is emitted at nearly 90° to the heavy fragments. In these experiments the number of events with long-range light fragments were few, being respectively 27, 6, 58, 30 and 80, and many of these were incomplete, the long track leaving the emulsion. Moreover, except in the cases of Demers and Marshall, the emulsions employed were insensitive to energetic protons.

During three years work at the Atomic Energy Research Establishment, Harwell, detailed experiments were carried out using Ilford C_2 and D_1 emulsions impregnated with a saturated solution of uranyl acetate and irradiated in slow-neutron fluxes in GLEEP and BEPO. These experiments had as their objective: (1) Determination of the possibility of proton emission at the instant of fission. (2) Investigation of possible negative proton emission as an alternative to the delayed neutron emission known to occur from certain fission products. (3) Study of the energy distribution, angular distribution and frequency of the α-particles known to be emitted. (4) Search for the emission of heavier nuclei. In particular, lithium-8, or boron-8, either of which would give rise to a 'hammer track'[9], or beryllium-8, which would give rise to two α-particles. Examples of beryllium-8 emission have been observed by Goward, Titterton and Wilkins[10] in the photofission of uranium and by Titterton[11] in the fast neutron fission of thorium-232. (5) Determination of the frequency of occurrence of fission into three equal fragments, one case of which was reported by Tsien *et al.*[7].

More than half a million fission tracks have been examined, about half in C_2 emulsions sensitive to protons up to an energy of 40 MeV. and half in D_1 emulsions which, under the conditions of the experiment, recorded α-particles well but protons only up to an energy of 2·5 MeV. More than a thousand cases of ternary fission were observed, and preliminary results were reported briefly at the 1950 Harwell Conference[12]. The main results may be summarized as follows:

(1) Protons associated with fission tracks were observed in the emulsions. Where these were of range greater than 20 μ (1·25 MeV.) it could be shown from the geometry of the event that the track was due to a proton knocked-on by one of the moving fission fragments. Such protons, therefore, were not associated with the fission process.

(2) Negative proton emission was not observed, and if it occurs at all, is an improbable process. An upper limit of 1 in 5 × 10^3 can be assigned to the probability of negative proton emission relative to delayed neutron emission from the fragments concerned. This is discussed in detail elsewhere[13].

(3) The long-range α-particles emitted in fission are found to have an energy distribution as shown in Fig. 1, which is based on 862 complete events. The most probable value of the energy is 15 MeV., but the distribution extends to a maximum value of 29 MeV. This maximum value is considerably greater than that given by early workers—Farwell *et al.*, 16 MeV.; Green and Livesey, 20 MeV.; Tsien *et al.*, 25 MeV.; Wollan *et al.*, 22 MeV.; Marshall, 26·5 MeV.; Allen and Dewan, 26 MeV. The angular distribution of the α-particles relative to the light fission fragment is shown in Fig. 2, and from its shape definitely precludes the possibility, suggested by Feather[14], that the α-emission might take place from one of the moving fission fragments, or the possibility that a (n,α) reaction is followed by fission. The observed maximum α-particle energy is consistent with the idea that the α-particle is left between the two heavy fragments and acquires its energy from their electrostatic fields. The angular distribution also supports the view that the α-particles, in most cases, are left at rest and acquire their energy by repulsion from the heavy fragments.

The energy released in this mode of fission was measured and, within the limits of the experimental errors, was found to be the same as for binary fission.

For three-particle events with α-particles in the energy range 5–30 MeV., the frequency of occurrence was found to be 1 event per 422 ± 50 binary fissions, a figure which compares with 1 in 505 ± 50 for the same energy-range found by Allen and Dewan[3] in the most recent counter experiment.

(4) In the present investigation, no instance of lithium-8, boron-8 or beryllium-8 emission has been observed. However, in agreement with other authors[6,7], short-range fragments, apparently associated with the fission instant, were observed. By plotting the frequency of occurrence of recoils along the fission track, it was shown that there is an excess of tracks in the central region over that to be

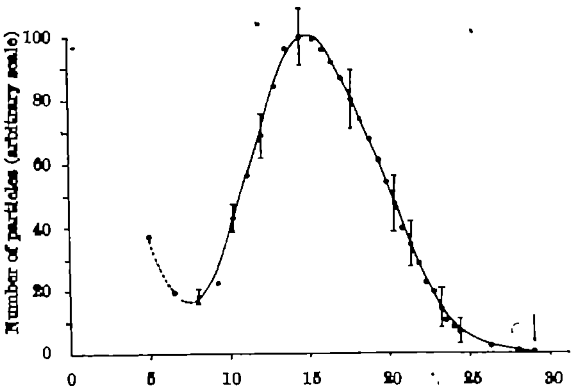

Fig. 1. Energy spectrum of the α-particles emitted in the slow-neutron ternary fission of uranium-235. The arrow indicates the energy of the most energetic particle observed
Ordinate: Number of particles (arbitrary units).
Abscissa: α-Particle energy in MeV.

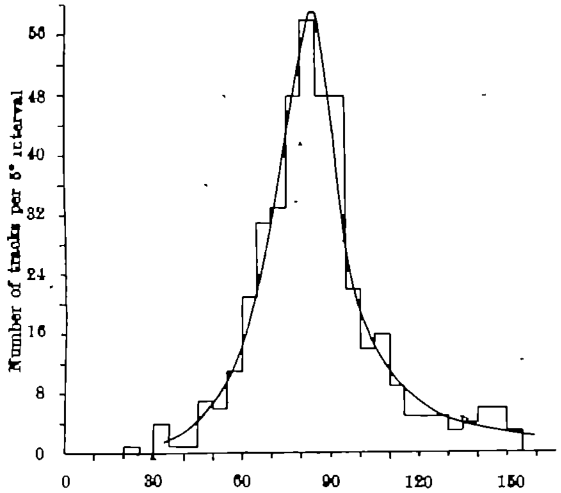

Fig. 2. Angle of emission of α-particle relative to the light fission fragment

Ordinate: Number of tracks per 5° interval.
Abscissa. Angle (degrees) measured from light fission fragment.

expected from the theory[16]. Moreover, work with desensitized emulsions showed that these tracks were still present when the emulsion was no longer recording α-particles. These experiments suggest that at least some of these short-range particles have a charge greater than 2, and tracks of this class were found with ranges up to 5 cm. of air[10], though the most probable value was observed to be ~ 1 cm. of air. After correction for random events caused by the chance superposition of fission tracks on the background of α-particles and protons (from the reaction $^{14}\mathrm{N}np^{14}\mathrm{C}$) which are present in the emulsions, a frequency of occurrence for these events can be obtained. Three-particle fission, in which the light fragment has a range less than 20 μ, was observed at the rate of 1 event per 85 ± 10 binary fissions. This frequency is in agreement with that found by Green and Livesey and Tsien *et al.*, while the indication of fragments of Z greater than 2 is supported by recent counter experiments of Dewan and Allen[15].

(5) Although events comprised of three heavy fragments each of range greater than 5μ were observed in the emulsions, the geometry in all cases was compatible with their being formed by the collision of the fission fragments with silver and bromine nuclei in the heavy component of the emulsion. Moreover, the frequency of occurrence of these events was as predicted theoretically, assuming the interaction to be with the silver and bromine nuclei in the emulsion.

The experiments thus provide no evidence for fission into three approximately equal fragments as originally suggested by Present[2], and, in this respect, confirm the counter experiment of Rosen and Hudson[17]. The event observed by Tsien *et al.*[7] in which a particle of mass ~ 32 was emitted must therefore be regarded with suspicion, since if it were true ternary fission some fifty such events should have been observed in the present experiments.

A detailed account of these experiments is in preparation and will be published at a later date. Thanks are due to the ten microscope observers who, in the course of their training, worked on the problem with great diligence, and especially to Miss E. M. Chellingworth, who helped with the analysis. I am grateful to Sir John Cockcroft, director, Atomic Energy Research Establishment, Harwell, for permission to publish these results.

[1] Bohr and Wheeler, *Phys. Rev.*, 56, 426 (1939).
[2] Present, *Phys. Rev.*, 59, 466 (1941).
[3] See summary given by Allen and Dewan, *Phys. Rev.*, 80, 181 (1950).
[4] Wollan, Moak and Sawyer, *Phys. Rev.*, 72, 447 (1947).
[5] Demers, *Phys. Rev.*, 70, 974 (1946).
[6] Green and Livesey, *Phil. Trans.*, A, 241, 323 (1948).
[7] Tsien, Ho, Chastel and Vigneron, *J. Phys.*, 8, 165, 200 (1947).
[8] Marshall, *Phys. Rev.*, 75, 1339 (1949).
[9] Franzinetti and Payne, *Nature*, 161, 735 (1948). Titterton, *Phil. Mag.*, 42, 113 (1951).
[10] Goward, Titterton and Wilkins, *Nature*, 164, 661 (1949).
[11] Titterton, *Phys. Rev.* (in the press)
[12] Titterton, 1950 Harwell Conference Report, A.E.R.E., G/M.68, p. 79.
[13] Scott and Titterton, *Phil. Mag.*, 41, 918 (1950).
[14] Feather, *Nature*, 159, 607 (1947).
[15] Dewan and Allen, *Phys. Rev.*, 76, 181 (A) (1949).
[16] Bohr, *Kgl. Danske Mat. Fysiske*, 18, 8 (1948).
[17] Rosen and Hudson, *Phys. Rev.*, 78, 533 (1950).

HIGHER EDUCATION IN BRITISH COLONIAL TERRITORIES

THE report on measures for the economic development of under-developed countries, which has recently been issued by the United Nations Department of Economic Affairs, stressed the difficulties which the low level of technology in such countries present to their development. One major obstacle to the advance of technology in such countries is the absence of an educational and administrative structure through which the producers can learn technology. Even where leaders of such a country at various levels—politicians, teachers, engineers, business leaders, trade unionists, religious leaders, journalists—all desire economic progress, understand what is required, and are willing to pay the price, much will still depend on education. The preparation, as recommended in this report, of a programme of education and research for a period such as five years, indicating not only objectives and proposed expenditure, but also what is required for agricultural extension services, for industrial training, and for the training of scientific workers and administrators, will make considerable demands, in both its preparation and execution, on the services of trained minds in such countries.

It is in the light of such ideas and plans that the significance of the work of the Inter-University Council for Higher Education in the Colonies is best assessed to-day. The third report of the Council*, which covers developments since September 1949, is thus appropriately considered against the background provided by the general survey over roughly the same period provided by the current report "The Colonial Territories, 1950–51"†, in which due weight is given to those political developments in self-government, for example, in the Gold Coast and Nigeria, which are making in themselves such demands on wise leadership by educated men and women. Those developments are summarized in Chapter 2 of the report, while the broad background of the educational situation is reviewed at the outset of Chapter 5, dealing with social services.

A feature of the report on "The Colonial Territories, 1950–51" is the evidence it supplies of the extent to

* Colonial Office Inter-University Council for Higher Education in the Colonies. Third Report, 1949–50. (Colonial No. 273) Pp. 24. (London: H.M. Stationery Office, 1951.) 9d. net.

† The Colonial Territories, 1950–51. Pp. ix+184. (London: H.M. Stationery Office, 1951.) 4s. 6d. net.

which the people of these territories are learning to increase their own revenues through a better use of their natural resources, to meet the many and varied professional and technical needs of their own countries—in medical and health work, in industry and commerce as well as in social services of all kinds, including education—and to acquire the art of government through participation in their own political institutions. Much yet remains to be done. It is early yet to judge the success or otherwise of the constitutional developments in the Gold Coast, Nigeria and elsewhere, and both in health and in education there are serious shortages of staff which limit developments.

Nevertheless, the expansion of education, despite this and the other main limiting factor—finance—is again encouraging. In Malaya, the number of children at school increased by 50,000 during the year, and in Hong Kong, where seventy-three new schools were opened, by 30,000. In Kenya a scheme has been approved for raising the standard of African education at an estimated annual cost of £966,000 and a capital outlay of £1¼ million over the next five years; Nyasaland has completed a survey of schools as a basis for a detailed programme of development to be completed in 1954; and in Tanganyika the 'ten-year plan' has been revised to provide primary schooling for a much larger number of African children. All territories, however, are still hampered by a serious shortage of teachers, although local training facilities and their output are increasing and there is a large recruitment of teachers from the United Kingdom each year. In Nigeria, for example, there are now eighty-eight teacher-training centres, including twenty-two for women, and two rural education centres for training teachers in rural science. Education for girls is a sphere in which expansion is particularly important.

The exchanges between the United States and the Colonial territories under the Fulbright scheme, and the research work and surveys briefly summarized in this report make special demands on the trained men and women coming from the Colonial universities. Travel grants have already been approved under the scheme to enable thirteen candidates from Malaya, Singapore, Nigeria, Kenya and Uganda to visit the United States for study and research. Meanwhile, progress in starting the various Colonial research stations and institutes is frequently hindered by the shortage of qualified staff.

There are now three universities and five university colleges in the British Colonial territories and the Anglo-Egyptian Sudan, and of these the University of Malaya was founded in October 1949, Makerere College achieved university college status in November 1949, and in February 1950 the University College of the West Indies installed its first chancellor. These eight institutions, according to the third report of the Inter-University Council, have a total of 3,056 full-time students, the University of Malaya having 791 students in the current session and the University of Hong-Kong 715, while in the 1949–50 session there were a further 4,014 Colonial students in the United Kingdom, of whom 1,745 were in universities and university colleges. The total has increased to about 4,500 in the current session, the proportion of university to non-university students being probably the same. Since in 1951 the minimum requirements for entrance to United Kingdom universities are being raised, the number of Colonial students qualified for admission will decrease, and the need for developing the Colonial universities and colleges and completing their building programmes will become the more urgent. The situation is now developing in fact in which a Colonial student will normally proceed overseas only for postgraduate and specialist courses or for courses not provided locally.

Excluding the Royal University of Malta, where much of the teaching is undertaken by part-time staff, there are now in the remaining institutions 130 professors or heads of departments, 24 readers or senior lecturers, 144 lecturers, 90 assistant lecturers and 69 part-time specialist staff (chiefly in the faculties of medicine) as well as 15 full-time staff in the extra-mural departments. The student/staff ratio varies considerably, from 8 at Hong-Kong to 28 at the University College of the Gold Coast; but the extent to which academic staffs of high qualifications have been recruited induces the Council to hope that it will invariably be possible to maintain a generous staff/student ratio, both because of the special teaching problems inherent in Colonial higher education and also because it is essential that the staff should have adequate time for research. It is also encouraging to note that the proportion of locally born staff is rising.

A feature of the latest report on Colonial research was the evidence of the close association in the Colonies between research and higher education, and during the year the Inter-University Council learned from the Colonial Research Council that the mutual advantages of such an association are fully recognized. The main volume of research at the Colonial university institutions, however, is the private work of the academic staff, and already this output from some five hundred specialists represents a substantial addition to the resources of science and scholarship. Its value should be enhanced by the Fulbright scheme already mentioned, for under that scheme American professors, research workers and students are enabled to work in Colonial institutions; during 1950–51 there were twelve such academic guests at the Universities of Malaya and Hong Kong and the University Colleges of the West Indies, Gold Coast, Ibadan, and Makere.

While progress in building schemes is extending the laboratory facilities which make the Colonial universities and colleges attractive as centres for research, and on the financial side these institutions are receiving generous local support from governments as well as from private organizations and individuals, appreciable progress is also reported in the libraries of all these institutions—in their holdings, administration, staffing and services. Again, particularly at the Colleges in the West Indies, the Gold Coast and Ibadan, extra-mural departments have been well developed, while all five university colleges are in a special relationship with the University of London to assist them to establish their standards and to devise the curricula and syllabuses for the degrees which they will award when strong enough to assume independent university status. Under this scheme, moreover, the University has made a separate arrangement with each of the colleges to meet the problem of entrance requirements and matriculation arising from the introduction by the Home Universities in 1951 of new minimum requirements for admission. The Council also welcomes the establishment in October 1949 of the Advisory Committee on Colonial Colleges of Arts, Science and Technology, and has held joint meetings with this advisory committee to discuss engineering education. Three such colleges have been established, in Nigeria, the Gold

Coast and Sierra Leone, and one of their most important functions will be to teach technical and commercial subjects up to professional level and to increase facilities for teacher training.

Technical education at the lower levels is, in fact, receiving increasing attention everywhere in the territories: in Uganda the main educational effort is towards schools of a less academic type; the junior technical schools in Malaya are filled to capacity, while a course in architecture has been added at the Technical College in Kuala Lumpur, and building for a new technical college is about to commence.

All these developments involve demands on the Colonial universities and university colleges and affect their work as well as the prospects for their students. But while the Inter-University Council has clearly been considering a wide range of problems as well as the factual developments recorded in this report, it scarcely touches on some fundamental issues concerning the position of university institutions in Colonial society. Satisfied that adequate academic standards of work have been attained and are likely to be maintained, the Council does indeed recognize that it is now becoming important to ensure that the most effective use is made of the services of students trained in such institutions, from the point of view of the students themselves and of their peoples. But it contents itself with expressing the hope that too high a proportion of the graduates will not be absorbed into government service, because of the importance of introducing some of this sure experience and trained ability into other sectors of society, such as journalism, commerce and industry.

The future of the Colonial universities does not depend solely on their ability to maintain high academic standards: it depends equally on their ability to provide the societies which they exist to serve with trained men and women who can meet the needs of these societies and fit happily into their way of life. If there is no place in such societies for the men and women coming from the new university institutions, no opportunity for the utilization of their technical or professional ability, and no adequate or satisfying cultural life, those institutions will themselves ultimately decay. The absorption of trained man- and woman-power into the Colonial life of to-day involves difficult and interesting problems, and the Inter-University Council could appropriately have used its annual report to discuss one or two such topics, particularly those bearing on the relationship between university education and secondary or primary education.

CURRENT TRENDS IN SOCIAL PSYCHOLOGY

At the recent Edinburgh meeting of the British Association, Section J (Psychology) devoted each of its five mornings to current trends in psychology, and in one session, "Current Trends in Social Psychology", four papers were presented which had many interlocking features. The first, by Dr. H. J. Eysenck, described researches into social attitudes. He held that popular newspaper polls of public opinion, the Gallup and similar polls, though interesting, are of little scientific value. Newspaper polls ask broad, general questions, and do not take sufficient account of the political affiliations of people questioned. Investigation into attitudes towards different issues of present-day importance show a great tendency for certain attitudes to cluster together in a manner characteristic of Radicals and Conservatives.

Dr. Eysenck propounded a distinction between what he calls "tough-minded" and "tender-minded" persons. (It is perhaps unfortunate that this distinction, well known in psychology since the late Prof. William James first used these terms, has been accepted by psychologists as meaning something different, but not entirely different, from Dr. Eysenck's new use of the term.) He contrasted the moral approach of the tender-minded, who are idealistic, ethical, religious and to whom the individual is sacrosanct, and the tough-minded, who believe in the inferiority of coloured people, Jews and women, and in the 'inevitability' of war. The working-class person, he said, is on the average very much more tough-minded and conservative than the average middle-class person. He described recent investigations into the organization of attitudes, their relation to political-party membership, age, sex, education, social class, and personality, and also into the effect upon the structure of attitudes of differences in culture-pattern.

The second paper, on "Personality Tests as Research Tools", by Dr. Hilde T. Himmelweit, considered 'objective' tests that require the subject to perform some task under standard conditions, the response to which can be objectively measured. Examples of these tests are of motor co-ordination, speed and accuracy of response, suggestibility, persistence, levels of aspiration and expressive movement. Though the behaviour involved in these may throw light on deeper mental levels, such tests do not tap these levels as specifically as projection tests do, and yet the results of objective tests are unaffected by the psychologist's subjective interpretation of the responses.

The use of batteries of objective tests makes possible the investigation of entirely new problems. One concerns the relationship between normal, neurotic and psychotic states. Kretschmer has maintained that these conditions differ from each other only quantitatively, not qualitatively, and can be viewed as lying along the same continuum with schizophrenia and manic-depressive psychosis. Eysenck, using a wide range of objective personality tests, has found that, on most tests, the patterning or inter-correlations of the test result was sufficiently similar in the normal and psychotic groups to support strongly Kretschmer's hypothesis. Objective tests are also useful in studying the effect upon the personality of leucotomy. Asenath Petrie has given tests to patients before and at stated intervals after this operation. The results enabled her to describe the characteristics of the post-leucotomy personality.

Objective tests will be used in a research, being carried out at the London School of Economics, into the differences in attitude to personality characteristics of young adolescents from different social classes. They will test the hypothesis proposed by Davis, of Chicago, that middle-class parents cherish higher aspirations for their children than working-class parents, that the child tends to introject the parents' demands and to react by having higher aspirations and being anxious regarding their attainment. It is proposed to find the extent to which middle-class children, compared with children from other classes, give significantly higher scores on tests of 'level of aspiration' and of anxiety.

The next speaker, Dr. A. T. M. Wilson, discussed "Social Changes in Structured Groups", a group being termed structured when it contains a manifest system of inter-related roles. The study of social processes in real (that is, not artificially created) situations, in terms of the psychological and social forces concerned, raises problems connected with the possibility of obtaining access to the group for the purpose of direct observation. There may be resistance or reluctance to proposals that the social investigator should be admitted to a 'reality situation', and this raises questions concerning the role of a participant observer in a community particularly susceptible to social change. If in a structured group need is felt for help in bringing about desired change, this need will provide one set of circumstances facilitating access by the investigator. A research worker, responding to a request for technical collaboration, in tackling a group problem, may assume a role the existence and independence of which are derived from its responsible professional character. The use of such roles may facilitate social change, since insight, derived from observations equally available to the group concerned and to the research worker, can be mutually communicated. The scope and limitations of such an approach were illustrated in detail from the work of one industrial organization which employs it.

Prof. T. H. Pear discussed "The Social Psychology of Everyday Life". This paper's title, borrowed with grateful acknowledgment, is that of a well-known article by Prof. Hadley Cantril, of Princeton University[1]. Written seventeen years ago, it urged that really important events in the lives of ordinary people had seldom been studied by psychologists.

To-day, one can report a considerable increase in the social significance of the subjects studied. The development of techniques for investigating attitudes and public opinion and for interviewing (for example, in vocational guidance, medicine and anthropology), the study of likenesses and differences in national characteristics and the effect of social factors upon test performances, the intensive study of patterns of culture and tensions between communities[2], all these events and more testify to a considerable change in the climate of opinion. The ordinary man in his social setting here and now is gradually if slowly becoming an object of scientific interest.

There are still important subjects which have received relatively little attention from social psychologists. Of these the most obvious are peace and war, since to-day almost all problems of planning are affected by the possibility of another war. Another neglected subject in Britain is social stratification. To the study of these subjects there certainly exist strong resistances; to discover and account for them is an interesting task for the social psychology of the future.

Prof. Pear's paper suggested that discovering the causes of this oversight is an interesting psychological project. Consider differences in classes, strata and *élites*. Much has been written about inferiority complexes[3], and our knowledge in this realm would be enriched by introspective accounts of how it feels to find oneself in such 'natural' situations of superiority or inferiority, and of the modifications of behaviour which one deliberately produces to adjust oneself. Partly conscious, partly unconscious factors may cause the widespread lack of interest among psychologists in problems of peace and war and of social stratification. It is time to realize frankly that in many people there are conscious reasons for not objecting to war. Unconscious reasons exist too; but they have had a good Press for the past three decades, and more research into the conscious reasons is needed. It is time for students of society to direct public attention less to the differences between peoples and much more to their resemblances, even if this decreases the 'novelty-rarity' value of their books and lectures.

During the meeting a demonstration was given of a film-gramophone technique, devised by Davide Boulting, C. E. M. Hansel and Prof. Pear, to investigate impressions of personality, vocation and social stratum from voice and facial appearance. While a voice spoke a prescribed passage designed to bring out geographical or social 'accents', pictured 'backgrounds', both physical and social, and faces were projected on the screen. In the experiments to be carried out, subjects will attempt to match these with the voices.

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[1] *Psychol. Bull.*, 297 (1934).

[2] cf. Klineberg, Otto, "Tensions Affecting International Understanding", Bull. 62, Social Science Research Council, New York, 17 (1950).

[3] cf. Brachfeld, Oliver, "Inferiority Feelings" (London: Routledge and Kegan Paul, 1951).

RECENT DEVELOPMENTS AND TECHNIQUES IN THE MAINTENANCE OF STANDARDS

A TWO-DAY symposium was held at the National Physical Laboratory during May 21 and 22 on "Recent Developments and Techniques in the Maintenance of Standards". Most of the standardizing laboratories of Europe, the Commonwealth and North America were represented, and delegates attended from many research organizations and industrial firms in Great Britain. Dr. E. C. Bullard, director of the Laboratory, in opening the symposium, remarked that it had every chance of being a successful occasion since there was no official business of any kind and no one need come to any conclusions. Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, was among the audience and added his welcome to Dr. Bullard's.

Dr. D. G. Sopwith, superintendent of the Engineering Division of the Laboratory, took the chair for the first session, on "Primary Load Standards". The first paper was presented by Mr. B. L. Wilson, head of the Engineering Mechanics Section of the National Bureau of Standards, Washington. He gave a very interesting summary of the various dead-weight machines belonging to the Bureau and the types of devices calibrated in them. Dr. F. Aughtie (National Physical Laboratory) followed this with a paper on "The Primary Load Standard" in which he described the 50-ton dead-weight standard at the National Physical Laboratory and spoke of the adjustment of it to 'standard' gravity (980·665 cm./sec.), which was about to be undertaken. He described also the Laboratory's 5-ton standard for the calibration of small proving rings, and experiments with resistance-strain gauges on compression elements for loads greater than 50 tons.

The second session was concerned with "The Standard of Length", and Mr. F. H. Rolt, superintendent of the Metrology Division, National Physical Laboratory, was chairman. The first paper, "The Present State of a Lightwave Standard of Length", by Dr. E. Engelhard (Physikalisch-Technische Bundesanstalt, Brunswick), was presented for him by Mr. H. Barrell (National Physical Laboratory) in the form of a summary. It was pointed out that for more than twenty years, industrial end-gauges have been calibrated by reference to wave-lengths of light, and at the same time investigations have continued to find the best light sources. The pure mercury isotope ${}^{198}_{80}$Hg and the krypton isotopes ${}^{84}_{36}$Kr and ${}^{86}_{36}$Kr are now available for the excitation of an optical wave-length standard of great accuracy.

The method developed by Kösters at the Physikalisch-Technische Reichsanstalt (now the Physikalisch-Technische Bundesanstalt) for comparing wave-lengths of light with the metre has some interesting features, first in the use of a new type of beam divider, the 'interference double prism', secondly in the direct absolute interferometric measurement of an industrial 500-mm. end-gauge by means of Fizeau's fringes and the subsequent direct comparison of the end-gauge with an *Endstrichmeter* (a line metre which is also an end-gauge), and thirdly in the elimination of the refraction of air by means of a vacuum chamber.

The question whether a light-wave standard ought to be defined by wave-length in air or *in vacuo* was discussed. Kosters's method of eliminating the refraction of air removes the objection to a vacuum wave-length standard that in practice all measurements (for example, of block gauges) would be made in air.

The relative advantages of the mercury isotope and the krypton isotopes as sources of light were discussed, and the use of the krypton lamps at the temperature of freezing nitrogen was described. Experiments using xenon instead of krypton have so far not met with success. Various manifestations of line broadening and line displacement were discussed, and the essential conditions were specified for eliminating self-reversal and asymmetry of lines, which would lead to errors in the use of a light-wave standard.

It is not possible at present to realize an ideal light-wave standard. Lines emitted by an atomic beam would be ideal theoretically, but the intensity is too low. The question now is whether a mercury or a krypton isotope should be used to define the new standard of length.

Mr. Barrell then read his own paper, "The Interferometry of Length", in which he began by summarizing the history of the spectroscopic reference standard, the red line of cadmium, with the events leading to the present use of the mercury isotope ${}^{198}_{80}$Hg and the krypton isotopes ${}^{84}_{36}$Kr and ${}^{86}_{36}$Kr. He reviewed the progress of the investigations to select a wave-length to serve as the ultimate standard of length.

For the mercury isotopes, a simple form of electrodeless discharge lamp, free from certain broadening effects, has been designed at the National Bureau of Standards, Washington, by Meggers and Westfall. A series of well-distributed wave-length standards reproducible to ± 0·0001 A. has been provided from the isotope ${}^{198}_{80}$Hg; these standards have recently been used at the National Physical Laboratory for testing the accuracy of a new dispersion equation for air, valid over the range 2500–6500 A.

In Great Britain, various types of mercury-198 discharge lamps are now being produced commercially by the General Electric Company, Ltd. At present, the electrodeless lamp with 3 mm. argon is the best source of mercury-198 standards, but it has been established at the National Physical Laboratory that the argon produces slight asymmetrical broadening of the mercury-198 lines, the consequent red shift in the visible spectrum amounting to 0·0001 A. (−0·0003 cm.$^{-1}$) per mm. of argon. The amount of argon in the lamps must therefore be controlled with 0·5 mm. mercury pressure to ensure reproducibility of wave-length within 1 part in 10^8.

The direct measurement of length by interferometry is now generally applied whenever the utmost precision and reliability are required. A specially designed form of Fizeau interferometer at the National Physical Laboratory will accept for measurement at one time up to twenty block gauges of size 2·5 cm. or less.

At the National Physical Laboratory, experiments in the measurement of distances of several metres are being made with electromagnetic waves of radio-frequency, using an interferometer of a modified Michelson form; a stabilized klystron source generates microwaves of frequency 24,000 Mc./s. (= 1·25 cm.). The velocity of radio waves may be determined by reversing the process employed.

In answer to a question as to whether the refractive index of air was known to the accuracy demanded for interferometric work, Mr. Barrell said that wave-length measurements made in air can now be reduced to the vacuum condition (or vice versa) with a reliability of 3 parts in 10^8.

For the afternoon session, on "Standards of Radioactive Isotopes", Dr. B. W. Robinson, superintendent of the Physics Division, National Physical Laboratory, took the chair, and Mr. R. C. Hawkings (Atomic Energy Project, National Research Council of Canada, Chalk River, Ontario) read the first paper, prepared by himself, W. F. Merritt and J. H. Craven, on "The Maintenance of Radioactive Standards with a 4π Proportional Counter".

There is a need for instruments by which the absolute rates of disintegration of atoms can be directly measured, and there are many advantages in a particle counter having a solid angle of 4 steradians with the source. The workers at Chalk River have constructed a spherical 4π counter, which Mr. Hawkings described in detail. Each of the two sections consists of a hemispherical brass cathode having an anode connexion passing through a plastic insulator in the apex. The operation of the counter was described, with the type of amplifier made necessary by the wide distribution of pulse heights originating in it. The type of plateau obtained and the linearity up to 3×10^4 counts per second are very satisfactory.

The efficiency of the 4π counter is reduced to some extent by absorption losses in the source mount and self-absorption of the source itself. The losses in the mount, however, can be minimized by using the thinnest possible film; the correction is determined by placing an identical film over the source and then applying the reduction in count as a correction to the original count. Film-absorption correction factors for some commonly used nuclides were listed. The elimination of self-absorption losses was also discussed.

The relative regions of maximum efficiency using various counter gases were discussed, and the stability and reproducibility of the counter. The limiting factor in attempts to increase accuracy now seems to be the technique of preparation of the source. Results obtained with the counter were compared with those derived from other methods, for example, defined solid angle and coincidence, for various nuclides.

The counter described, while sturdy and easily and quickly decontaminated and reassembled, is nevertheless a precision instrument which, when used in conjunction with the coincidence method of counting, has already proved invaluable in Canada and the United States.

The second paper of this session, by Mr. W. E. Perry (National Physical Laboratory), dealt with "Standardization of Radioactive Isotopes by Coincidence and γ-Ray Ionization Methods". Pure specimens of artificial radioactive isotopes in weighable quantities are not available; hence it has not been possible to prepare gravimetric standards as with radium. Standardization therefore requires activity measurements. At the National Physical Laboratory three methods have been used: β-particle counting by the small defined solid-angle method, the (β–γ) coincidence method and the γ-ray ionization method. Mr. Perry's paper was concerned with the last two.

In the (β–γ) coincidence method, the elementary formula for the disintegration-rate was derived, and the modifications to it to allow for various types of unwanted coincidences were discussed. The method requires two separate counting measurements and the measurement of the resolving time of the coincidence circuit, and the techniques of these were described. In particular, the introduction of an absorption screen, used to separate β- from γ-counts, is open to argument.

Results of the measurements of six cobalt-60 sources were given, in which the accumulated total error is thought to be at least ± 2 per cent.

The γ-ray ionization method was also briefly described. This is based on the relationship between ionization and the γ-ray energy: a value may be derived for the ionization produced by γ-rays from a given quantity of a radioactive isotope if certain fundamental constants can be assumed. Results were given of comparative measurements using both the coincidence method and the ionization method; the uncertainty in the ionization values is believed to be about ± 4 per cent and the differences between the ionization and coincidence values do not exceed this. Activity values for isotopes reported by various institutions in Great Britain reveal differences of the same size, and investigation must continue so that reliable standards may be provided and maintained.

After the two papers, Prof. J. Rotblat (St. Bartholomew's Hospital Medical College, London) opened a lively discussion on the method described by Mr. Hawkings of evaluating the correction for absorption in the source mount and on the effects of backscatter on the correction. There was some discussion also on the relative accuracy of the various counting methods; Mr. Hawkings considered that a great drawback of the coincidence method is the complexity of the electronic apparatus, which permits errors to arise.

Dr. Robinson was also in the chair for the first session on the following morning, when the subject was "Temperature". Dr. H. van Dijk (Kamerlingh Onnes Laboratory, University of Leyden) read a paper on "The Extension of the International Temperature Scale below the Oxygen Point", in which he summarized and discussed the most recent measurements of the thermodynamic temperature of the boiling point of hydrogen and helium, with the possibilities for interpolation between these fixed points and for extension of the scale below 4·2° K.

This was followed by a paper by Mr. C. R. Barber (National Physical Laboratory) on "Improvements in the Realization of the International Temperature Scale over the range –182·97° C. to 630·5° C.", an account of work in progress at the National Physical Laboratory. A platinum resistance thermometer and Smith bridge of new design were described; the noteworthy feature of the bridge is the form of the coils, which are specially wound to give freedom from mechanical strain. An account was also given of apparatus of new design for realizing the steam and sulphur points.

Dr. L. A. Sayce, superintendent of the Light Division, National Physical Laboratory, was chairman for the next session, which dealt with "The Standard of Luminance", and Dr. J. W. T. Walsh (National Physical Laboratory) presented the first paper, on "The Establishment of the Photometric Scale at the National Physical Laboratory", in which he described the primary standard of light, the preparation of sub-standards and working standards and the accuracy which can be assigned to the results of measurements made at the Laboratory on lamps submitted for standardization. M. J. Terrien (Bureau International des Poids et Mesures, Sèvres) then read a paper on "Co-ordination of the Photometric Units at the B.I.P.M.", in which he described the arrangements made for comparing the photometric units of the standardizing laboratories of France, Great Britain, United States, U.S.S.R., Germany and Japan, and the equipment of the photometric laboratory at Sèvres. It is estimated that the precision with which the B.I.P.M. comparisons indicates the value of the photometric standards throughout the world is, on an average, three or four parts in a thousand; an important source of error is variation in the lamps during transport.

For the final session, on "Standards of Frequency", the chair was taken by Mr. R. S. J. Spilsbury, superintendent of the Electricity Division, National Physical Laboratory. Dr. Erik Bergstrand (Kartverket, Stockholm) read a paper on "The Precision of Optical Methods for the Determination of the Velocity of Light", in which he made a critical survey of the methods and results of the main optical experiments and described in detail his own method in 1950 using a Kerr cell. He believes that the new value first obtained at the National Physical Laboratory by the cavity resonator method is not incompatible with the earlier results when these are given more realistic limits of error; the reason for earlier workers' almost universal arrival at lower values is perhaps that they were unconsciously influenced by the results of the elaborate experiments in 1931 and 1932 with the mile-long evacuated pipe. Dr. L. Essen (National Physical Laboratory) then described, in a paper on "The Measurement of Time, Frequency and Velocity", the recent improvements in the technique of frequency measurement, particularly at microwave frequencies. The measurement of velocity was one application of these techniques and another was likely to be the development of an atomic frequency standard. In the discussion which followed, Mr. J. H. Briggs (Telecommunications Research Establishment), Mr. H. M. Smith (Royal Observatory) and Mr. H. B. Law (Post Office Research Station) all supported the need for an atomic clock, but Dr. L. Hartshorn (National Physical Laboratory) raised the question why we believe that atomic standards will be more nearly constant than other material standards. The question can only be answered by the agreement between different experiments and, as Dr. Bullard pointed out, agreement does not always indicate that the answer is correct.

The full proceedings of the symposium are to be published by H.M. Stationery Office in the course of the next few months. M. M. POSTGATE

OLD MOUNTAINS OF NEW GUINEA*

By L. EVELYN CHEESMAN

FOR all taxonomists interested in the west Pacific the fact that New Guinea possesses series of pre-Cambrian rock that have never been submerged has significance which cannot be over-stressed. Their existence indicates a solution of what otherwise would be inexplicable, namely, whence New Guinea derived its Oriental insect fauna and flora.

The huge island was raised from a drowned land-mass by the Miocene–Pliocene tectonic movements. So much is well known; but this furnishes no working hypothesis for botanists or for entomologists. The deductions which appear self-evident actually conflict with biological data; and, owing to their antiquity, it is to the insects and plants that we must turn for convincing evidence of land movements.

Land raised from the ocean bed during the Tertiary, its only subsequent continental connexion being periodically with Queensland and by sundry land bridges to Asia through the Philippines, might be expected to possess a flora and fauna basically Australian with an Oriental influence. Moreover, they should be discontinuous with many lacunæ in their totality. On the contrary, analyses of species belonging to any important group reveal an undoubted Oriental origin. There is an Australian element—more or less strong according to the group. There is a Malaysian influence attributable to a common Asiatic ancestry. There is a very rich peculiar neo-endemism suggesting isolation over a long period which makes Papuasia, that is, New Guinea with adjacent islands and archipelagoes, an extremely distinct zoological sub-region in geologically recent times. The flora and insect fauna are harmonious, their totalities show no serious lacunæ and no important group is unrepresented.

Papuasia therefore ranks with Australia and Asia in its continental full populations and not with neighbouring land-masses, Sumatra, Java and Borneo. These were also raised during the Tertiary, connected for a period with Asia and then isolated; but they possess a discontinuous flora and insect fauna.

Whence then did New Guinea receive its continental populations, since palæogeology apparently does not support the conclusions of botanists and entomologists?

We find on analysis of species that: (1) the average ratio of the older species groups is one-tenth Australian, three-tenths Asiatic, and six-tenths endemic; (2) the nearest genera allied to Papuasian endemic genera are found in Asia; (3) genera which are represented in both Malaysia and Papuasia are also found in India, Burma or China, often in all three countries. This points to a two-branched migration from the continent, which can be foreseen because there has been no land connexion between Malaysia and New Guinea subsequent to the Late Cretaceous. Otherwise the Sumatra tiger and monkeys and apes would have found their way to the New Guinea forests.

Before the War, Prof. Lam, of Leyden, was engaged on an analysis of the flora of Malaysia and Dutch New Guinea. He found that the proportionate representation was approximately the same as in the Insecta, and he agreed also with points (1), (2) and (3). Botanists have a decided advantage over entomologists in such matters because their material collected and determined is far more abundant. As in the Insecta there are no very old forms; the slight South American influence comes through Australia. There are many endemic genera but no endemic family.

The fact that there are two distinct geanticlines in New Guinea belonging to different periods sheds a most important light upon these questions of the distribution of species. The ancient geanticline was investigated by the Australian government geologist, R. C. Stanley, and his results were published in 1923. He directed attention to the existence of this ancient wrecked mountain system represented by relics, some of which have never been submerged, pre-Cambrian and Asiatic in origin. They are situated along the northern coast of New Guinea with the same alignment as the young Tertiary central ranges which are Malaysian in origin. It is concluded that as the folding movements raised the central ranges the greater part of this old northern system was submerged. The series comprises south-west New Britain, which is still subsiding and has never been submerged, Finisterre Mountains, Torricelli Range, Omake Massiv (Mount Bougainville), Cyclops Range which has never submerged, Japen Island, and Waigeu Island.

These form the margin of a drowned land which for my present purpose I have named Cyclopea. All these remnants are characterized by a strong tilting on their ocean side so that valley heads and gullies alone remain above the sea, and on their shoreward side there is a proportional elevation with much weathered cliffs of Cretaceous limestone containing Eocene Foraminifera. There has been land subsidence on a huge scale.

If we conceive this lost land-mass Cyclopea as having maintained connexion with Asia until the Early Pliocene, there we have ancient fully populated land from which the young land would be colonized as it rose from the ocean bed. This is acceptable to geologists and accords with the biological evidence. It is, in fact, the only working hypothesis satisfactory for taxonomists. The drift and overthrust of continents in that part of the globe does not directly concern biologists of New Guinea to-day, because Cretaceous New Guinea of yesterday, which with New Zealand formed the margin of Australia, was submerged, and the stupendous folding movements entirely altered all previous land formation.

Cyclopea has a different history; but whether palæogeologists decide that the land looped, festooned, arched, buckled, or streamed by New Guinea with the Solomon Islands in pursuit is immaterial to us. What we do insist is that they must postulate Cyclopea as a continuous land to Asia through the Moluccas and the Philippines prior to the Early Pliocene, otherwise any hypothesis will be rejected as untenable because of the testimony of botanists and entomologists.

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* Substance of a paper read before the Royal Entomological Society on August 15.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Pure *All-trans* Vitamin A Acetate and the Assessment of Vitamin A Potency by Spectrophotometry

The international unit of vitamin A activity corresponds with 0·3 μgm. of vitamin A alcohol or 0·345 μgm. of vitamin A acetate[1]. The International Standard Preparation is a solution of the *all-trans* acetate in cottonseed oil, and it serves a dual purpose as a biological and a spectrophotometric standard of reference. The properties of the acetate are therefore important.

The absorption spectra of many organic solutes vary to some extent in different solvents, even when there is no evidence of equilibria between isomeric forms. In the case of vitamin A such variations have been known to occur since 1935[2]; but they are second-order effects which have hitherto been largely ignored.

Advances in spectrophotometric technique, together with the advent of pure vitamin A and its esters, have made it possible to ascertain the solvent effects with considerable precision, and it is no longer appropriate to neglect them. Further, the spectrum of vitamin A alcohol (expressed in terms of molar extinction coefficient plotted against wave-length) is not necessarily identical with that shown by its esters in the same solvent. Granted that solvent effects occur, it is necessary to establish their magnitude in relation to the degree of accuracy which is both attainable and worth while. The present report is the result of work in five laboratories on synthetic samples (supplied by Dr. O. Isler of Hoffmann-La Roche, Basle). We are satisfied, however, that purified samples of *all-trans* vitamin A acetate obtained from natural products (and supplied by Dr. J. Matet of Alimentation Equilibree, Commentry) are identical with the synthetic acetate by chemical and physical tests[3,4].

Properties of *All-trans* Vitamin A
(Each figure is the mean of the results from the five laboratories)

Solvent	Alcohol $\lambda_{max.}$ (mμ)	 ($\epsilon_{max.}$)	Acetate $\lambda_{max.}$ (mμ)	 ($\epsilon_{max.}$)
*Iso*propanol	324–326	52,300*	324–326	50,280†
Ethanol	324–325	52,480*	325–326	51,180
*Cyclo*hexane	320–327	49,760†	327–328	50,000†
Light petroleum (40°–60°)	324–326	52,000*	324–326	52,200*

Analysis of variance of the forty individual results indicates that: (1) the coefficient of variation between laboratories is 1·3; (2) the residual coefficient of variation of the one determination is 1·1; (3) the four means marked * are not significantly different; (4) the three means marked † are not significantly different; and (5) the remaining mean (51,180) falls between the other two groups and cannot confidently be regarded as a normal sampling variant of either. The two coefficients of variation given in (1) and (2) are normal—perhaps, indeed, rather below (that is, better than) normal. With the possible exception of the *cyclo*hexane result, the given mean values are generally consistent with those in the literature. Most published figures, however, favour a 1–2 per cent lower value for vitamin A esters in *cyclo*hexane than in *iso*propanol.

It follows from the above, and from the definition[1] of the International Unit of vitamin A so as to give a potency of $3\cdot\dot{3} \times 10^6$ I.U./gm. to the *alcohol*, that the appropriate factors for conversion of values at $\lambda_{max.}$ to I.U. per gram are most likely to be those given below:

Conversion Factors

Solvent	Vitamin A alcohol	Vitamin A acetate
*Iso*propanol	1,825	1,906
Ethanol	1,825	1,850
*Cyclo*hexane	1,906	
Light petroleum (40°–60°)	1,825	

The value of 1,906 for vitamin A acetate in *iso*propanol corresponds to an E(1 per cent, 1 cm.) value of 1,525, identical with the figure accepted by the Expert Committee on Biological Standardization of the World Health Organization[1]; and that body recommended the rounded-off factor 1,900 for practical purposes.

Now, in practice, vitamin A is often estimated in the form of the alcohol (the U.S. Pharmacopœia assay[5] stipulates saponification of vitamin A-containing oils, and chromatographic methods may involve saponification) for which the factor 1,900 would seem to be about 4 per cent too high if the final solvent is *iso*propanol. *Cyclo*hexane, on the other hand, would take the 1,900 factor under all conditions. In light petroleum $\epsilon_{max.}$ is apparently identical with $\epsilon_{max.}$ in *iso*propanol for the alcoholic form of the vitamin. This has certain practical advantages.

It should be emphasized that use of the conversion factors here accorded would not cut across the recommendation of the World Health Organization Committee, because the primary definition of the International Unit of activity is a weight of the vitamin, and the conversion factor is derivative. The presence of some neo-vitamin A (an isomer) in natural products is an additional complication. This point has been discussed by several authors[4,6] and will not be considered here.

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H. R. Cama, F. D. Collins and R. A. Morton (University of Liverpool).

N. T. Gridgeman (Lever Bros. and Unilever, Ltd., Bedford).

O. Isler and M. Kofler (F. Hoffmann-La Roche and Co., Ltd., Basle).

R. J. Taylor (Lever Bros. and Unilever, Ltd., Port Sunlight).

A. S. Welland and T. Bradbury (Van den Berghs and Jurgens, Ltd., Purfleet).

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Simple Equipment to Estimate Radiocarbon

We have built a low-pressure argon-alcohol counting tube of very satisfactory performance for radioactive carbon dioxide (Fig. 1). The cathode is a brass cylinder of 16 mm. diameter, 0·5 mm. thickness and 80 mm. length. A wire is soldered to the cylinder and sealed into the glass with a thermosetting plastic ('Araldit', Ciba). The anode, tungsten wire of 60 μ, is kept taut by a steel spring, and again sealed in with 'Araldit'. 'Pyrex' is used.

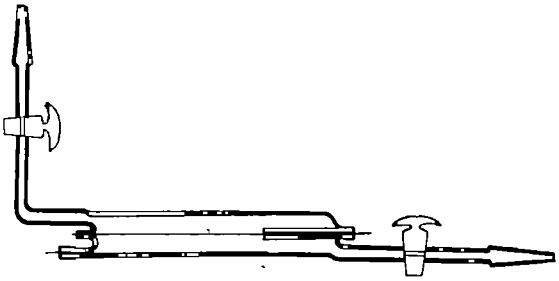

Fig. 1

The active carbon dioxide is generated in an all-glass vacuum line (Fig. 2) from barium carbonate and perchloric acid. The gas is dried by silica gel, and the carbon dioxide frozen out in a U-shaped capillary with liquid air. (No carbon dioxide is found to be held back by the silica gel.) After freezing the carbon dioxide, taps *A* and *B* are closed. Alcohol vapour is introduced into the filling line and the attached counting tube to a pressure of 15 mm. mercury. Now the liquid air is removed and tap *B* is opened again, until the desired pressure of carbon dioxide is attained. Finally, 3 cm. pressure argon is let in, and the counting tube is shut.

The length of the plateau is 250 volts with a gradient of 1–2 per cent/100 volts up to a carbon dioxide pressure of 5 cm. (Higher pressures could not be tested for want of a source of sufficiently high voltage; at carbon dioxide pressures of 1, 3, 5 cm. the plateau voltages were 1,150, 1,450, 1,800 volts.) The background of the counter, under 3 cm. of lead, is 28 min.$^{-1}$; it does not increase with time, that is, no radiocarbon is held back by the counter. Extreme differences in measured activities between repeated fillings, supposed to be identical, are 3 per cent. This reproducibility is at present limited only by the precision of the mercury manometer. The measured activity is strictly proportional to carbon dioxide pressure. The total time required to generate carbon dioxide and fill the counter is about two hours.

Loss of activity in air (through exchange) on heating barium carbonate, prepared as described below, for one hour, was found to be zero at 100°, 5 per cent at 300°, 11 per cent at 500°, and 15 per cent at 700° C. The rate of loss rapidly decreases with time: at 400° C., the losses after 1, 2, 4, 8 hr. were 8, 10, 11, 12 per cent respectively. In view of the fairly small losses at elevated temperatures, losses at room temperature are curiously high 7, 9·5, 16 per cent after 7, 10, 18 days. Apparently a different mechanism operates at low temperature. At 100 per cent relative humidity, the losses at room temperature even reach values as high as 9·5, 16, 17, 17·5 per cent after 2, 6, 9, 11 days. Marked loss (3 per cent) has also been observed, after one hour, on stirring freshly precipitated barium carbonate with water.

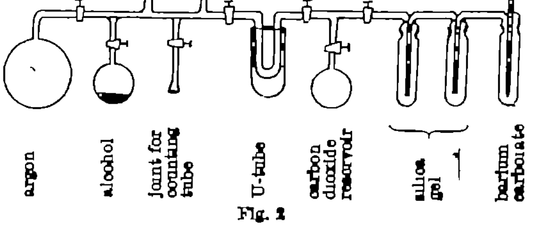

Fig. 2

It follows that no loss need be feared if samples are handled reasonably quickly in air; but kept in an atmosphere free from carbon dioxide for longer periods. In fact, no specific activity was lost at all in a cycle involving generation of carbon dioxide from barium carbonate, absorption in caustic potash, reprecipitation as barium carbonate—after addition of ammonium chloride to reduce alkalinity—with barium chloride, and drying in an oven in air at 140° C. for half an hour.

We thank Prof. K. Przibram and Prof. L. Ebert for their constant support, Dr. W. J. Arrol for the gift of radiocarbon, and our colleague Mr. H. Ebenberger for much friendly help.

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A New Radio Method for Measuring the Electron Density in the Solar Corona

Present estimates of the electron density in the solar corona are based on the measurements during an eclipse of the optical radiation which originates in the photosphere and is scattered in the corona[1]. These measurements and their interpretation present considerable difficulties, particularly when attempts are made to determine the electron density in the outermost layers of the corona[2,3]. In this communication a possible method of determining the electron density at different heights in the corona is suggested, which should allow the exploration of regions where the density is as low as 10^4 cm.$^{-3}$.

It can be shown that if the radiation from a remote source passes near a spherical transparent body in which the refractive index increases outwards, and the angular separation between the source and the centre of the sphere is less than a certain value, no radiation from the source can reach the observer. At larger separations, a deviation of its apparent position occurs. If, therefore, a radio star is situated in a direction near that of the sun, the radiation on certain frequencies may be 'occulted' even when the radio star is at a considerable angular distance from the visible limb. Using the existing data on coronal electron density, it can be shown that, for frequencies of 210, 81·5 and 38 Mc./s., the effective radii of the sun for occultation are of the order of $2 \cdot 9 R_{\odot}$, $3 \cdot 6 R_{\odot}$ and $4 \cdot 5 R_{\odot}$ respectively, where $R_{\odot}$ is the photospheric radius. A precise determination of the values of the radii for a number of frequencies would allow the distribution of electron density with height to be deduced.

In order to perform this experiment, it would be necessary to observe the radio star when its direction is very near that of the sun; the solar radiation is then likely to mask the much weaker radiation from the star. It is, however, possible to reduce the effect of solar radiation, without reducing that from the star, by using an aerial arrangement which is relatively insensitive to sources subtending a comparatively large angle. It has been shown[4,5] that if an interferometer aerial were used with an aperture of 100–200 wave-lengths, the response from the sun would be reduced by about 98 per cent, although the response from a radio star would not be reduced at all. The presence of intense radiation from sunspots cannot unfortunately be eliminated so simply, owing to the smaller angular diameter of the sources of radiation; very much greater resolving powers would therefore be necessary.

It was noted that the intense radio star 05·01 in Taurus (R.A. 05^h 31^m 34^s, decl. 22° 04′)[6] offered the possibility of carrying out this experiment, since with the existing aerial systems its intensity was sufficient to allow observations even in the presence of weak sunspots. A series of observations was carried out during June 1950 when the direction of the sun passed near the radio star (the minimum separation was about $4\ R_{\odot}$) and again in the corresponding period in 1951. During the latter observations, interferometers of aperture 205, 105 and 60 λ were used on frequencies of 210, 81·5 and 38 Mc./s. respectively.

Unfortunately, during both these experiments, sunspot radiation was abnormally intense, and no useful results were obtained. It is hoped to repeat the experiment in the future, when the sunspot activity is likely to decrease, possibly using aerials of greater resolving power. The co-ordinates of the radio star may then also be known with greater precision. The use of aerials of increased resolving power might also make it possible to use other less intense radio stars, and so increase the number of occasions on which the experiment could be carried out.

This work was carried out as part of a programme of radio research at the Cavendish Laboratory, supported by the Department of Scientific and Industrial Research, to which also one of us (K. E. M.) is indebted for a senior award. We are grateful to Mr. M. Ryle for suggesting the method.

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Structure of Amorphous Aluminium Oxide Films

ALUMINIUM generally is covered with an oxide layer which gives excellent protection against corrosion. Preston and Bircumshaw[1] and other workers, using the electron diffraction method, showed that the layers are not crystalline. Their electron diffraction photographs show two diffuse rings which have not yet been explained satisfactorily. In air and at temperatures below the transition into the crystalline phase, the oxide layer grows very slowly, and only up to about 100 A. in thickness. Consequently, as the layer is too thin for X-ray methods, electron diffraction techniques have to be used.

Diffuse electron diffraction rings can be interpreted in two different ways. Commonly they are explained by a size effect only. It is assumed that the material consists of normal crystals the grain size of which is exceedingly fine. Using this method, Belwe[2] evaluated the size of the individual crystals to be equal to about one elementary cell of γ-Al_2O_3. Belwe thinks that the diffuse rings found are due to the (220) and (440) reflexions, and the assumption is made that (220) and (440) are the strongest reflexions of Al_2O_3; other investigators, however, found (311) to be the strongest pattern.

The second possibility is to assume that the layer consists of totally disordered uniformly built molecular groups. It is then necessary to find, by trial and error, a molecular group such that the electron diffraction patterns which are calculated by the formula derived by Debye[3] and Ehrenfest[4] for the molecules of a gas:

$$I = \text{const.} \sum_i \sum_j \Phi_i \Phi_j \frac{\sin x}{x},$$

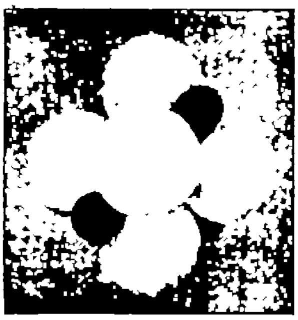
agree with the experiment. In that formula, I is the intensity, $\Phi = \dfrac{Z - F}{\sin^2 \theta/\lambda^2}$ is the atomic scattering factor for electrons, Z is the atomic number, F is the atomic scattering factor for X-rays, θ is the glancing angle, λ the wave-length and $x = 4\pi \,.\, l_{ij} \dfrac{\sin \theta}{\lambda}$, with l_{ij} the distance between the atoms i and j in the particle. Debye[3] further derived a correction for X-ray diffraction in gases and amorphous substances which takes account of the mutual distances between all the atomic groups. He found this correction to be appreciable in the case of a substance of bi-atomic molecules. That correction should be considered whenever the above method is used. The first investigations using this second method were carried out by König[5]. For amorphous germanium König found that its diffraction patterns show that it consists of tetrahedral particles, a result which has been confirmed recently by X-ray diffraction methods.

In the present investigation, I have investigated amorphous aluminium oxide (Al_2O_3) by the same method. The oxide films were grown in air (400° C., 75 hr.). They were lifted free by a dilute mercuric chloride solution, washed and placed on specimen carriers with holes of 0·08 mm. diameter. The films were investigated with 40–60 kV. electrons in transmission. The photographs obtained were measured with a photometer, and the corresponding intensity curves were plotted. The maxima lay at $\sin \theta/\lambda = 0{\cdot}17$ and at $0{\cdot}36$.

After a number of unsuccessful attempts to find the atomic arrangements of the groups, a particle consisting of two Al_2O_3 molecules was found to give a good result (see photograph). This particle is an octahedron of six closely packed oxygen ions with four aluminium ions in a tetrahedral arrangement. The ionic distances involved correspond to those of the γ-Al_2O_3 lattice. They are:

O – O = 2·80 A.
O – O = 3·95 A.
O – Al = 1·73 A.
O – Al = 3·28 A.
Al – Al = 2·80 A.

The Debye correction[3] for the present case is negligible; but the intensity due to the inelastic



Model of the particle found, consisting of two Al_2O_3 molecules

scattering was taken into consideration, for which purpose the table of Bewilogua[7] was used. It should be stressed that the exact atomic arrangement of the particle found does not occur in the γ-Al_2O_3 lattice.

A detailed account of the present investigation and a discussion of the mechanism of the oxidation process will be published shortly. The present communication is published by permission of the South African Council for Scientific and Industrial Research.

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Estimation of the Approximate Ionization Constants of Inorganic Bases

Most of the common acidic compounds can be classed as derivatives of the hydrides:

$$H_3O^+ \rightarrow H_2O + H^+ \quad \Delta G^\circ = -\ 1 \text{ kgm.cal.}$$

$$H_4N^+ \rightarrow H_3N + H^+ \quad \Delta G^\circ = +\ 13 \text{ kgm.cal.}$$

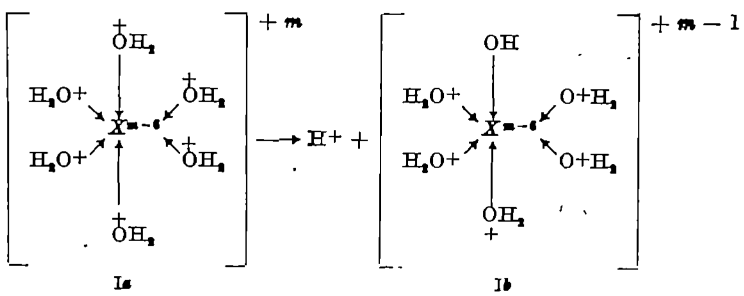
$$H_2O \rightarrow HO^- + H^+ \quad \Delta G^\circ = +\ 20 \text{ kgm.cal.}$$

Within any of these classes, large differences in the free energies of ionization ($\Delta G^\circ = -RT \log_e K$ for the reaction $BH \rightarrow B^- + H^+$ in dilute aqueous solution at 25° C.) can usually be attributed[1,2] to the presence of charges in the near neighbourhood of the dissociating proton. Each charge on the atom next to the one bearing the dissociating proton will decrease the value of ΔG° by about 14 kgm.cal. if positive and will increase ΔG° by about 14 kgm.cal. if negative. The effect of a charge upon ΔG° is reduced when it is situated farther from the dissociating proton and $\pm 14Q/2^n$ kgm.cal. has to be added to ΔG° to account for the effect of a charge, where n is the number of atoms between the atom bearing the charge and the dissociating proton[2,3].

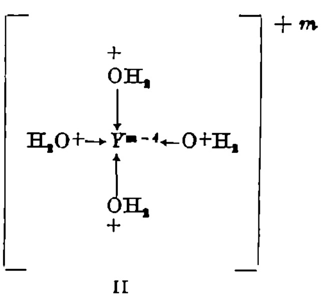
The ions of many inorganic bases are hydrated and may be regarded as acids[1,4]. For example, in aqueous solutions, and in many crystals as well, simple chromic salts contain the hydrated ion[5] $[Cr(H_2O)_6]^{3+}$. Brönsted and Volquartz[4] have shown that this ion is a moderately strong acid and they give a value of $\Delta G^\circ = 5 \cdot 1$ (at 15° C.) for its ionization. This chromic ion (Ia, X = Cr, m = 3) is a derivative of H_3O^+. There are three negative charges on the chromium atom, to which are attached five positive oxygen atoms besides the oxygen atom bearing the dissociating proton. When allowance is made for these charges, a value of $\Delta G^\circ = -1 + (3 \times 14) - (5 \times 7) = 6$ is obtained. A correction should be made to this calculated figure for symmetry factors, since there are twelve equivalent protons in the acid (Ia) and only one basic position in the base (Ib); $RT \log_e 12/1 = 1 \cdot 5$ should be subtracted from the figure calculated above, bringing ΔG° to 4·5 kgm.cal., which is close to the observed value. It would be expected that any hydrated trivalent ion of formula (I) would have a ΔG° value in the neighbourhood of this calculated figure. Brönsted and Volquartz[4] measured the ionization constants of the trivalent ions of iron and aluminium, and their experimental figures give ΔG° equal to 2·9 and 6·5 respectively. In more recent determinations, ΔG° values for the ferric ion (4·0[6]; 3·5[7] and 3·2[8]) closer to the calculated figure have been obtained.

These values approximate to the calculated value, and it should be borne in mind that it is difficult to ensure that the experimental ΔG° value is a true measure of the free energy of ionization of one hydrated ion. The degree of hydration of the ion may change on ionization. Some metallic complexes condense to form ions containing more than one atom of the metal, while the measurements have to be carried out in the presence of several species of ions, and many ions, for example, chloride and sulphate, readily form complexes with certain metals. Brönsted and Volquartz[4] also measured the ionization constants of cobaltic ions in which some of the co-ordinated water was replaced by ammonia. The ammonium ion is so much less acidic than the H_3O^+ ion that only the hydrogen attached to the co-ordinated water molecules need be considered as dissociating. The calculated and observed values of ΔG° are as follows:

Ion	ΔG° kgm.cal. Found	Calculated
$[Co.4H_2O.2NH_3]^{3+}$	4·5	4·8
$[Co.3H_2O.3NH_3]^{3+}$	6·2	5·0
$[Co.2H_2O.4NH_3]^{3+}$	6·9	5·2
$[Co.\ H_2O.5NH_3]^{3+}$	7·5	5·6



Ia Ib



II

The substitution of a divalent atom ($m = 2$) for a trivalent atom ($m = 3$) in (I) will increase ΔG° by 14–18·5 kgm.cal., in good agreement with ΔG° values of 17·3 and 18·2 found for the ionization of the hydrated calcium ion and barium ion respectively. These ΔG° values are calculated from the second basic dissociation constant of calcium hydroxide[9,10] and of barium hydroxide[10,11], which seem to be known with fair accuracy because recent determinations by different methods have given results in excellent agreement. The second basic dissociation constant for magnesium hydroxide gives ΔG° equal to 15·5 for the ionization of the hydrated magnesium ion[12], which is decidedly lower than the value of 18·5 just calculated for the hexahydrate (I, X = Mg, $m = 2$). In these calculations of ΔG° no allowance has been made for steric effects or for differences in the electronegativities of the atoms in the complexes. Some increase in the acidity of the magnesium ion might be due to steric effects in the hexahydrate of this small ion and to the fact that magnesium is more electronegative than calcium and barium[13].

All the ions mentioned above have been taken to be hexahydrates, as would be expected[14]. When the degree of hydration of a metallic ion is known, a rough estimate can now be made of its ΔG° value for ionization. Thus any monovalent ion X (I, $m = 1$) would be expected to give a value not very far from 32·5 kgm.cal. Alternatively, if ΔG° has been determined, it may be possible to suggest the degree of hydration. Thus, for the ion (II) with m equal to 1, the calculation of ΔG° gives $-1 + (3 \times 14) - (3 \times 7) - 1{\cdot}2 = 18{\cdot}8$, which is close to the value of 18·5 recently obtained[10] for the thallous ion.

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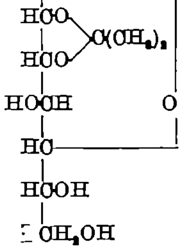
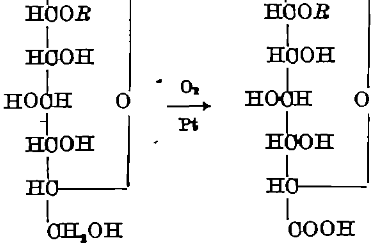
Catalytic Oxidation of Glucosides to Glucuronides

STUDIES of the structure and metabolism of the conjugated glucuronides formed from alcohols and phenols in the animal body have been hindered by the lack of a convenient method for the synthesis of these compounds. Controlled oxidation of the corresponding glucoside would appear to hold most promise as a method of glucuronide synthesis. This oxidation has been carried out with α-menthol and α- and β-methyl glucosides[1–4]. The reagents so far employed (bromine, hydrogen peroxide and nitrogen tetroxide) have, however, given very poor yields of the glucuronides.

Fernandez-Garcia *et al.*[5] have recently found that 1,2-*iso*propylidene glucose (I) is smoothly converted to the corresponding derivative of glucuronic acid when oxygen is passed through the solution in the presence of a platinum catalyst. Comparison of (I) with the general formula for an α-glucoside (II) suggested that this procedure might be employed to oxidize the latter to the α-glucuronide (III). As described below, *l*-menthol α-D-glucuronide (III, R = menthol) was obtained in good yield by catalytic oxidation of the glucoside (II, R = menthol), and the technique was found to be equally applicable to the preparation of *l*-menthol β-D-glucuronide. The possibility of preparing galacturonides and mannuronides by this method is at present under investigation.



(I)



(II) (III)

l-Menthol α-D-glucuronide. 500 mgm. *l*-menthol α-D-glucoside and 100 mgm. platinum black were suspended in 80 ml. water and maintained at 65°. Oxygen was passed through the liquid, which was stirred and kept neutral to litmus by addition of dilute sodium bicarbonate solution. After 10 hr., one equivalent of alkali was consumed and no further change in pH occurred. All the glucoside had gone into solution at this stage. The catalyst was removed by filtration and the solution evaporated to a small volume. On acidifying to congo red with hydrochloric acid, the crude glucuronide, melting point 135–36°, separated in 31 per cent yield. Recrystallization from a mixture of ethyl acetate and petrol ether, boiling point 100–20°, gave a pure product which was identical with an authentic specimen prepared by the method of Bergmann and Wolff[1] (see table).

	Product from catalytic oxidation	Reference compound	Mixture
l-Menthol α-D-Glucuronide (hydrated)	m.p. 141–42° $[\alpha]^{21^\circ}_D = +45{\cdot}6^\circ$	m.p. 137–38° $[\alpha]^{21^\circ}_D = +45{\cdot}9^\circ$	m.p. 141°
l-Menthol β-D-Glucuronide (hydrated)	m.p. 75–77° $[\alpha]^{21^\circ}_D = -99{\cdot}3^\circ$	m.p. 79–80° $[\alpha]^{21^\circ}_D = -101{\cdot}7^\circ$	m.p. 78–80°

Melting points are uncorrected.

l-Menthol β-D-glucuronide. 100 mgm. platinum black was added to a solution of 500 mgm. *l*-menthol β-D-glucoside monohydrate in 50 ml. water and the oxidation was carried out as described above. The reaction was complete in 4 hr. After removing the catalyst, the glucuronide was precipitated as the ammonium salt and then converted to the free acid[6]. One recrystallization from water gave the impure glucuronide, melting point 65–75°, in 34 per cent yield. A further recrystallization gave the pure glucuronide, which proved to be identical with a specimen of biosynthetic *l*-menthol glucuronide[6] (see table).

I wish to express my gratitude to Dr. G. A. Levvy for encouragement and advice in this work.

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---

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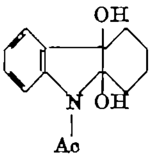
Perhydroxylation of Indole Derivatives by Osmium Tetroxide

The very various transformations undergone by 9-acetyl-10 : 11-dihydroxyhexahydrocarbazole (I) have recently aroused some interest[1]. The related compound (II) does not undergo Wagner–Meerwein rearrangements like those given by (I)[2]. Witkop[1a] has satisfactorily explained this failure by pointing out that such rearrangement of (II) would involve the formation of a four-membered ring compound. While this suggestion is convincing, it seemed worth while to confirm that the diols (I) and (II) possess similar configurations, for the Wagner–Meerwein change is markedly affected by the *cis*- or *trans*-configuration of the compound involved, only the *cis*-diols becoming readily rearranged[3]. Further, (I) and (II) have hitherto been prepared by rather different methods.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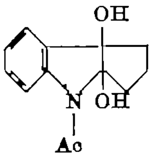
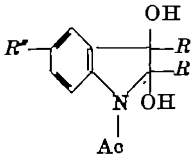

II


III

Most of the small number of known diols of type (III) have been obtained by Perkin, Plant and their associates[4], by the action of nitric acid in acetic acid upon the acylated indoles. We have now prepared such compounds by treating various N-acetylindoles with osmium tetroxide and pyridine in benzene solution, and afterwards hydrolysing the highly crystalline, fawn-coloured esters which were formed. Thus, N-acetyltetrahydrocarbazole gave (I) (found: C, 68·3; H, 7·1; calc. for $C_{14}H_{17}O_3N$: C, 68·0; H, 6·9 per cent), melting point 203–204° alone and mixed with an authentic specimen; and (II) (found: C, 66·7; H, 6·6; calc. for $C_{13}H_{15}O_3N$: C, 66·9; H, 6·5 per cent), melting point 149–151°, identical with the preparation of Plant and Tomlinson[2], was obtained similarly.

Other examples, obtained from the appropriate indoles, which might be mentioned, are (III; $R = R' =$ Ph; $R'' =$ H), melting point 206–208° (found: C, 76·8; H, 5·6; $C_{22}H_{19}O_3N$ requires C, 76·5; H, 5·5 per cent), and (III; $R = R' = R'' =$ Me), melting point 102–108° (found: C, 66·3; H, 7·4; $C_{13}H_{17}O_3N$ requires C, 66·3; H, 7·3 per cent). Likewise, N-acetyl-2 : 3-dimethylindole gave a product of melting point 130–133° (Plant and Whitaker[5] give melting point 132–134° for (III; $R = R' =$ Me; $R'' =$ H)).

The method of preparation of these compounds proves conclusively that they possess the *cis*-configuration[6].

A more detailed and extended description of these and other experiments in perhydroxylation of indoles will be given later. We are greatly indebted to Dr. Plant and Dr. Tomlinson, who kindly provided specimens of their preparations of (I) and (II).

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Estimation of Deoxycorticosterone by a Modified Hagedorn–Jensen Procedure

Heard, Sobel and Venning[1] demonstrated that estimation of the reducing powers of lipid-soluble extracts prepared from urine provides a measure of the corticosteroid content of such extracts. The value of the method depends upon the presence of characteristic reducing groups in the corticosteroid molecules, making it possible to utilize oxidation reactions similar to those used in the estimation of sugars. Various methods based on this principle have been reviewed by Sprechler[2].

It is of interest in this connexion to report some experimental findings on a convenient and rapid procedure which we have recently developed for the estimation of pure deoxycorticosterone and its acetate in aqueous methyl alcohol solution, based on a modification of the Hagedorn–Jensen blood sugar method[3]. This modification was made possible by employing the reaction which takes place when ammonium molybdate solution is added to potassium ferrocyanide solution in presence of strong acetic acid. The intensity of the brown coloration produced is a direct measure of the amount of ferrocyanide present and may be estimated by a colorimetric or absorptiometric method, thereby avoiding the necessity for the thiosulphate titration.

The standard procedure adopted was as follows: 1 ml. of 50 per cent aqueous methyl alcohol containing deoxycorticosterone or its acetate was measured into a tube, treated with 2 ml. of the Hagedorn–Jensen[3] alkaline ferricyanide reagent, and the tube immersed in a boiling water-bath for 3 min. A blank estimation on 1 ml. of 50 per cent aqueous methyl alcohol was carried out simultaneously. After heating, the tubes were rapidly cooled and the contents made up to 6 ml. with distilled water. 1 ml. of 10 per cent ammonium molybdate solution was added, followed by 5 ml. glacial acetic acid, and, after mixing, the colours (which are stable up to at least 1 hr.) were read on a Spekker photoelectric absorptiometer, using Ilford violet filters.

Representative results showing the effects produced by standard quantities of deoxycorticosterone and its acetate, compared with certain non-reducing steroids, are shown in the accompanying table.

Steroid	Quantity (µgm.)	Extinction
Deoxycorticosterone	50 100 150	0·175 0·344 0·505
Deoxycorticosterone acetate	50 100 150	0·180 0·350 0·510
Androsterone Dehydroisoandrosterone Cholesterol	45 104 250	0·025 0·025 0·025

It will be noted that the reaction distinguishes sharply between deoxycorticosterone or its acetate and the other steroid compounds tested, and that the effects produced by deoxycorticosterone and its acetate are closely comparable. We have found further that the extinction value is proportional to the amount of either up to at least 200 µgm., and that reproducible standard graphs may be obtained over this range with an accuracy ± 5 per cent.

Promising results have also been obtained on application of this method to lipid extracts of urine, and further work on the suitability of the method for the routine estimation of corticosteroids in urine is being carried out in this Department.

We are indebted to Messrs. Organon, Ltd., for supplies of deoxycorticosterone and its acetate.

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Separation of Deoxypentose and Pentose Nucleic Acids

CRUDE preparations of deoxypentose nucleic acids are almost invariably contaminated with pentose nucleic acids. This admixture renders many studies of the chemical and biological specificity of nucleic acids difficult. A preliminary separation must be carried out before the exact determination of the constituent purines and pyrimidines becomes possible[1]. Only in a few cases (sperm, thymus and, possibly, spleen) will suitable washing of the biological material, prior to its extraction, sufficiently depress the extent of contamination of the nucleic acid specimens[2-4].

Among the methods for the removal of pentose nucleic acids occasionally found useful in this laboratory, the following may be mentioned. (1) Separation by electrophoresis[5]: this mild, but laborious, procedure has proved particularly suitable for the purification of microbial nucleic acids endowed with transforming activity[6]. (2) Fractionation by way of the calcium salts[5,7]: the separation will, however, be far from complete. (3) Purification of deoxypentose nucleic acids by treatment with crystalline ribonuclease[5,7] and of pentose nucleic acids by the action of crystalline pancreatic deoxyribonuclease[8]: the enzyme-resistant 'cores' are, however, left behind. (4) Dialysis against dilute sodium hydroxide of *p*H 13·5 at 30° for 18 hr.[9]: this treatment injures[10], as it purifies, the deoxypentose nucleic acids, though without noticeable change in composition; the pentose nucleic acids are converted quantitatively to mononucleotides[11].

The new method described here permits the almost complete removal of pentose nucleic acids without appreciable loss of deoxypentose nucleic acids. It is based on the observation that under proper conditions pentose nucleic acid is much more readily adsorbed by activated charcoal than is highly polymerized deoxypentose nucleic acid. This diversity appears to be due to a difference in the molecular weight rather than in the chemical nature of these two nucleic acid types. The dialysable fragments[12] resulting from the depolymerization of deoxypentose nucleic acids by crystalline deoxyribonuclease were, in fact, quantitatively adsorbed by charcoal.

A 0·14 *M* sodium chloride solution proved best as the solvent; the extent of adsorption of pentose nucleic acid from distilled water was too small for practical purposes; with 2 *M* sodium chloride solutions greater losses of deoxypentose nucleic acid were incurred. Washed neutral 'Norit A' (pharmaceutical grade) was used as the adsorbent. 'Darco *G*-60' also could be used, though it was found less adsorptive. As a preliminary step, the adsorbent was washed with running tap water for 18 hr., then once with eight volumes of 2 *M* sodium chloride solution and twice with the same quantity of 0·14 *M* sodium chloride solution. The quantitative procedures for testing the purity of the nucleic acid preparations have been noted previously[13]. It is essential that the nucleic acid solutions be thoroughly freed of protein before being subjected to the treatment.

A typical experiment was carried out with a crude preparation of the sodium salt of highly polymerized deoxyribonucleic acid from pig's liver which was contaminated with 30 per cent of pentose nucleic acid. A viscous solution in 0·14 *M* aqueous sodium chloride containing 0·5–1 mgm. of this product per c.c. was shaken at 2° for one hour with 1/15 to 1/20 volume of wet charcoal. After the complete removal of 'Norit' by centrifugation, no pentose could be detected in the supernatant. The recovery of deoxypentose nucleic acid (containing less than 1 per cent of pentose nucleic acid) was of the order of 94 per cent; the loss was partly attributable to the retention of some liquid by the adsorbent.

The treatment has no depolymerizing effect: the recovered deoxypentose nucleic acid showed no change in viscosity, nor did it exhibit thixotropy[14]. In order to exclude the occurrence of a fractionation in the course of this treatment, a solution in 2 *M* sodium chloride containing 1·75 mgm. of calf thymus deoxyribonucleic acid per c.c. was treated three times with larger quantities of 'Norit' (1/8 volume) until only 27 per cent of the original nucleic acid remained unadsorbed. It cannot be stated whether it is significant that the resulting solution had a specific viscosity 26 per cent higher than that of the original solution after the latter had been diluted to the same nucleic acid content. No indications that a fractionation with respect to chemical composition had taken place were, however, obtained. The analysis of the final product for individual purines and pyrimidines showed the proportions of nitrogenous constituents to be identical with those of the untreated deoxyribonucleic acid[1,2].

Full accounts of the successful application of this procedure to the purification of deoxypentose nucleic acid preparations, especially from micro-organisms and from plants, will be published in due course.

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Action of Phytopathogenic Bacteria on Pectate Gel

MANY of the bacteria which cause diseases of plants attack their hosts, in the first instance, by breaking down the pectic substances of the middle lamella. This is particularly true of the soft-rot organisms and of those pathogens causing diseases of the parenchyma.

During the course of study on the bacterial die-back and canker of poplar[1], it has been found that the liquefaction of pectate gel is a sound criterion by which the pectolytic abilities of parasitic organisms may be demonstrated. Previous work[2,3] with pectate gel has been mainly confined to soft-rot organisms. By this present method, it has been possible to extend the use of this medium to other pathogens. This medium has the following advantages: (1) it sets rapidly; (2) the action of the bacteria is amplified by the presence of sodium asparaginate, which most of the organisms can utilize as an extra source of carbon and nitrogen; (3) no adjustment of *p*H is needed, provided that the sodium pectate used is neutral or slightly alkaline.

The medium was prepared as follows: 500 ml. distilled water was put into a one-litre beaker with a mechanical stirrer adjusted so that its speed remained constant during the whole process. It was heated with a bunsen burner, and when the water temperature reached 70° C., 15 ml. bromthymol blue followed by 5 gm. sodium pectate were added and the temperature kept constant for five minutes. When the temperature had dropped to 60° C., 2·5 ml. of 10 per cent calcium chloride in water, 0·5 gm. ammonium dihydrogen phosphate, and 1·0 gm. sodium asparaginate were added in succession. The temperature was kept constant for 10 min. The final *p*H of the mixture was between 7·0 and 7·2 (bluish-green) and no adjustment was therefore needed. The medium was then poured into tubes quickly, and autoclaved momentarily at 15 lb./sq. in. The tubes were placed standing in water at room temperature until the gel set in three to four days. They were then stored in a cool place.

A number of organisms, covering the four genera of bacterial plant pathogens, were inoculated by needle stabs into the medium.

The following species of the genus *Pseudomonas* were used: *Ps. syringae*, *Ps. syringae f. sp. populea*[1], *Ps. mors-prunorum*, *Ps. angulata*, *Ps. tabaci*, *Ps. medicaginis f.sp. phaseolicola* and the saprophyte *Ps. fluorescens liquefaciens*. All except *Ps. fluorescens* produced slight to moderate liquefaction and full thick liquid; the medium became alkaline. *Ps. fluorescens* did not liquefy the medium although it grew readily in it.

Of the genus *Xanthomonas* the following species were used: *X. campestris*, *X. citri*, *X. malvacearum* and *X. begoniae*. The first two organisms produced moderate liquefaction and clear liquid, while the others produced slight thick liquefaction. In all cases the medium remained neutral.

All the species of *Corynebacterium* used, namely, *C. fascians*, *C. tritici*, *C. michiganense* and *C. flaccumfaciens*, produced slight to moderate liquefaction, thick liquid and slight alkalinity.

Different types of action were produced by pathogens belonging to the genus *Bacterium*. In the first type, *B. aroideae*, *B. carotovorum* and *B. phytophthorum* produced moderate liquefaction, semi-transparent liquid and acid. In the second type, *B. salicis* produced less liquefaction, thicker liquid and no change in *p*H. In the third type, *B. tumefaciens* produced slight liquefaction, still thicker liquid and alkalinity. The saprophyte *B. lathyri* did not liquefy pectate gel.

It is suggested that the differences in the extent of liquefaction by the various organisms may be attributed to the nature and amount of pectic enzymes they secrete. Two enzymes may be concerned with the breakdown of the pectic salts present in the medium, namely, pectinase and protopectinase. While soft rot organisms secrete a large amount of both enzymes, saprophytic organisms, on the other hand, may secrete pectinase only. Vascular and hyperplastic organisms secrete very little protopectinase, as they do not depend, in their parasitism, on the breakdown of the middle lamella.

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Effect of Vitamin B_{12} on the Synthesis of Protein and Nucleic Acids in the Liver

IT is known that the cytoplasm content of the liver is determined by protein nutrition[1], and recently vitamin B_{12} has been shown to promote amino-acid assimilation[2]. A decrease in liver basophile cells (attributable to ribonucleic acid) is observed in rats deficient in vitamin B_{12} [3]. The vitamin also protects against hepatic damage during carbon tetrachloride intoxication, which causes a considerable reduction in the

EFFECT OF VITAMIN B_{12} ON THE PROTEIN AND NUCLEIC ACID CONTENTS OF THE LIVER

Dietary condition	No. of animals	Liver protein nitrogen	Liver nucleic acid phosphorus		
			Total	Deoxyribo-nucleic acid	Ribonucleic acid
		(mgm. per 100 gm. body-weight)			
Fasted 48 hr.	8	85 ± 1·6	3 88 ± 0·30	0·90 ± 0·08	2·96 ± 0·19
Re-fed adequate 10 per cent casein diet :					
(a) without B_{12}	8	101 ± 2·1	4 14 ± 0 20	0 90 ± 0·04	3·22 ± 0 20
(b) with parenteral B_{12} supplement	8	109 ± 1·9	5·24 ± 0·46	1·16 ± 0·08	4·13 ± 0 18

ribonucleic acid content of the liver[4]. All these findings suggest that vitamin B_{12} may influence protein as well as nucleic acid metabolism in the liver. We have sought direct experimental evidence for this in studies based on the regeneration of the labile liver cytoplasmic proteins in the rat following a brief fast. The results of a typical experiment are presented here.

Adult male albino rats weighing 180–220 gm. (average 200 gm.) were chosen for the experiment. They were kept on a vitamin B_{12}-free ration for four weeks to deplete as much of their tissue reserves of the vitamin as possible. To prevent intestinal biosynthesis of the vitamin, 1 per cent of sulphasuxidine was included in the diet. The diet used during the preparatory period, and also for refeeding after the fast, was the same and had the following composition : casein (prepared from commercial casein and devitaminized by exhaustive extraction with ethyl alcohol) 10, coconut oil 10, cane sugar 10, corn starch 65, salt mixture 4, and sulphasuxidine 1. The experimental animals received adequate amounts of vitamins A and D, and all pure vitamins of the B-complex excepting B_{12}.

The duration of the fast was 48 hr. and the period of refeeding four days. Comparable groups of rats were sacrificed at the end of the fast and after refeeding. During the refeeding period, one group served as a control, and the animals in a parallel group received daily 3 μgm. of vitamin B_{12} (Merck's 'Cobione') each intraperitoneally, the food intake in both the groups being restricted to 12 gm. a rat per diem.

The livers were excised from the animals under amytal anæsthesia after thorough bleeding through the abdominal aorta, immediately weighed and homogenized in ice-cold water in a Waring blendor. Aliquots of the homogenate were used for the various analyses. The true protein nitrogen was estimated after precipitating the proteins with trichloracetic acid (5 per cent). The procedure of Brues *et al.*[5] was adopted for fractionating the deoxyribonucleic and ribonucleic acids, their content being determined by estimating the acid-insoluble, non-lipid phosphorus in the different fractions. The results are given in the accompanying table. The liver constituents are expressed in terms of 100 gm. of the body-weight of the animals just prior to the fast.

It is evident from these results that vitamin B_{12} stimulates both protein and nucleic acid synthesis in the liver. The liver protein nitrogen increment over the fasted level is raised by nearly 50 per cent, and the total nucleic acid content of the liver by about 27 per cent in the group receiving vitamin B_{12} as compared to the control. The increases in the deoxyribonucleic and ribonucleic acid components are of the same order as in the total nucleic acids. The greater regeneration of liver protein in the animals receiving vitamin B_{12} is presumably due to its effect in enhancing amino-acid utilization. The changes in the nucleic acid content of the liver produced by vitamin B_{12} are much more than what would correspond to those in its protein content, and are therefore to be considered a specific effect of the vitamin. The rise in the liver deoxyribonucleic acid content brought about by the vitamin appears particularly noteworthy in view of the fact that it is not affected by fasting and even wide variations in dietary protein content[1b,6]. We believe these results are the first experimental proof of the direct intervention of vitamin B_{12} in mammalian nucleic acid metabolism.

Further studies relating to the effects observed are in progress. A detailed account of the findings will be published at a later date.

We are grateful to Dr. V. Subrahmanyan, director of this Institute, for encouragement and interest in the work.

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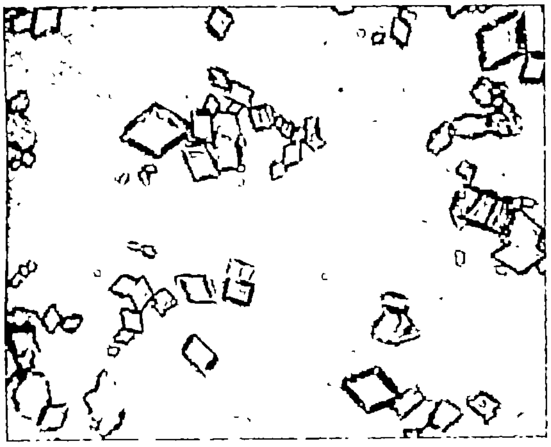
Crystallization of the α-Amylase of *Aspergillus oryzæ*

COMPARISON[1] between crystalline α-amylases of malt[2], bacteria[3], hog pancreas[4], human pancreas[5] and saliva[6] indicate that their properties vary regularly in that order, emphasizing the close relationship which exists between proteins of the same biological activity from the vegetable to the animal kingdom.

As would be expected for a bacterial enzyme, *B. subtilis* α-amylase is much more closely related to the animal than to the vegetable enzymes. For example, as is the case for animal amylases, it is activated by chloride ions. Calcium ions, which are indispensable to malt α-amylase[7], are ineffective.

In order to throw light on variations which occur among the amylases, it appeared of interest to study an enzyme from a material which, from a systematic point of view, would be intermediate between malt and bacterial amylase. With that purpose in mind, we prepared pure amylase of the mould *Aspergillus oryzæ* (taka-diastase).

An aqueous 1 : 6 suspension of 'Clarase 900' (Takamine Laboratory, Clifton, New Jersey, U.S.A.) is left for 12 hr. in the cold. After centrifugation, the dark brown liquor is brought to 0·8 saturation with solid ammonium sulphate. The precipitate obtained by filtration on 'Filter Cel' is dissolved, the solution is adjusted to pH 6·0 and fractionated by acetone. The 40–58 per cent acetone fraction is dissolved in a small amount of water. This solution (pH 7·2) is brought to 0·75 saturation with sodium chloride and then fractionated between 0·54 and 0·70 saturation with a saturated solution of ammonium sulphate. The fractionation is repeated twice under approximately the same conditions. The last precipitate is now dissolved in the minimum quantity of water, and the slightly brown solution, adjusted to pH 7·2, is left in the cold. Crystals appear after two or three days, and, after a week, at least 50 per cent of the activity of the suspension is found in the crystalline material. This has been recrystallized (see photograph).



Crystals of α-amylase from *A oryzae* × 150

A product the activity[4] of which was 2,400 mgm. maltose/mgm. nitrogen has been obtained. The total yield was approximately 15 per cent with a fourfold activity/nitrogen enrichment, based on the original extract. The purified enzyme behaves as a strictly homogeneous substance in the electrophoresis apparatus at all pH's investigated, namely, 4·7–8·6. Its isoelectric point lies at $\sim pH$ 4.

The enzyme is stable in the cold between pH 4·7 and 7·8 and can be dialysed for long periods against aqueous or salt solutions without any loss of activity. Its activity is not dependent upon the presence of chloride ions as for the animal and bacterial amylases, nor does it need calcium ions as does malt α-amylase.

The accompanying table compares some of the properties of taka-amylase with those of other crystalline amylases.

Properties	Crystalline α-amylases of				
	Malt	*Asperg. oryzae*	*B. subtilis*	Pig pancreas	Human pancreas and saliva
Mgm. Maltose/ mgm. N	2,350	2,400	3,600	4,000	6,200
Optimum pH	4·7–5·4	5–7	5·3–6·8	6·9	6·9
Solubility (per cent)	>15	>10	∼5	0·3	0·3
Activation energy (cal./mol.)	7,050	10,500	13,500*	13,500	13,500
Activation by $Ca^{\cdot\cdot}$	+	–	–	–	–
Activation by Cl'	—	—	+	+	+

* At temperatures less than 20° C.

In conclusion, although the properties of crystalline taka-amylase are intermediate between those of malt and bacterial amylase, this enzyme should be considered separately due to the fact that its activity does not depend on the presence of any ion.

We wish to express our thanks to Prof. Kurt H. Meyer for many helpful suggestions and discussions in connexion with this work.

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'Streptozyme', a Lytic Enzyme from Lactic Streptococci

IT has already been shown that antibiotic-producing streptococci other than the lactic group (Lancefield's Group *N*) are rare. The difficulties of survey were increased by toxic metabolic by-products, lactic acid in particular giving false inhibitory reactions on agar[1]. During the later stages of this work (unpublished) neutralized culture fluids were used to overcome the inhibitory effects of lactic acid. A cylinder-plate method was used for assays with *Staphylococcus aureus* (491) as the test organism. Several strains of streptococci were isolated from silage, the neutralized culture fluids of which gave 20-mm. zones of inhibition, while the un-neutralized acid culture fluids were inactive. These cultures were proved serologically to belong to Group *N* (*Str. lactis*), yet the inhibitory substance produced is inactive in acid media and is heat-labile, characters distinguishing it from the main antibiotic, nisin, produced by *Str. lactis*[2].

After centrifuging, both cells and supernatant were inactive and the inhibitory substance appeared to be mainly associated with the intact living cells. When growing cells were killed with nisin (200 units/ml.), they promptly became autolysed. Autolysis depended on pH (ceasing completely at pH 6 or below) and on the age of the culture. The activity of cultures more than 10 hr. old declined gradually, even when the pH was maintained by periodic neutralization at 6·5.

The autolytic nature of this enzyme clearly distinguishes it from lysozyme; it also appears to be more heat-labile. The lytic effect is not due to bacteriophage, since a cell-free culture filtrate was incapable of lysing living cells, but there was some activity against a heat-killed suspension. The name 'streptozyme' is proposed for this enzyme.

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Deoxyribosenucleic Acid Synthesis during Cell Division in Mouse Epidermis

A STUDY of the energy relations of epidermal mitosis in the adult mouse has shown that active production of energy is of vital importance only during that period which immediately precedes the prophase and for which Bullough[1] has suggested the term 'antephase'. By the time an epidermal mitosis becomes recognizable, it is so highly independent of external conditions that it may be regarded as a classical example of an all-or-none reaction. It appears that the critical importance of the active production of energy in the antephase may be related either to a demand for energy at this time, or to the necessity for energy storage for the maintenance of the cell during some two hours of division and reconstitution[2].

In examining the first of these alternatives it was noted that the view is widely held that an increase in the nucleic acid content of the nucleus occurs during early prophase. Thus Ris[3], using the photometric method of Pollister and Ris[4] for a study of the total nucleic acid content and the deoxyribosenucleic acid content of the cells of onion roots and grasshopper testes, has concluded that "during the mitotic prophase and the first meiotic prophase the constituents of chromosomes increase about twofold". It was suggested by Bullough[2] that this conclusion, if it is also applicable to mouse epidermis, may suggest a reason for the active production of energy in the antephase, since any substantial increase in the nucleic acid content of the cell at this time must involve a significant amount of work.

In contradiction to this, however, Pasteels and Lison[5], using the technique of Lison[6], have shown in the erythrocytes of embryo rats, the crypts of Lieberkühn of adult rats, and chick heart fibroblasts "qu'il n'y a pas de modification de la teneur en D.N.A. au cours de la prophase ; qu'à l'anaphase cette teneur tombe de moitié pour chaque noyaufils ; que la teneur initiale se reconstitue immédiatement au moment de la reconstitution du noyau". Lison and Pasteels[7] have also described a similar pattern of deoxyribosenucleic acid synthesis during mitosis in sea urchin eggs. It was therefore necessary to determine the conditions in mouse epidermis before attempting to relate energy production to deoxyribosenucleic acid synthesis, and measurements have now been carried out on the ear epidermis, the tissue in which the original observations on energy production were made. The mice used were four-month old Kreyberg white label males. These were killed while asleep in order to obtain a high number of epidermal mitoses, their ears were sectioned, and the deoxyribosenucleic acid content of their epidermal nuclei was estimated by the method described by Lison[6] (see table) ; for comparison, the deoxyribosenucleic acid content of lymphocyte nuclei is also shown.

DEOXYRIBOSENUCLEIC ACID CONTENT OF NUCLEI IN THE MALPIGHIAN LAYER OF THE EAR EPIDERMIS OF ADULT MALE MICE (ARBITRARY UNITS)

Type of nucleus	Number of nuclei examined	Deoxyribosenucleic acid content Extreme values	 Mean and standard error
Interphase	150	123–642	—
Prophase	1	362	—
Metaphase	20	333–467	338·7 ± 7·5
Telophase × 2	28	384–568	460·0 ± 10·6
Lymphocyte	26	230–327	276·9 ± 5·3

The measurements showed that in the Malpighian layer, which alone contains cells capable of division, the deoxyribosenucleic acid content of interphase nuclei varied widely. Clearly the Malpighian cells were not homogeneous, and, using lymphocyte values as standard, it was found that they could be roughly divided into three groups : those with a deoxyribosenucleic acid content equal to that of the lymphocytes, those with a lower content, and those with a higher content. It was apparent that only the cells of the last group, those with the highest deoxyribosenucleic acid content, could undergo division, since all the nuclei measured in prophase and metaphase showed similarly high values. During early anaphase each of the two newly forming groups of chromosomes had only half the deoxyribosenucleic acid content of the metaphase nucleus. During late anaphase and telophase, however, deoxyribosenucleic acid synthesis was rapid so that, by the time each daughter cell entered the interphase, it again showed the high level typical of the prophase.

Evidently, conditions in the ear epidermis of the adult male mouse closely resemble those in the crypts of Lieberkühn of the adult rat, concerning which Pasteels and Lison[5] have concluded that "au cours de l'intercinèse, les cellules ont des teneurs très différentes ; en revanche, les valeurs observées à la métaphase sont d'une très grande homogénéité ; la synthèse en D.N.A. débute à l'ana-télophase et se poursuit au cours de la reconstitution du noyau ; la valeur anaphasique est ainsi progressivement doublée ; et une valeur égale à celle de la métaphase est rétablie au début de la nouvelle intercinèse".

These conclusions appear to contradict any suggestion that the high production of energy observed during the antephase may be related to active nucleic acid synthesis at that time, and to be in agreement with the alternative hypothesis that the antephase is the period when energy is stored for the support of all the various cellular activities, including synthesis of deoxyribosenucleic acid, which occur during the ensuing division. A fuller account of these observations will be given elsewhere, together with a description of conditions in the superficial epidermal layers.

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May 31.

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A New Biological Method for Evaluating the Efficiency of Insecticides for the Protection of Sheep against Blowfly Strike

THE protection afforded to sheep against blowfl strike by the new synthetic chlorinated hydrocarbo insecticides applied to the fleece has been shown t be the result of two different actions. Insectary test have demonstrated distinct repellent effect and th prevention of oviposition in the case of gravid femal flies, whereas implantations of first instar larvæ, according to the method of McLeod (1937), have indicated the larvicidal role.

The retention of larvicidal properties and the consequent continued protection of sheep long after all demonstrable repellency has disappeared indicate that larvicidal properties are of much greater importance than fly repellence.

It is known that the larvæ of the primary blowfly, *Lucilia cuprina* Wied., live principally upon the serous fluid exuding from the superficial wounds produced by them. In order to determine the minimum concentration of insecticide capable of destroying all first-stage larvæ in a nutritional medium, a series of *in vitro* tests was conducted. First instar larvæ were placed in glass tubes, 3 in. × 1 in., each containing a pledget of cotton-wool soaked in serum in which was suspended the test insecticide in wettable powder form in serial dilutions over the range 1,000–0·004 parts per million. Insecticides in wettable powder form were chosen in order to eliminate the possible larvicidal effect of organic solvents. The tubes were plugged with cotton-wool and held in an incubator at 27° C. (80·5° F.). Observations on mortality were made at 1, 3, 6, 24, 48 and 72 hr. It was unnecessary to extend the observations beyond this period as the maggots become more resistant to insecticidal action with increasing age, and if not killed within 72 hr. will not be affected by the strength of insecticide applied.

Four replications of the above test gave the minimum concentrations of insecticide in parts per million to kill all young *L. cuprina* larvæ in the time specified shown in the accompanying table.

Insecticide	Time (hr.)				
	3	6	24	48	72
Dieldrin	1000	250	16	4	1
Gamma-BHC	250	64	16	4	4
Aldrin	1000	1000	16	16	4
'Methoxychlor'	1000	250	16	16	4
DDT		1000	16	16	4
Chlordane			250	64	16
Toxaphene		1000	250	64	64
DDD (TDE)				64	64

The eight compounds tested fall naturally into four groups according to their larvicidal properties, and both DDT and gamma-BHC are included in the same group as they are capable of killing the larvæ at a dilution of 4 parts per million.

Sheep may be protected for long periods when reated with relatively high concentrations of these synthetic insecticides. Under experimental conditions, DDT at 5 per cent *pp*-isomer affords protection for approximately three months, whereas BHC at 0·5 per cent gamma isomer still protects after six months, provided that at the time of application the wool has a length of 1–1½ in. Under South African conditions, wool grows at the fairly constant rate of ¼ in. per month, so that at the end of three to six months the wool fibres have increased in length by about ¾–1½ in. This new wool, untreated at the time of the original application, was found to be apable of killing first instar larvæ.

In order to ascertain the larvicidal properties of treated wool at various stages after treatment, a group of sheep bearing wool of fibre length 1¼–1¾ in. were treated with the eight different compounds listed in the table in wettable powder form at a concentration of 0·5 per cent of the active ingredients. An area over the rump approximately 12 in. in diameter was thoroughly soaked with each suspension. Commencing nine weeks after treatment, samples of wool of about 0·5 gm. were removed weekly from the treated area on each sheep for laboratory tests, and first instar larvæ were implanted on these areas at the same time.

Half an inch of wool, representing the new growth, was removed from each sample. These portions and the remaining portions of old wool were placed separately in glass specimen tubes and well soaked with normal serum. Into each tube was then implanted 50–100 first instar larvæ of *L. cuprina* for incubation and observation.

The time of survival of the larvæ served as an index of the concentration of insecticide present in the wool samples. By comparing the rates of mortality with those given in the table, an accurate estimation of the concentration of insecticide in the particular portion of the fleeces tested could be obtained.

It was possible to deduce from these *in vitro* tests that the sheep were no longer protected against strike when the concentration of insecticide in the newly grown fleece fell below the larvicidal level, namely, 4 p.p.m. in the case of DDT and BHC. When the larvæ survived in the tubes, strikes developed on the sheep upon which larvæ had been implanted. This method was sufficiently sensitive to indicate partial protection of sheep by observing retarded larval development.

The method described has disclosed distinct differences in the behaviour of the different insecticides in the fleece of sheep. The concentration of gamma-BHC, aldrin, dieldrin, chlordane, and to a lesser extent toxaphene, in the newly grown wool was sufficient to be fully larvicidal nine weeks after application of the insecticide to the sheep which were protected against fresh strike. In the case of DDT, 'Methoxychlor' and DDD(TDE) the larvæ remained alive in the tubes containing the new-growth wool samples, and strikes developed upon the sheep.

The compounds in the first group appear to possess remarkable powers of diffusion down the wool fibres, where they persist at concentrations lethal to first instar larvæ for considerable periods. DDT and its allied compounds, on the other hand, appear to remain fixed in the wool originally treated, and protect sheep for considerably shorter periods in spite of possessing equal larvicidal properties.

Tests conducted to date have revealed that gamma-BHC, aldrin and dieldrin applied originally at 0·5 per cent concentration will diffuse more than 1½ in. along the wool fibre and so provide protection for six months.

The length of wool at the time of treatment and the initial concentration of insecticide applied play an important part in the extent to which diffusion will occur and the degree of protection afforded.

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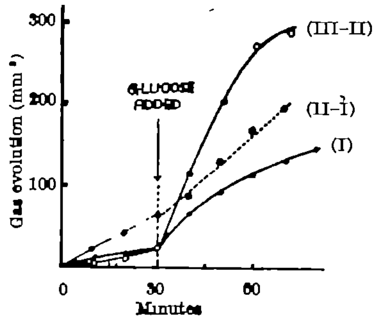
Hydrogen Evolution by *Trichomonas fœtus*

Trichomonas fœtus, a polyflagellated protozoon, is parasitic in the vagina of the cow and causes impaired reproduction. J. Andrews and T. von Brand[1] carried out some quantitative studies on glucose consumption by *T. fœtus* during cultivation, and then also found that a gas, which burned explosively when mixed with air, was produced by the organism when growing in serum broth with 0·1 per cent glucose. This fact suggested that it might be hydrogen.

Table 1. COMPOSITION OF THE GAS EVOLVED DURING ANAEROBIC CULTIVATION

Exp. No.	Gas evolved (ml.) per 50 ml. medium	Gas analysis (per cent) Carbon dioxide	Oxygen	Methane	Hydrogen	Nitrogen
1	10·0	0·00	1·77	1·89	83·73	12·61
3	9·4	0·00	6·00	0·30	73·65	20·04
7	11·9	1·96	5·57	2·05	78·65	11·77

We cultivated *T. fœtus* anaerobically in a 200-ml. injection syringe with a cock attached to its nozzle so as to catch any gas evolved. Cultivation was in a bacteria-free condition on a boiled beef extract containing 1 per cent peptone, 10 per cent bovine serum, 1 per cent glucose and 0·5 per cent sodium chloride at 37° C. for 48 hr. The gas evolved amounted to 9–11 ml. per 50 ml. culture medium. As shown in Table 1, it was demonstrated by micro gas analysis that the gas contained a large quantity of hydrogen and a small quantity of methane.



Relationship of the evolution of (I) hydrogen, (II–I) metabolic carbon dioxide, and (III–II) carbon dioxide by acid formation in the course of anaerobic glucose breakdown by *T. fœtus* suspension

By using the saline suspension of *T. fœtus*, we further investigated manometrically this hydrogen evolution under anaerobic conditions. In order to differentiate metabolic carbon dioxide from the hydrogen evolved and formation of acid, three flasks (Warburg manometers) were used, of which both flask I, containing 20 per cent potassium hydroxide in the centre well, and flask II, without potassium hydroxide, were filled with nitrogen as the gas phase, and flask III was kept in an anaerobic carbon dioxide–bicarbonate buffering state. We found a gas other than carbon dioxide in flask 1, and estimated the metabolic carbon dioxide evolution by subtracting the volume of gas evolved in flask I from that in flask II, and acid formation by the determination of bicarbonate remaining, as shown in the accompanying graph (in the presence and absence of glucose as substrate). Table 2 shows that this hydrogen evolution depends on the amount of glucose added and not on the peptone, and that it increases somewhat on the addition of pyruvate or formate. These facts suggest that the evolution of hydrogen is connected with the anaerobic carbohydrate metabolism accompanied with acid formation.

Table 2. EFFECT OF SUBSTRATES AND pH ON THE HYDROGEN EVOLUTION

Substrates	Final concentration	pH	Relative amount of hydrogen evolved during 30 min.
Endogenous		7·0	100
Glucose	0·005 mol. 0·01 0·01 0·01 0·015	7·0 7·0 4·8 8·5 7·0	130 234 133 264 280
Peptone	1 per cent	7·0	99
Pyruvate Formate	0·01 mol. 0·01	7·0 7·0	160 128

Further investigations showed that the main end-product of this acid formation is neither lactic nor pyruvic acid, but succinic acid. These results suggest that the anaerobic glucose breakdown differs considerably from the usual glycolytic process.

We are indebted to Dr. C. Koyama for the micro gas analysis.

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Helical Thickenings and Micellar Orientation in the Secondary Wall of Conifer Tracheids

THE suggestion that the cytoplasmic surface possesses the capacity to govern the micellar orientation of the cell wall has been made both by Frey-Wyssling[1] and Preston[2], whereas the possible influence of forces arising from cell turgor and protoplasmic streaming have been discussed by Castle[3]

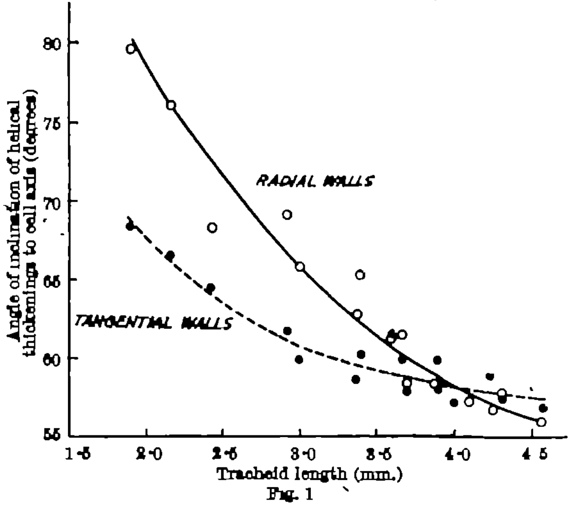

Fig. 1

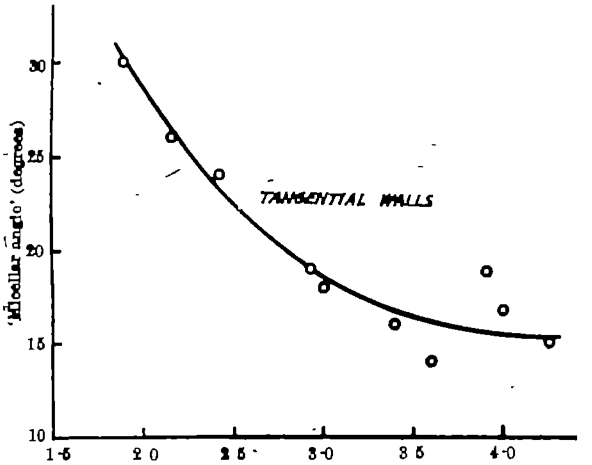

Fig 2

and by van Iterson[4]. Difficulties in technique have prevented any direct experimental proof of either hypothesis. The formation of cell-wall thickenings which are present in the prosenchyma of many plants has, however, been shown by Cruger[5] and others[6] to reflect a structural differentiation in the cytoplasm of a pattern similar to that of the later-formed thickenings, and recognizable upon plasmolysis. In conifer tracheids the phenomenon has been illustrated diagrammatically by Jeffrey[7], although it is not clear whether his diagram was based on direct examination or analogy with other cells. These observations, however, point clearly to the influence of the cytoplasm in governing the orientation of cell-wall thickenings, to the axis of which the micelles of cellulose are parallel[8]. As the thickenings are an intrinsic part of the cell wall, and in view of the cytoplasmic differentiation which precedes their development, it becomes of interest to consider whether further evidence can be obtained to indicate a similar function of the cytoplasm n governing micellar orientation in the cell wall generally.

In conifer tracheids the normal secondary cell wall consists of three layers of different helical micellar orientation such that in the outer and inner layers the micelles make a large angle ('micellar angle') with he longitudinal cell axis, whereas in the middle layer his angle is small[9,10]. A remarkable feature of this organization demonstrated by Preston[11,12] for the middle layer is that the micellar angle becomes less with increasing cell-length, hat is, the helix becomes steeper. It was noted further by Preston[11] that the micellar angle was greater on the radial han on the tangential walls. The relation between cell-length and micellar orientaion has since been demonstrated to apply also to the outer layer of the econdary wall[13] as well as to organizaion of the secondary wall in other cells[12].

The demonstration of a similar relation between cell length and the orientation of he helical thickenings in species in which hey occur could be regarded as support or the assumption that factors which govern the orientation of such thickenings (and of their constituent micelles) lso govern the micellar orientation of he cell wall. Accordingly, a study was made of the variation in the angle of orientation of the helical thickenings with respect to the increase in cell-length which occurs in successive growth-rings from the centre of both stems and branches of conifers. The results obtained for *Pseudotsuga taxifolia* (stem – late wood) are shown in Figs. 1–3. Early wood from the *Pseudotsuga* and late wood of *Taxus baccata* (branch) gave parallel results. The 'micellar angle' of the middle layer of the secondary wall was determined from the spread of the 002 arc of the X-ray diffraction diagrams of the specimens and has been plotted for comparison (Fig. 2). The number of turns per cell of the spiral thickenings was found to increase with cell length (Fig. 3). In both specimens two helices were observed in each cell.

From Fig. 1 it is clear that the change in the angle orientation of the helical thickenings with cell length paralleled that of the micellar orientation of the middle layer of the secondary wall. Furthermore, in *Pseudotsuga*, both in early wood and in late wood tracheids, the angle of orientation of the thickenings was greater on the radial than on the tangential walls, which is a result similar to that obtained earlier by Preston[11] for the micellar orientation in the middle layer of the secondary wall. The suggestion that the angle of orientation of the thickenings is a function of cell wall thickness[14] is not confirmed by the present results, as in both the early wood and late wood of *Pseudotsuga* the change in orientation with increasing cell length was observed with little or no change in cell wall thickness.

If it is assumed that the change in orientation and number of turns of the helical thickenings with increasing cell length reflects a similar and prior differentiation of the cytoplasm, then the change in orientation cannot be attributed to the unwinding of a helically organized protoplast in the ageing cambium. The greater number of turns in the longer cells suggests the synthesis of additional cytoplasmic material, as the dimensions of the cells differentiating from the cambium increased. This is of interest in relation to the concept[15] that helical form may originate from rectilinear growth on the surface of a cylindrical object and may have implications in relation to cases of so-called "spiral" growth of plant cells[16]. Although admittedly of an indirect nature, it is considered that the present observations give added support to the view that the cytoplasmic surface is a major factor in determining micellar orientation and may give some indication of the complex

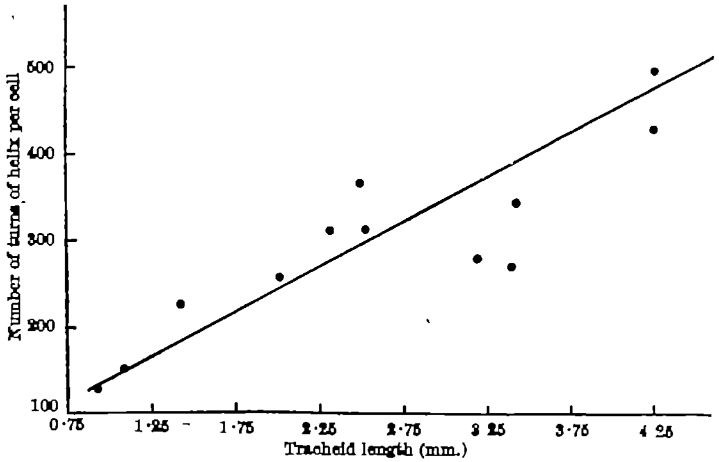

Fig. 3

morphogenic factors involved in the development of the fine structure of the cell wall.

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July 24.

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Spermatheca in Sucking Louse

The spermatheca is stated to be absent, by Patton and Cragg[1], in the Anoplura, *Pediculus humanus*, and also by Florence[2] in *Hæmatopinus suis*. But Keilin and Nuttall[3] indicate the existence of a spermatheca in their figure of the reproductive system of *P. humanus*. Qadri[4] disputes this finding and points out that a spermatheca is also absent in *Hæmatopinus tuberculatus*.

On reference to the literature, we find that Mjoberg[5] records the presence of a spermatheca, but only in two species of Anoplura, *Linognathus angulatus* and *Acanthopinus sciurinus*, and gives a brief description of the structure of an empty spermatheca. Ferris[6], in summing up the generic character of *Linognathus* End, mentions the presence of a spermatheca, the opening of which is marked by a sclerotic scar. In view of discrepancy regarding the existenc of a spermatheca in sucking lice, we have examine a few related species. We find that the spermathec exists in the cow-louse, which we provisionall identify as *Linognathus vituli* (Linn.). But th structure is quite different from that given b Mjöberg, in so far as there is no chitinous disk o the spermatheca near the origin of its duct, nor i there any sclerotic scar as mentioned by Ferris. Th spermatheca in this species is a large club-shape sac, bent in the middle and lying to the left of th median line. It opens dorsally into the vagina, b a short duct (Fig. 1). The spermatheca, in one ou of ten specimens, contained oval-shaped spermatophores, varying in number from one to eight. In th photomicrograph (Fig. 2) a single spermatophore i shown within the spermatheca. In the majority o cases the spermatheca is empty. The shape of th spermatheca changes as it becomes distended wit spermatophores. The occurrence of spermatophore within a spermatheca is of special interest, as it ha not been reported by previous investigators, an Wigglesworth[7] remarks that spermatophores are neve transferred to the receptaculum of the female. Th disproportionate number of females to males, namel 3 : 1 in the cow-louse, is noteworthy. We confirm tha the male possesses a tubular seminal vesicle an accessory glands, as pointed out by Mjoberg an others.

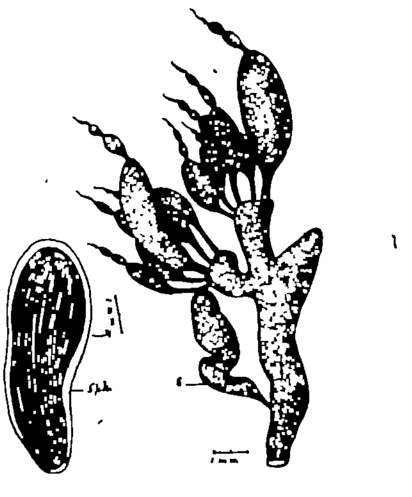

Fig. 1. Female genital system of the cow-louse showing the spermatheca (s). On the left, a spermatophore

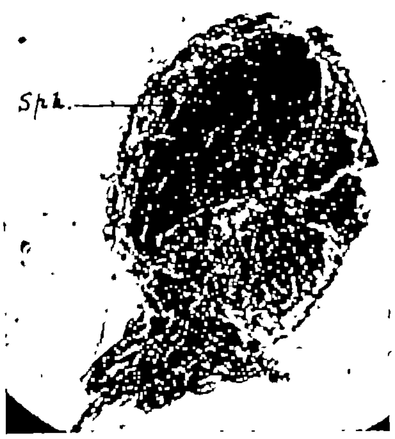

Fig. 2. Photomicrograph of a spermatophore (sph) within the spermatheca

We also wish to record the presence of a spermatheca in the elephant-louse *Hæmatomyzus el phantis* Piag., as there is no mention of it in th descriptions of previous authors.

We wish to thank the Director of the School (Tropical Medicine, Calcutta, for the photomicr graph.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 8

Physical Society, Acoustics Group (in Room C4 (East Wing), King's College, Strand, London, W.C.2), at 5.30 p.m.—Mr. P. H. Doak: "The Pulse Response of Auditoria".

Tuesday, October 9

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. Daryll Forde: "Strange Families".*

Chadwick Public Lecture (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Mr. F. H. Bruce: "Some International Aspects of Environmental Hygiene".*

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Institute of Physics, Education Group (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Prof. A. D. Ross: "Experiences in Education in Science in Australia".

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Discussion on "The Education of the Chemical Engineer by Part-time Study".

Royal Society of Medicine, Experimental Medicine Section (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Discussion on "Aureomycin" (to be opened by Dr. B. Duggar, Dr. J. G. Scadding and Lieut. J. Killough, U.S.N.).

University of London (at the Assembly Hall, Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. E. Adrian, O.M., F.R.S.: "The Scientific Basis of Medicine, 1, The Scientific Approach to Medical Research".*

(Further Lectures on October 11, 16, 18, 23, 25 and 30, November 2, 5, 7, 14, 16, 20, 23, 27 and 29, December 4, 6 and 11.)

Illuminating Engineering Society (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Mr. J. G. Holmes: Presidential Address.

Textile Institute, Yorkshire Section (at the Midland Hotel, Bradford), at 7.15 p.m.—Mr. R. G. Oversby: "My Impressions of Textile Technical Training, Research and Production in the Textile Industry of the United States of America".

Wednesday, October 10

Society of Chemical Industry, Microbiology Group (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 2.15 p.m.—Symposium on "The Use of Isotopes in Microbiology".

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Symposium on "Acid Sludge—its Utilization and Disposal".*

Thursday, October 11

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. D. R. Newth: "Lamarck and Neo-Lamarckism".*

University of London (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at p.m.—Prof. Ronald S. Edwards: "Industrial Technologists and the Social Sciences". (Inaugural Lecture.)*

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Sir John Hacking: Inaugural Address as President.

British Institution of Radio Engineers (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Dr. R. G. Richardson: "Acoustics in relation to Radio Engineering". (Members of the Acoustics Group of the Physical Society are invited.)

Manchester Literary and Philosophical Society (at Whitworth Art Gallery, Manchester), at 7.30 p.m.—Dr. H. A. Thomas: "Development and Design with Man-made Fibres".

Friday, October 12

Association of Applied Biologists (at the Royal Entomological Society of London, 41 Queen's Gate, London, S.W.7), at 11 a.m.—"Insect Physiology in relation to Applied Biology".

Oil and Colour Chemists' Association, Manchester Section, at the Grand Hotel, Aytoun Street, Manchester), at 2.30 p.m.—Discussion on "The Report of the Light Fastness Committee of O.C.C.A." (to be opened by Dr. J. G. Gillan and Mr. F. A. Walker).

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Royal Institute of Philosophy (at University Hall, 14 Gordon Square, London, W.C.1), at 5.15 p.m.—Sir Henry Cohen: "The Status of Brain in the Concept of Mind" (Manson Lecture).*

Saturday, October 13

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. J. W. Jones: "The Spawning of the Atlantic Salmon".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer (with a degree in pharmacy, physiology, pharmacology or medicine) in the Department of Pharmacology—The Secretary, School of Pharmacy, 17 Bloomsbury Square, London, W.C.1 (October 13).

Assistant Physicist (with an honours degree in physics or allied subject) in the Physics Department—The Clerk to the Governors, St. Bartholomew's Hospital, London, E.C.1, endorsed 'Physicist' (October 13).

Research Assistants with electrical engineering knowledge (to at least Higher National Certificate standard) and experience of, or aptitude for, training in measurements in the field—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds (October 13).

Scientist, Grade III (with an honours degree in either geology or botany) in the Coal Survey Laboratory, Sheffield, for work on the palæobotany of coal and the correlation of seams—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/374 (October 13).

Scientists, Grade III (with a good honours degree in chemistry, experience in analytical technique desirable) in the Laboratories at Chester and Newcastle-upon-Tyne—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/376 (October 13).

Technical Officer II (temporary, with a good honours degree in geography or geology) for work in the employment service of the Technical and Scientific Register, dealing mainly with graduates in geography, geology and psychology—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.335/51 (October 13).

Graduate Chemist (with biochemical training or interest) to assist in a programme of research on nucleoproteins and allied problems—The House Governor, Royal Cancer Hospital, Fulham Road, London, S.W.3 (October 15).

Lecturer in Glasshouse and Flower Crops, and an Assistant Lecturer in Machinery—The Principal, Kent Horticultural Institute, Swanley, Kent (October 15).

Research Fellow to work in the Department of Metallurgy on theoretical problems concerning the structure and properties of metals—The Secretary, The University, Edmund Street, Birmingham 3 (October 15).

Vice-Chancellor of the University of New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 15).

Aeronautical and Mechanical Engineers (Experimental Officer grade) mainly in the aerodynamics and structures departments at the Royal Aircraft Establishment, South Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.572/51A (October 20).

Assistant Experimental Officers to train in London as weather forecasters, for services mainly at airfields in the United Kingdom—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.260/51A (October 20).

Chemical Engineers (Principal Scientific Officer grade), with a first- or second-class honours degree in chemical engineering, at a Ministry of Supply research and development establishment, initially in North-West England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.651/51A (October 20).

Chemist (male) for the post of War Department Analyst (Food Supplies), to take charge of the chemical laboratory at the Army Supply Depot, Singapore—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.657/51A (October 20).

Consultant to take charge of and develop a consultant service to advise commercial and industrial concerns, learned societies, etc., on the establishment and efficient conduct of technical information services and specialized libraries—The Director, Aslib, 4 Palace Gate, London, W.8 (October 20).

Electrical and Mechanical Engineer in the Public Works Department under the Government of Cyrenaica—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.429/51-O A. (October 20).

Lecturer in Surveying in the Mining Department—The Registrar, The University, Leeds 2 (October 20).

Mathematicians at a Ministry of Supply research and development establishment in the South-East of London. Senior Experimental Officer or Experimental Officer to take charge of, organize and build up a small computing section, and an Experimental Officer or Assistant Experimental Officer, with interest in applied mathematics or numerical analysis—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.254/51A (October 20).

Research Assistant (with a good honours degree in physics or physical chemistry) for work on the physical and chemical aspects of selective flotation—The Registrar, The University, Leeds 2 (October 20).

Senior Scientific Officer (with a first- or second-class honours degree in engineering, hydro (or aero) dynamics and/or in physics, or an equivalent qualification) at the Marine Laboratory, Aberdeen, to work in conjunction with the fisheries biologists in studying the effects of modifications of commercial fishing gear and in devising new types or modifications of gear to increase fishing efficiency—The Establishment Officer, Scottish Home Department, Room 364, St. Andrew's House, Edinburgh 1 (October 20).

Research Officer (biochemist) in the Division of Food Preservation and Transport, Commonwealth Scientific and Industrial Research Organization, to conduct investigations on the biochemistry of muscle, initially with particular reference to the problem of labile sulphur—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3579 (October 27).

Chemist, Government Metallurgical Laboratory—The Secretary, Southern Rhodesia Government, Rhodesia House, 429 Strand, London, W.C.2 (October 31).

Lecturer in the Department of Economics at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

Physiologist (with honours degree in physiology or honours degree in zoology or biochemistry, with physiology as subsidiary subject) for studies in the general field of the environmental physiology of animals in hot environments, and an Experimental Physicist (with honours degree in physics or equivalent) for work concerned with the instrumentational and biophysical aspects of heat exchange in animals—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (October 31).

Principal Scientific Officers in the Mechanical Engineering Research Organization of the Department of Scientific and Industrial Research: Engineer (with experience of research on engineering materials, preferably on the creep and fatigue resistance of metals at high temperatures) for research into the properties of engineering materials at high temperatures, and an Engineer (with experience of the application of research in industry) to lead research into generic problems of mechanical engineering in the Division studying lubrication, wear, and the mechanical engineering aspects of corrosion, on such problems as the lubrication of high-speed bearings, reciprocating mechanisms, gears, etc.—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4079/51 (November 8).

Principal Scientific Officers in the Royal Naval Scientific Service: Physicist (with considerable experience in the development of electronic amplifiers and similar devices, together with a wide experience of magnetic and electromagnetic apparatus and a thorough knowledge of eddy current phenomena in various conducting media) to lead a group of scientists engaged on the development of electric and electromagnetic devices, at the Underwater Countermeasures and Weapons Establishment, Havant; a Physicist able to take charge of a division carrying out applied research in connexion with underwater explosives, gun and rocket blast, and the effect of these on ships' structures, and an Engineer familiar with modern techniques of and theory of structures, to undertake both small and large-scale load strain measurements, and with a sound knowledge of the design investigations and experiments involving the mechanical testing of structural assemblies in steel, at the Naval Construction Research Establishment, Rosyth—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4080/51 (November 8).

Senior Lecturers in Mechanical Engineering (Thermodynamics and Heat Engines). (*a*) Internal Combustion Engines and Gas Turbines, (*b*) Steam and Refrigeration, at the New South Wales University of Technology—The Agent General for New South Wales, 56–57 Strand, London, W.C.2, stating post applied for (November 12).

Principal Scientific Officer (with a first- or second-class honours degree in physics or engineering, or corporate membership of one of the professional institutions, or able to produce evidence of outstanding qualifications and experience; sound knowledge of the radio valve industry in this country, including manufacturing techniques and the development of commercial radio valves is essential) in the Royal Naval Scientific Service for temporary assignment to the staff of the British Joint Services Mission, Washington, U.S.A.—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4078/51 (November 15).

Professor of Philosophy, and a Lecturer (Grade I) or Senior Lecturer in Mathematics, at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 15).

Senior Lecturer in Geography at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 15).

Director of the Central Building Research Institute, Roorkee, Uttar Pradesh, India—The High Commissioner of India, General Department, India House, Aldwych, London, W.C.2, quoting No. 474.A (November 17).

Lecturers (2) in Biochemistry at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 17).

Chair of Social Studies in the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 30).

Senior Research Officer in charge of the Microbiological Chemistry Section of the National Chemical Research Laboratory in Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, December 1).

Assistant Lecturer (experienced social worker with university qualifications) in the Department of Sociology, Social Studies and Economics—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1.

Assistant Lecturer (Grade B) in the Department of Mathematics—The Principal, Sir John Cass College, Jewry Street, London, E.C.3.

Assistant Lecturer, Grade B (with a good honours degree in physics or electrical engineering; some industrial or teaching experience in electronics is essential) for Applied Physics, at the College of Technology and Commerce—The Director of Education, City Hall, Cardiff.

Chemist II/Engineer II in the Ministry of Supply, London, for the supply and planning of either ferrous or non-ferrous metals used in the manufacture of aircraft, engines and associated equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.674/51A.

Chemists (Principal Scientific Officer grade), with a first- or second-class honours degree or equivalent in chemistry, with many years responsible research experience in modern methods of analysis of inorganic materials, including microchemical methods, at a Ministr of Supply research and development establishment near London—The Ministry of Labour and National Service, Technical and Scientifi Register (K), York House, Kingsway, London, W.C.2, quotin F.640/51A.

Chemists (Principal Scientific Officer grade), with a first- or second class honours degree in chemistry, or equivalent qualification, witl experience in the field of combustion research, at a Ministry of Suppl research and development establishment in Buckinghamshire, fo work on problems of combustion in solid and liquid propellant rocke motors—The Ministry of Labour and National Service, Technica and Scientific Register (K), York House, Kingsway, London, W.C.2 quoting F.650/51A.

Chemists II and III in the Ministry of Supply, London, for th investigation of requirements for non-metallic materials used in th manufacture of aircraft, engines and equipment, and the assessmen and planning of manufacturing capacity for these materials—Th Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.675/51A.

Chief Hydrological Engineer, and Hydrological Engineers (4), in the Soil Conservation Section of the Ministry of Agriculture, Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Chief Hydrologica Engineer 4/404' or 'Hydrological Engineer 4/404'.

Departmental Assistant in Poultry Husbandry at the Schoo of Agriculture, Sutton Bonington—The Registrar, The University Nottingham.

Electrical Engineers (Experimental Officer grade) at the Roya Aircraft Establishment, South Farnborough, for work on aircraf electrical generating equipment—The Ministry of Labour and Nationa Service, Technical and Scientific Register (K), York House, Kingsway London, W.C.2, quoting D.425/51A.

Field Officers (2) in a Tsetse Survey and Reclamation tean working in the Southern Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Veterinar Field Officer, 4/2202'.

Field Zoologist, Kenya (Ref. 27066/12), to undertake surve work of tsetse distribution, to make ecological studies of tsetse control, etc., a Provincial Tsetse Officer, Tanganyika (Ref. 27059/74) to carry out tsetse surveys and inaugurate all anti-tsetse measure in the province, a Public Analyst, Northern Rhodesia (Ref. 27106 53/51), to perform the normal duties of a Public Analyst, includin toxicology, and a Chemist in Tanganyika (Ref. 27106/36/51), for general analytical work of a development research nature, particular in connexion with agriculture, etc.—The Director of Recruitme (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smit Street, London, S.W.1, quoting the appropriate Ref. No.

Junior Investigator (with B.Sc. or equivalent in metallurg for work on the physical metallurgy of mild steel weld metal—Th Secretary, British Welding Research Association, 29 Park Crescen London, W.1.

Lecturer in Geology, and an Assistant Lecturer in Pharmacognosy—The Registrar, The University, Nottingham.

Meteorological Assistants for service in the Antarctic with th Falkland Islands Dependencies Survey—The Crown Agents for th Colonies, 4 Millbank, London, S.W.1, quoting M.27576 B.

Meteorological Officers (women, with honours degree in mathematics, physics or geography), for special Short Service Commission—The Director, Women's Royal Naval Service, Admiralty, Whitehal London, S.W.1.

Microanalyst to take charge of the Microanalytical Department—The Chairman of the Scientific Committee, Weizmann Institute Science, Rehovoth, Israel.

Physicist to supervise research work connected with the mechanical properties of metals and alloys, including creep, fatigue, corr sion fatigue and stress corrosion, and to be responsible for the inte pretation of results according to modern physical conceptions—Th Ministry of Supply, Division of Atomic Energy (Production), Risley Warrington, Lancs.

Research Officer (Ref. A.31) (with university degree in chemic engineering or physics) for work on problems in connexion with soli fuel fired gas turbines, and an Experimental Assistant (Ref. A.1 for work in connexion with the instrumentation of experiment coal burning equipment, and Research Officers (Ref. A.35) (ma or female, with degree in physics or equivalent) to work on proble in connexion with the use of fuel in domestic appliances wit particular reference to smoke elimination—The Assistant Secretar British Coal Utilization Research Association, Randalls Roa Leatherhead, Surrey, quoting the appropriate Ref. No.

Research Officer (biochemist) for service in Kenya, Tanganyi and Uganda, to be responsible, under direction of medical staff, f chemical work in connexion with testing new drugs on humans, a to assist in dietary surveys—The Under-Secretary of State, Resear Department, Colonial Office, Sanctuary Buildings, Great Smith Stree London, S.W.1.

Scientific Assistant (Analyst) by the East Africa High Co mission for the East African Agriculture and Forestry Resear Organization—The Crown Agents for the Colonies, 4 Millban London, S.W.1, quoting M.27761.G.

Scientific Officer (Chemist) at the Water Pollution Researc Laboratory (Department of Scientific and Industrial Researc Minworth, Birmingham, for work on the effect of temperature on ra of oxidation of organic matter by bacterial action—The Ministry Labour and National Service, Technical and Scientific Register (K York House, Kingsway, London, W.C.2, quoting F.323/50A.

Statistical Officer (who will be responsible for the planning statistical surveys and returns, and for statistical analyses) in th Government Statisticians Department, Gold Coast—The Director Recruitment (Colonial Service), Colonial Office, Sanctuary Buildin Great Smith Street, London, S.W.1, quoting 27297/1/51.

Surveyor (Ref. 27076/23) to carry out special duties in char of levelling in Kenya, and Assistant Surveyors (Ref. 27070/28/5 in the Federation of Malaya—The Director of Recruitment (Coloni Service), Colonial Office, Sanctuary Buildings, Great Smith Stre London, S.W.1, quoting the appropriate Ref. No.

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THE BALANCE OF SCIENTIFIC RESEARCH AND DEVELOPMENT

A PASSAGE in the latest report of the Advisory Council on Scientific Policy gives point to misgivings recently expressed as to the possible restriction of national expenditure on scientific research and development. The Advisory Council is already considering the extent to which a policy of restricting such expenditure could safely be pursued; indeed, quite apart from the effect of rising costs, in present circumstances it is clearly imperative that those responsible for the conduct of research in all institutions dependent, like the universities, to any extent upon State support, should look carefully at their programmes with the view of making sure that resources are not being wasted. In a recent press interview in London, Dr. C. A. Thomas, chairman of the Board of Directors of the American Chemical Society, expressed concern as to whether in Britain and in some Continental countries fundamental research is prosecuted to-day as intensively as in the past. Dr. Thomas paid tribute to British excellence in this field and suggested that unless our effort is maintained the Western powers will be seriously handicapped in future.

Dr. Thomas's concern appeared to be prompted at least in part by the fear that political conditions such as nationalization and government monopoly might be inimical to the atmosphere in which fundamental research can flourish, and that bureaucracy might lead to industrial stagnation or atrophy. Whether those fears are well-founded or not—and reports from the Nuffield Foundation suggest they warrant examination—they are doubtless also inspired by the emphasis placed in Great Britain in recent years on our shortcomings in applied research. Sir Henry Tizard's remarks in his presidential address to the British Association in 1948, that the productivity of labour in Britain is far lower than it would be if the results of past research were more resolutely and continuously applied, and his view that it is not the general expansion of research that is of the first importance for the restoration of industrial health, have been widely quoted. It is generally recognized that that industrial prosperity will depend more and more on the continuous application of science to industrial practice. Unless we can raise our standard of technology, unless there are many more men in executive positions in industry whose practical experience has been preceded by a scientific education, we shall inevitably fail to keep our place among the great manufacturing nations.

In the long run, as Sir Henry then pointed out, the expansion of research will fail of its full effect unless at the same time we promote education in the higher branches of technology and unless the technologist takes his rightful place in industry. Sir Ewart Smith's address last year at the Birmingham meeting of the British Association on what was essentially this text made a great impression, and although little has been done in the past three years to implement the expansion of higher technological education, the concentration on this issue may well have suggested to Dr. Thomas that fundamental research in Great Britain is likely to be curtailed so as to permit the expansion of applied or industrial research. Such a view is not, however, supported by the trend of the reports of the Advisory Council on Scientific Policy, in spite of the stress laid on securing the fuller and wider application of existing knowledge. It is widely recognized that the prosecution of fundamental research on an adequate scale and under appropriate conditions is an essential factor in the well-being of every industrial nation, and one which cannot be neglected with impunity. Even when writing under the title "The Neglect of Science", Prof. F. E. Simon, in his recently reprinted essays to laymen, does not suggest that the position in Britain is unsatisfactory, but that the need is rather to ensure that our opportunities and resources for scientific research are fully used.

It is, of course, well to recognize, as Lord Hankey pointed out on August 29 in his Centenary Lecture, under the auspices of the Ministry of Labour and National Service (available from the Ministry), on higher technical and scientific man-power, that when government expenditure on science and technology in its own establishments, universities, technical colleges and the like, reaches its present high level, there is latent danger of starving pure science through too great insistence on immediate and practical results. He did not think that this has happened, or is likely to happen in Britain in the near future, under the present system, but universities must be on guard against the risk. It is one to be watched all the more carefully at a time of financial stringency, when some halt in expenditure, if not actual reduction, may be unavoidable; and the risk is one to be considered in determining the form which the expansion of technological education should take.

As to the necessity for such expansion, there is general agreement, in spite of the competition for resources which the rearmament drive and the deterioration of the general economic situation in the past year or so may involve. Concern to improve the means or even the resources available to secure the application of existing knowledge has not in practice led to proposals to direct resources from the prosecution of scientific research to the application of its results. On the contrary, it is recognized that considerable expansion in both higher technological education and in technical education is imperative. The real questions at issue are the relative scale on which such expansion should take place, and where and how it can most efficiently be achieved.

On those questions Lord Hankey was able to give little guidance in the Lecture just noted. As chairman of the recently reconstituted Technical Personnel Committee, he could not well discuss the future work of that Committee; but its reconstitution should ensure that expansion of technological education will be on the basis of quantitative figures for the supply and demand of technologists and technicians.

It is from this point of view that Prof. A. R. Ubbelohde's contribution to a symposium of articles on postgraduate studies in the *Universities Quarterly* of August is of special interest at the present time. Dealing particularly with scientific research at the universities, Prof. Ubbelohde makes a number of very important points. He recognizes that university policy should seek to foster not only the vitality of individual schools, but also to impart a unifying spirit to all the diverse cells of research and scholarship it embraces; he reminds us, however, first that academic research must maintain its broad contacts with other intellectual activities in the university, and secondly that it should not make inflexible demands which would distort general university provisions for the advancement of knowledge.

These are the considerations which Prof. Ubbelohde applies to the critical review of future university policy in this field. First, almost challenging Sir Cyril Hinshelwood's remark to Section B (Chemistry) at the British Association meeting in Edinburgh, he points out that the failure of the scientific man to take a proper part in university administration may be detrimental to the general educational functions of the natural sciences. Admittedly, it is difficult to find really balanced university teachers of the highest quality; but if scientific men shirk their administrative responsibilities in the university, wasteful and dangerous situations can arise, just as they can when the use of the scientific man in public affairs is neglected.

One consequence in the university to which Prof. Ubbelohde directs attention is the warping of the selection of new staff and the provisions for teaching commitments. On this point he makes several suggestions designed to avoid such distortion and to secure the most effective use of staff for research during the creative years. These may seem relatively minor matters; yet it is only by attention to such administrative detail that we can hope to make the most of our limited resources of man-power, not only in the universities but also in other fields of activity.

Even more important, however, particularly in view of current discussions on higher technological education, are Prof. Ubbelohde's observations on the conduct of very high-cost research in the universities. No really satisfactory location of such research is, in his view, possible within the academic framework, and he urges that research programmes requiring very costly capital equipment should normally be segregated to the appropriate research institute or association. Their location in the universities tends to limit the free choice of research programmes by the universities, leading to the selection of programmes of comparatively poor training value, and limiting the experience of the young research worker as well as the flexibility of the research school around such equipment, and particularly the choice of new senior appointments.

In a technological foundation specially instituted for postgraduate work, mature and adequately paid staff can be engaged to run such high-cost equipment, and a better return of new results can be expected before the equipment becomes obsolete. It should not be difficult to provide access to such apparatus for the universities when necessary.

Prof. Ubbelohde makes the further suggestion that the separation of technologies from the academic community should be made at the postgraduate stage, when really heavy costs of equipment first arise. The risk of advanced work and research at the universities being crowded out by demands of expensive equipment requiring administration of an entirely different type would thus be avoided.

One point on which there is general agreement at the present time is that, even in face of the rearmament drive, much more must be spent on technical education, including higher technological education. It is all the more important, therefore, not only that we should, as the Duke of Edinburgh emphasized at Edinburgh, develop a co-ordinated system of scientific and technological education, lack of which is a prime cause of our failure to produce sufficient trained technologists to meet the urgent needs of scientific development in industry and to provide leaders for the future, but also that we should ensure that the money appropriated is most effectively spent. The policy to be followed should ensure so far as possible that all sources of wasted man-power or equipment such as those to which Prof. Ubbelohde directs attention are avoided.

No such policy can be achieved if excessive tenderness is shown to the prejudices or wishes of individual authorities or institutions: the national interest must prevail over sectional interest, but for reasons given and not by bureaucratic decree. It must be recognized that many parties concerned have already made contributions towards the delineation of the principles on which an agreed policy could be based. At Edinburgh, for example, Prof. J. C. Prescott indicated clearly principles which should determine the scope of university teaching in technology. The Association of University Teachers, in an appendix to its report on the place of technology in the universities, published last May, gave some figures regarding the extent to which technologies are dealt with in British university institutions; these show that the range covered at the Massachusetts Institute of Technology is individually equalled or excelled by Birmingham, Newcastle, Leeds, Liverpool, the Imperial College of Science and Technology and Manchester. Staff-standard ratios are not a function of the size or character of the institution, and may well be influenced considerably by the number of staff employed on full-time research.

The Association draws the further conclusion that in Great Britain the distribution of students among the subjects accords reasonably with the relative importance of the various industries; and, when due regard is paid to the location of industry, duplication of subjects among institutions is not excessive. Further, it considers that the number of technological students in British universities could be substantially increased without seriously disturbing the balance of faculties. It also comments on the extent to which the resources of the technological institutes such as those of Zurich and of Massachusetts are devoted to sponsored research. That was the subject of adverse comment in the report of the recent Committee on Educational Survey of the latter Institute; but there is no reason for supposing that it would seriously warp the work of any such institutions which might be established in Great Britain. Other institutions like the Technical University of Delft are conspicuously free of such influence, and all research is done on their own initiative; but the danger must be kept in mind in considering the expansion of research in the colleges of technology generally, as suggested by Dr. H. J. Cull.

This note from the Association of University Teachers is exactly the kind of survey which should have come independently from the Advisory Council for Scientific Policy. It illustrates once more the imperative necessity for dealing with the expansion of university and higher technological education as a whole, and for placing it under a single competent authority. Moreover, here again we see how closely the research aspect of technological education, and possibly that of teaching also, is linked up with the work of the research associations. It is manifest that the whole problem is one for which the responsibility in our existing organization for research and development rightly falls on the Lord President of the Council, to whom indeed, through the Advisory Council on Scientific Policy, the new Standing Committee on Scientific Man-power is presumably responsible.

The position disclosed by the latest returns from the University Grants Committee for the academic year 1949–50 emphasizes the need for early assessment of the situation as a whole. The expansion of the full-time student population of universities and university colleges of Great Britain to 85,421—the highest ever recorded—as compared with 50,002 in 1938–39, gives no indication of the extent to which the accommodation of the universities is already seriously strained. No significant increase in the student population, the Committee comments, would be possible without the provision of new buildings on a much larger scale than seems practicable in present conditions. This is its reason for regarding any substantial increase in this figure as unlikely in the near future. It might have added that the crowding of lecture rooms gives no idea of the even more serious congestion of the time-tables of the teaching staff. Some halt in expansion must, in fact, be called if standards are to be maintained; and the increasing extent to which students are dependent on scholarships and other forms of financial assistance might well in present circumstances operate to afford the universities a breathing space for consolidation and long-term planning. Meanwhile, it should be noted that the number of full-time students in technology, 10,933, was relatively unchanged from 1948–49 (10,884), although the number of advanced students of technology, included in these figures, increased from 858 in 1948–49 to 953.

Over the past three years, the number of full-time students of technology in the universities, though slightly increasing, has been relatively stable and is now only 12·8 per cent of the total as against 12·9 per cent in 1947–48. The essential point is that policy should be formulated, not by the Ministry of Education or any authority concerned with one segment of the problem, but by some authority carrying a general responsibility, independent and strong enough to resist sectional pressure and to probe *ex parte* statements and capable of taking a balanced view of the requirements of Great Britain in regard to the supply of trained men and women, the resources available for the production of that supply, and the repercussions of the redistribution of the effort demanded upon other national needs; this applies not merely in science or technology but also in other fields. Without such a balanced view and wide responsibility, there can be little hope of a policy or programme which will meet the situation without involving waste of resources in man-power and materials that can ill be spared now, and will be hard to recoup by greater efficiency or productivity in the long run.

NATURAL PRODUCTS OF INDIA

The Wealth of India

A Dictionary of Indian Raw Materials and Industrial Products. Vol. 2, Part 1: Raw Materials. Pp. xx+427. Rs. 25; 40*s*. Vol. 2, Part 2: Industrial Products. Pp. xii+251. Rs. 15; 24*s*. (Delhi: Council of Scientific and Industrial Research, 1950–51.)

In the last two decades of the nineteenth century considerable attention was paid by men of science in India, more especially by Warden and Hooper, to the study of Indian natural products. Much of this important work was summarized by Sir George Watt in his two classics, "A Dictionary of the Economic Products of India" and "The Commercial Products of India". Owing possibly to the rapid development in Europe and elsewhere of synthetic organic chemistry, this interest gradually waned. Only recently has there been a notable revival associated more especially with the names of Seshadri, Siddiqui and Venkataraman.

No doubt the study of Indian natural products will form one of the main subjects for research in the National Chemical Laboratory in Poona, while those plant products which have played so large a part in indigenous medicine will be examined at the Central Drug Research Institute opened last February in Lucknow. On that occasion Sir Edward Mellanby remarked: "It is an astonishing fact that whereas a large part of the plants, from which official drugs in the pharmacopœia are made, are already found in this country, yet many of these drugs are imported in large quantities".

To future research workers in these fields the dictionary "The Wealth of India" will undoubtedly prove of great value. When Parts 1 and 2 of Vol. 1, covering the letters *A* and *B*, were reviewed (see *Nature*, 163, 743; 1949), the view was then expressed that the publication would prove indispensable to all those interested in natural products. This is equally true of the present work, Vol. 2, Part 1, "Raw Materials", and Part 2, "Industrial Products", which have now appeared under the editorship of Mr. B. N. Sastri, who has replaced Mr. B. L. Manjunath.

Part 1, which covers the letter *C*, comprises some four hundred pages and is liberally illustrated with excellent coloured plates and line drawings. It is clearly impossible within the scope of a brief review to refer in detail to the individual articles; but one cannot but be impressed by their high quality, their value being much increased by the numerous references to the original literature. In dealing with agricultural products, not only are details given of the most satisfactory methods for their cultivation, their processing and their chemistry, but also statistics are included of Indian production and exports. In the article on pyrethrins there is an informative table of the effect of this insecticide on the pests attacking Indian crops. In view of the fact that although the spinning mills are in India jute is mainly grown in Pakistan, the lengthy article on this subject is of particular interest, and it is clear that the cultivation of jute in India is being widely extended. It is hoped that this will not be allowed to curtail the growing of foodstuffs in which India is so lamentably deficient. It is natural in a dictionary covering so many subjects that it is not free from errors, and in some cases recent work has been overlooked. This is, however, a very minor defect. The book is beautifully printed and produced, and it is remarkably free from typographical errors. It can be most cordially recommended, and its low price (40*s*.), which must be below the cost of production, should ensure a wide circulation.

Outside India, Part 2, "Industrial Products", will have a much more limited appeal. The articles are very diverse, dealing with such subjects as cotton spinning, clocks, cigars and cigarettes. Perhaps the main interest of this volume outside India will be to indicate how rapidly industrialization is advancing. Naturally there is some overlap between Parts 1 and 2 as, for example, in the articles on camphor; but this is unavoidable. It may be anticipated that this account of Indian industries will act as a catalyst and stimulate the further advance of India as an industrial nation. Like Part 1, Part 2 is well illustrated and its cost (24*s*.) is low.

J. L. Simonsen

CHEMISTRY OF HETEROCYCLIC COMPOUNDS

Heterocyclic Compounds

Edited by Robert C. Elderfield. Vol. 1: Three-, Four-, Five- and Six-Membered Monocyclic Compounds containing One O, N and S Atom. Pp. ix+703. 88*s*. net. Vol. 2: Polycyclic Five- and Six-Membered Compounds containing One O or S Atom. Pp. vii+571. 120*s*. net. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950–51.)

The need for an up-to-date reference book on the chemistry of organic heterocyclic compounds has been widely recognized for some time, and, from several quarters, indications have been given that the need was to be met. The publication of the first two of a projected series of volumes on the subject is consequently a matter of general interest, and Prof. R. C. Elderfield's work will be received with eagerness and carefully scrutinized.

In form, these volumes follow the now familiar pattern of a series of contributions by individual authors under a single editorship. It is the expressed purpose of the authors primarily to present in critical fashion the principles rather than the particulars of individual topics, and to elaborate only in proportion as the lack of monograph or other specialist literature may require. For example, alkaloids receive only incidental mention and, following systematic treatment of simple butenolides, cardiac glycosides are dismissed with a general reference in the appropriate subsection which deals with naturally-occurring derivatives of furan. This policy should commend itself to the reader's purse, although it may not always serve his convenience and will evoke a critical attitude to the use which is made of the space gained.

Volume 1 comprises uncondensed heterocyclic compounds containing one hetero-atom, namely, oxygen, sulphur or nitrogen, in rings of three to six members. This accommodates (Chapters 1–3) discussion of ethylene (and trimethylene) oxides, of ethylenimines and of azete derivatives (azetidine = trimethylenimine) including β-lactams. Furans, thiophenes and pyrroles are assigned separate Chapters (4–6), which are followed (Chapters 7–9) by one on pyran/thiapyran types and by two on pyridines and their hydrogenated derivatives. Tribute must be paid to the authors no less for their clarity of style than for the wealth of information presented. In a composite work of this sort and in a field of this size, expedients of arrangement and occasional rather arbitrary selection of material are inevitable. Biotin, for example, a condensed bicyclic compound, takes up fully a quarter of the chapter on thiophene, whereas this chapter lacks the factual discussion of resonance to make it consistent with analogous sections. Again, the subsection which deals with reduced pyrroles is so severely restricted as to exclude even the mention of proline. Such criticisms, however, are overwhelmed by the merits of the book, which by its modern outlook, its range and readability will command the admiration as well as the interest of both the general and specialist reader.

Volume 2 deals with polycyclic compounds containing one oxygen or sulphur hetero-atom in a five- or six-membered ring. The first five chapters are devoted to the benzo-derivatives of furan, including phthalan and phthalide types, and of thiophene. Thereafter eight Chapters (6–13), all contributed by S. Wawzonek, present the various classes of compound derived from the benzopyran and dibenzopyran systems, the volume being completed by a Chapter (14) on thiochroman derivatives. A consistently high standard of treatment and presentation is maintained throughout, and the assemblage of much material that is otherwise widely dispersed will be particularly welcome. Attention is mainly directed to the fundamental chemistry of the heterocyclic systems, and where naturally occurring compounds are too numerous for detailed consideration, they are briefly described in tables (with references). It is regrettable, however, that these tables and their contents are not mentioned in the index.

Both volumes are well produced. The subject-matter is copiously illustrated with clear-cut, readily intelligible formulæ and is extensively documented by means of footnote references—many of them to recent work—providing a service of inestimable value. As judged by the present volumes, the series is conceived on a generous scale and when completed should go far to meet the requirements of all who have interests in the field of heterocyclic chemistry.

JAMES D. LOUDON

EMBRYONIC DEVELOPMENT IN THE SEED-PLANTS

Plant Embryology

Embryogeny of the Spermatophyta. By Donald Alexander Johansen. (Plant Science Books, Vol. 24.) Pp. xviii+306. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1950.) 6 dollars.

THE unique range of Prof. Johansen's information on the embryology of the seed plants gives him an obvious authority to write upon the subject. Moreover, there has always been a conspicuous gap in botanical literature in the English language for this book to fill. The author has presented a magnificent compendium of all the recorded observations on embryogeny, largely supplemented by his own researches. It is veritably a mine of information, from which little or nothing, positive or negative, seems to be missing. Indeed, the negative statements are often as valuable as the positive, provided that one bears in mind that such remarks as "nothing is known about so and so" refer only to the author's somewhat strict point of view.

The book is not, however, one which can be recommended for general student reading. It is as a work of reference that it makes its greatest appeal. One should except from this statement the introduction and Chapter 16, "Anthophyta; General Considerations", which deal with the history and scope of plant embryology.

The author has devised a system of algebraic notation for summarizing the sequence of cell divisions during embryonic development, which should be valuable to the research worker as a shorthand method of recording observations. It certainly gives greater precision to descriptions, but if applied too strictly to such plastic material it may prove deceptive. It is certainly difficult to follow without intimate acquaintance.

The first oospore division is taken as the starting-point for description, and therefore fertilization and embryo-sac structure are scarcely mentioned. Although this limitation is in accordance with plan and may have been inevitable in view of the amount of detail presented, it does detract from a rounded presentation of embryology such as is to be found, for example, in Maheshwari's recent book.

On p. 93, the author's plan of embryology is explained under three headings: (1) embryonic morphology, the static aspect or embryography; (2) embryonic physiology; (3) embryogeny, the kinematic aspect, with four sub-divisions—(*a*) embryogenesis, (*b*) embryotectonics, the architecture of the embryo, (*c*) embryogenergy, the destination or functions of the embryo, (*d*) embryonomy, the laws of embryonic development. The book is destined to expound only the last of these four.

The Gymnospermæ occupy eighty pages, while two hundred pages are given to the Angiospermæ, under the name Anthophyta. The families and genera included are compared and related by means of a system of types and variations. The word 'type' has been inherited from Schnarf, and his six type designations, named after exemplar families, have been retained, with one exception. The separation of these types is based primarily on the behaviour of the terminal cell of the two-celled embryo and secondarily on whether the basal cell does or does not contribute to the embryo proper. The classification is simple, clear, and expresses differences of a fundamental nature.

Each type is sub-divided into a number of 'variations'. This term is unfortunate, for it has no genetical implication and is a purely formal expression of certain morphological concordances in embryonomy, grouping together plants which are otherwise unconnected. The term 'sub-type', though cumbrous, would have been better. Better still would have been the word 'pattern', which Johansen himself uses only in the Orchidaceæ, a family more or less *sui generis* embryologically. Terminology is, however, always a bone of contention between British and American authors and need not be further pursued here.

It is a reviewer's privilege to differ from his author; but he must not be ungenerous to his merits. This work has been so carefully compiled and it is so fully documented that it gives a very favourable impression of accuracy and reliability. The book is really a most notable addition to botanical literature, and it will retain its place and value for a long time.

R. C. McLean

HANDBOOK OF ENSILAGE

Silage

By Dr. Stephen J. Watson and Dr. A. M. Smith. (Agricultural and Horticultural Series.) Pp. 143+17 plates. (London: Crosby Lockwood and Son, Ltd., 1951.) 10*s*. 6*d*. net.

THE making of silage is no new thing in British farming. In the last quarter of the nineteenth century it had a considerable vogue, but the science of the process had not been worked out, mistakes were made and results were often disappointing; a few farmers persisted, but, speaking generally, silage-making languished for fifty years. During the Second World War great efforts were made to extend the practice, but these efforts had very little success. By this time much more was known of the changes which occur in green material when it is ensiled, but many farmers had not that knowledge and failed to appreciate that ensilage is merely a method of conservation and that it can never produce good feed from poor herbage. After the War farmers came to realize that the days of cheap imported feeding-stuffs were definitely ended, and not likely to return, and so they were ready to give ensilage a further trial and assign to it its proper important place in their farming systems.

Arable silage plays a part, but it is the ensiling of grass and clover which has been extended so much recently. Grassland provides by far the cheapest food for livestock, but the seasonality of its growth requires that the surplus of spring and early summer should be conserved for winter feeding The established method is haymaking; but this is dependent on the weather, and even in good conditions it entails considerable waste of nutrients. Artificial drying is increasing, but it is very expensive both for equipment and in operation. Ensiling grassland herbage costs less than half that of drying it artificially and, on the other hand, entails little more than half the nutrient loss that accompanies haymaking. It is the appreciation of these simple facts which has led to the remarkable increase in ensilage witnessed in the past two or three years, and it really does seem that the practice is now at last established in British farming.

There is no simple rule of thumb for making good silage. Details of the process must vary according to the material to be ensiled, the silo and equipment available, and to the weather at the time. For success, some knowledge of the principles involved is essential, and hitherto there has been no simple and complete handbook on the subject. Prof. S. J. Watson and Dr. A. M. Smith have met this need and met it very adequately. Their book is written in the plainest language; it deals sufficiently with the underlying principles and exhaustively with the details of the various methods. The book will be welcomed by farmers and by students, and it should do much to consolidate the position which silage-making has newly won.

H. G. Sanders

STUDIES IN ECONOMETRICS

Statistical Inference in Dynamic Economic Models

By Cowles Commission Research Staff Members and Guests. Edited by Tjalling C. Koopmans. (Cowles Commission Monographs, No. 10.) Pp. xv+438. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 48*s*. net.

THIS book, to which eleven authors have contributed, represents the work which has been done by the members of the Cowles Commission and their collaborators during the past few years on the exploration of economic relationships by statistical methods. It is one of the most important works on econometrics which has yet appeared, and, although it is not easy to read, particularly for the economist with no special mathematical knowledge, it will be widely studied.

The basic problem of econometrics is to set up a model of the economic system and to formulate the equations which determine its behaviour. This raises questions which are distinct in degree and emphasis, though not perhaps in kind, from the parallel problems of writing down the equations of physics. The approach of the Cowles Commission is to formulate a set of linear equations in two kinds of variables: *endogenous*, namely, those inherent in the economics of the system; and *exogenous*, namely, those which impinge on the system from without. The effect of disturbances and the impossibility of experimentation are taken into account by allowing these variables to incorporate a random element. There are then four classes of problem for examination: to set up the system of equations; to determine whether they are soluble; to construct a system of estimation for the unknown parameters; and to compare the results in practical cases to see whether they are plausible enough to justify acceptance of the model.

The basic memoir in this volume is that by Koopmans, Rubin and Leipnik on "Measuring the Equation Systems of Dynamic Economics". The other articles develop various aspects of the subject in dealing with problems of identification, structural and predictive estimation and time-series. The papers, considered as a whole, are of a high standard; but the connectivity of the treatment suffers from the fact that they are by different authors, there is no clear set of definitions of some of the terms employed, and no practical examples are given. This is therefore a book for the specialist. The Commission promises a further volume of a more expository character in which emphasis will be placed on basic ideas and techniques rather than on mathematical proofs.

Colloques Internationaux du Centre National de la Recherche scientifique, 14

Méthodes de calcul dans des problèmes de mécanique, Marseille, 30 Mars–6 Avril 1948, Paris, 8–9 Avril 1948. Pp. 105. (Paris: Centre National de la Recherche scientifique, 1949.) 900 francs; 20*s*.

THE subject of these lectures is more restricted than might be anticipated from their title. The first part of the colloquium was held at Marseilles, where it was hoped to establish a mathematical laboratory, and opened with an appreciation of British methods by J. Valenski (Marseilles). The proceedings consisted chiefly of an exposition of Southwell's well-known 'relaxation method', delivered by D. N. de G. Allen, one of Sir Richard Southwell's colleagues. A later British method, the 'escalator method' of Morris and Head, was explained by T. Vogel (Marseilles); it has roughly the same relation to dynamics as Southwell's method has to statics.

In the second part of the colloquium, held at Paris, M. Picone (Rome) dealt with the analysis of periods, a problem of great importance in astronomy, meteorology, statistics and other branches of science. This problem has been studied by H. and Mme. Labrouste (Paris) and by F. Vercelli (Italy). An account of the 'Logobax' machine which can perform the calculations needed in the Labrouste method was given by L. Couffignal (Paris). J. M. Burgers (Delft) discussed some problems of turbulent motions in fluids. L. Malavard (Paris) dealt with calculations by the aid of electric circuits, and their application to hydro- and aero-dynamics. A. van Vijngaarden (Amsterdam) and F. H. van den Dungen (Brussels) dealt with other methods applicable to hydrodynamics. Finally, L. Couffignal discussed in general terms the role of numerical calculation in scientific and technical research.

The organizers deliberately excluded consideration of mechanical and electronic calculating machines on the ground that a subject so vast would require a whole colloquium to itself. H. T. H. P.

Fluorine Chemistry

Edited by Dr. J. H. Simons. Vol. 1. Pp. xvii+615. (New York: Academic Press, Inc., 1950.) 12 dollars.

"FLUORINE", it has been stated by Prof. N. V. Sidgwick, "is in some ways the most interesting of the halogens." Yet the importance, both real and potential, of the element and its compounds has become apparent only in recent years. Extensive and vigorous researches have occurred since 1940, and have rendered obsolete and inadequate the two classical works on fluorine by Henri Moissan and Otto Ruff. For this and other reasons, the publication of a new and thorough treatise on fluorine chemistry is timely and welcome.

The first volume of this work is written by a group of fifteen authors, each dealing with a branch of the subject in which he has personal experience. The inorganic chemistry of fluorine is described in detail by H. J. Emeléus, A. B. Burg, H. S. Booth, J. T. Pinkston, jun., D. R. Martin and J. H. Simons—special attention being given to the halogen fluorides, boron trifluoride and hydrogen fluoride. The preparation of elementary fluorine—now no longer a laboratory curiosity, but an item of industrial production—is dealt with by G. H. Cady. Some theoretical aspects of fluorine chemistry are examined by George Glockler in one of the more speculative chapters.

Perhaps the most fascinating sections of the book are those by L. A. Bigelow, J. H. Simons, T. J. Brice, W. H. Pearlson, and J. D. Park, in which the fluorocarbons and their derivatives are described. This field is potentially one of the most enormous in chemistry, for the fluorocarbons are not only more stable than hydrocarbons, but form large numbers of derivatives.

Altogether, this is an excellent production, authoritatively written. H. A. SKINNER

Practical Dairy Bacteriology

By Prof. Paul R. Elliker. (McGraw-Hill Publications in the Agricultural Sciences.) Pp. ix+391. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 34*s*.

THIS book, as the preface proclaims, is intended for the elementary student. Bacteriological descriptions of the organisms encountered in the production and processing of milk and the manufacture of dairy products are not seriously attempted. The treatment is mainly technological, and in this respect the book can safely be recommended to the operative and to the student in this field. References abound in all the chapters, but these are, with few exceptions, to American publications.

Flamingo City

By G. K. Yeates. Pp. 210+38 plates. (London: Country Life, Ltd.; New York: Charles Scribner's Sons, 1950.) 25*s*. net.

THIS can fairly be said to be an outstanding bird book. Mr. G. K. Yeates is already well known as a bird photographer; but this work shows that he can also write very well indeed. His chapters on the flamingo colony of the Carmargue do not exhaust the interest of the book, although they are its highlights. Mr. Yeates writes on the other birds of Provence, and we have an insight of the beauty of their colouring and the attractive feature of their lives in that sun-drenched land which has only two disadvantages—the mistral and the mosquito. The strange habits of the pratincole and the domestic happiness of the brilliantly plumaged bee-eater are told clearly and arrestingly. The mind of the reader is indeed held throughout the chapters of the book, so that the author's disappointments and his most exciting moments are shared.

In a book where the illustrations are of so high a standard, it is difficult to single out any specially for praise; but the coloured photograph of the flamingo group on p. 158 is truly magnificent. Scarcely less beautiful are the illustrations (p. 62) of the pratincole on the nest, and of the two bee-eaters on the sand (p. 90). The author has interesting things to tell us of the unusual nesting habits of the flamingo. It does not necessarily nest each year, unless the water-level is to its liking. The food of this large and strikingly beautiful bird is not known with certainty. Gallet, who has studied the flamingo more closely than any other living observer, has advanced the novel and bold theory that the bird feeds on putrid mud. This would account for the nesting of the flamingo in a terrain so saturated with salt as to support no apparent life.

The publishers have done their part of the work admirably, and have produced a book which must add distinction to the library of the owner fortunate enough to possess it. SETON GORDON

A CENTURY OF PHYSICS*

PHYSICS FROM 1850 to 1900

By PROF. E. N. da C. ANDRADE, F.R.S.

ONE characteristic of this great period of physics is the complete dominance of Newtonian mechanics; this dominance does not, it is true, distinguish it from the previous fifty years, but does offer a contrast with the period with which Prof. Born is to deal. What, perhaps, characterizes the period more closely is the way in which Newtonian mechanics was applied outside the field of astronomy, and the mechanics of visible masses in general, to which it had been more or less restricted before 1850. In all the various ether models which were a feature of nineteenth-century physics Newtonian mechanics found expression, as the Newtonian system did, indeed, in all the early atom models. But perhaps its most striking direct expression was in the kinetic theory of gases, the creation and development of which to a high degree of precision is almost entirely the affair of this period.

The period is further characterized by the prominence which electrical forces came to attain and the great generalization of the relation between electric and magnetic forces which, at the hands of Maxwell and Hertz, led to the formulation and triumph of the electromagnetic theory of light. The first establishment of the wave theory of light, by Young and Fresnel, in the early years of the past century, necessarily involved the conception of an ether of space: whereas the light particles of Newton could travel through empty space, the propagation of waves seemed to demand a medium, something in which the waves could travel (I must add, in parenthesis, that Newton's particles had certain wave aspects, so that his theory, like that which prevails to-day, demanded for light mixed wave and particle properties). The ether of space, however, if it is to express the experimental facts, must have very peculiar properties, and the history of physics from 1850 to 1900 is characterized by the extraordinary skill, imagination, mathematical ability and physical credulity used in the construction of ethers. Let us glance at some of the steps by which the ether attained its command over much of the physics of the period in question.

The work of Oersted in 1820 first showed that an electric current produced a force that acted upon a magnetic pole—a magnetic force—and Ampère worked out a beautiful mathematical theory of this effect and of the mutual action of steady currents. Faraday developed the laws of electromagnetic induction in the 1830's and put forward a general theory of electric and magnetic action in terms of lines of force. One great contrast between Faraday's views of what we now call the electromagnetic field (the term 'magnetic field' seems to have been first used by Faraday in 1845, just before the period opens) and the views which were then current is the emphasis which Faraday placed on the part played by the medium. In 1851, when the period opens, he published a paper "On lines of Magnetic Force: their definite character: and their distribution within a Magnet and through space" which gives the results of his mature reflexion and develops the conception of cutting lines of magnetic force in connexion with induced currents. This was against the feeling of his times, especially the feeling of the mathematicians. Airy, the Astronomer Royal, for example, said of a slightly later paper in which Faraday had further developed his views on lines of force, "but I declare that I can hardly imagine anyone who practically and numerically knows this agreement [that between the inverse square law of attraction and observation] to hesitate an instant in the choice between this simple and precise action, on the one hand, and anything so vague and varying as lines of force, on the other hand". That was written in 1855. In the same year Clerk Maxwell wrote his first paper on electricity, an elaborate treatise which occupies seventy-five pages in his collected works, entitled "Faraday's Lines of Force". Here he showed that the conception of lines of force could be made to yield precise mathematical results when suitably treated. He wrote: "By a careful study of the laws of elastic solids and of the motion of viscous fluids I hope to discover a method of forming a mechanical conception of the electrotonic state adapted to general reasoning". This sentence expresses as a particular case the general ambition of the man of science of the period—to find the mechanical characteristics which would endow an ether with the necessary properties. This is probably the only occasion on which, in this short paper, I shall have an opportunity of referring to another characteristic feature of the period, the great development of the mathematical theory of the perfect elastic solid and of the perfect fluid, represented by the work described in the great text-books of Love and Lamb. As for real fluids, Newtonian viscosity was just tolerated; but real solids, which did not obey Hooke's law, or, still worse, which showed plastic deformation, were not mentioned in decent scientific society.

A few years after this first paper Clerk Maxwell developed his project and put forward the electromagnetic theory of light. He used illustrations from the motion of a medium governed by Newtonian laws; for example, he conceived magnetic lines of force as vortex filaments. He introduced the conception of a displacement current: when one plate of a parallel-plate condenser was being charged, something between the plates was being elastically displaced, so that the current was continuous. From his equations he deduced that electromagnetic waves must exist, estimated their velocity, found that it agreed with that of light and concluded, in his own words, "We can scarcely avoid the inference that light consists of the transverse undulations of the same medium which is the cause of electric and magnetic phenomena". This is one of the great unifying discoveries of physics. I can only refer to Maxwell's classical "Treatise on Electricity and Magnetism", which is, in the main, a precise quantitative expression of Faraday's general views. Stresses in the medium play a prominent part. Maxwell deduced the pressure of light, which was later investigated experimentally by Lebedew, Nichols and Hull, and Poynting, and has proved of such importance in connexion with astronomical problems and thermodynamic theory. Poynting's name reminds us of his great theoretical discovery, the Poynting vector.

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* Substance of three papers read on August 13 before Section A (Mathematics and Physics) of the British Association meeting at Edinburgh.

Following Maxwell, Hertz, having first deduced Maxwell's equations on a different basis, proceeded to realize electromagnetic waves experimentally, by means of the oscillating spark discharge. He invented the resonant circuit. Hertz, followed by FitzGerald and Trouton, showed that all the properties of light, reflexion, refraction, polarization, could be demonstrated with the electromagnetic waves from the spark discharge. This irrefutably established the electromagnetic theory of light. I need scarcely refer to the extraordinary developments that have flowed from Hertz's work.

Meanwhile, the search for a satisfactory mechanical ether continued to occupy many of the great names of theoretical physics. Even if the chief result of all this brilliant and sustained effort was to show that such an ether was impossible, I cannot pass it over without mention. Fantastic values for the elasticity and density of the elastic medium which was postulated by many were worked out. Vortices, mixtures of vortices and irrotational elements to make what Kelvin called a vortex-sponge, an aggregate of vortex rings and other kinds of vortex elements were made to bear cumbrous loads of mathematics which now awaken the kind of wonder evoked by the Pyramids—prodigious labour to enclose a small chamber empty of anything that has significance for us. As late as 1903 Osborne Reynolds published a book of 250 pages on an ether consisting of uniform spherical grains beginning, "By this research it is shown that there is one, and only one, conceivable purely mechanical system capable of accounting for all the physical evidence, as we know it, in the Universe", which reminds one of Newton's "It remains, that from the same principles, I now demonstrate the frame of the System of the World", the only difference being that Osborne Reynolds's statement is the inscription on a tombstone of the dead and forgotten and Newton's is on a triumphal arch. It was with reference to Osborne Reynolds's ether that FitzGerald said "Hard particles are an abomination". It is only of recent times that we have come to accept that the ether is no more than a subject for the verb "to undulate" and that Clerk Maxwell's theory is simply Clerk Maxwell's equations.

We cannot leave this cemetery of dead ethers, however, without recounting one consequence of inestimable importance which the search for a satisfactory ether produced. If there were a stationary luminiferous ether, the motion of the earth through it would appear to have as a consequence that the velocity of light in the direction of motion, as measured by an observer on the earth, should be slightly different from that at right angles to this direction. Albert Michelson, with the collaboration of Morley, undertook the task of trying to establish this difference of velocity by an apparatus based on the interference of two beams of light which had travelled at right angles to one another. The sensitiveness of the method, which was an optical triumph, was amply sufficient to establish the motion through the ether, if the reasoning on which it was anticipated was correct. Everybody knows that the result was negative. This result, supported by the failure of other attempts to detect a motion through the ether, was the only begetter of the first theory of relativity, which graced the early years of the succeeding period.

I should here just refer to the experiments on the velocity of light. They begin in 1840 with Fizeau's toothed-wheel method, much improved twenty-five years later by Cornu. Foucault's rotating mirror method enabled much shorter light paths to be used. Michelson effected great improvements and obtained in 1882 a value 299,853 km./sec., which compares well with the value 299,792 recently obtained by Essen—sixty-five years later—a difference of 1 part in 5,000.

The theory of heat as we know it is, with the exception of Carnot's fundamental work (1824), practically the creation of the period 1850–1900. Perhaps I should also mention as a forerunner Fourier, of the importance of whose work there is no question, but his "Théorie Analytique de la Chaleur" (1822) is a mathematical development, not depending on the nature of the heat which is assumed to pass at a rate proportional to the temperature gradient. The first prime advance to which I will refer is the establishment of heat as a form of energy. Julius Robert Mayer's first announcement, in which he calculated a value of the mechanical equivalent of heat, goes back to 1842 and 1845, just before our period, but it received no recognition, rather the opposite. The date 1850 is remarkable as that on which Mayer, probably as a result of persecution, partly real, partly imagined, jumped out of a window and received severe injuries. It was owing to Tyndall that his work first received due recognition in 1862. Joule it was, however, whose work really established in a convincing manner the equivalence of work and heat and gave an accurate value of the mechanical equivalent. This work extended over the period 1843–78. The experiments on the heat generated by stirring water with a measured expenditure of work are described in all the text-books: what is often forgotten is that Joule also measured the heat generated by the current from a dynamo driven by a measured power; by the compression of a gas; and by the forcing of water through fine tubes. The value he obtained in his best experiments on stirring water (1878) was $4 \cdot 184 \times 10^7$ ergs as equal to a standard (15°) calorie: the accepted value to-day is $4 \cdot 181 \times 10^7$ ergs, a difference of less than 1 part in 1,000. Reference should be made to Rowland's extremely careful determination, which gave the value 4·187.

That the various determinations, made by widely different methods, gave the same value of the mechanical equivalent of heat means the experimental establishment of the first law of thermodynamics, which was explicitly enunciated by Clausius in 1850. At the same time Clausius formulated the second law of thermodynamics, which was independently put forward by William Thomson (Lord Kelvin) in a slightly different form. Clausius and Kelvin may rank together as the founders of modern thermodynamics.

The next fifty years saw the rapid development of the two methods of treating thermal phenomena, one the method of thermodynamics, which makes no assumptions as to the nature of heat but deals with its transformation into work according to general laws, and the other the method of statistical mechanics, which assumes the atomic structure of matter and calculates heat effects and transmutations as statistical averages of atomic events. Clausius introduced the term and conception entropy, to express the availability of energy in a thermodynamic system. The two laws of thermodynamics may be expressed as (i) the energy of the universe is constant;

(ii) the entropy of the universe tends to a maximum. Classical thermodynamics rests on the principles of energy and entropy, both defined without reference to the structure of matter. The introduction of the conception of entropy, which is a one-valued function of the state of a system, is one of the great achievements of our period.

It is impossible here to trace the great developments of thermodynamics that, at the hands of Maxwell, Kelvin, Kirchhoff, Helmholtz, van t'Hoff, Willard Gibbs and others led to results of such importance for physics, physical chemistry and engineering. The foundation of the absolute scale of temperature is one great landmark. The application, initiated by van t'Hoff, of thermodynamics to the study of chemical equilibrium—we may mention, as indicative, van t'Hoff's isochore—founded a new branch of science, which has had immense consequences for industrial chemistry. Willard Gibbs, whose work lies entirely in this period, deserves, perhaps, a special word. When, in 1901, the Copley Medal of the Royal Society was awarded to him, the citation said that he was "the first to apply the second law of thermodynamics to the exhaustive discussion of the relation between chemical, electrical and thermal energy and capacity for external work", which summarizes the chief advances of thermodynamics in the last decades of the century. The phase-rule was one of his achievements. I may, perhaps, quote Einstein's words referring to certain papers which he wrote in 1902 and 1903: "Wenn mir das Gibbsche Buch damals bekannt gewesen ware, hätte ich jene Arbeiten uberhaupt nicht publiziert, sondern mich auf die Behandlung einiger weniger Punkte beschränkt".

The application of thermodynamics to radiation was another step of first importance. It was as long ago as 1884 that Boltzmann showed that, by considerations involving the pressure of radiation, Stefan's laws of radiation—that the total energy of radiation of a black body is proportional to the fourth power of the absolute temperature—could be proved thermodynamically. The introduction of the conception of a black body, or full radiator, by Kirchhoff reminds us of the great services of this man. And a close link between this period and that which follows is furnished by a paper written in 1900 by W. Wien, in which he deduced a general formula for the distribution of energy in the spectrum of a black body. What the development of this problem led to at the hands of Planck is well known: it is fundamental for modern physics.

As an experimental physicist I cannot pass over the brilliant work that established experimentally the distribution of energy in the spectrum of a black body, for this, after all, is what guided theory. The work of Lummer and Pringsheim came right at the end of the century, while that of Rubens and Kurlbaum on the infra-red falls precisely in 1900.

So much—or rather so little—for thermodynamics. Let us look at the other method of approaching the problem, the molecular and statistical. The development of the kinetic theory of gases is a capital feature of the period, and led directly to the more comprehensive statistical mechanics. The only work that comes before 1850 is that of Waterston, which had no influence, as it was not published until 1892! It was Kronig (roughly) closely followed by Clausius (more precisely) who early in our period showed that the simple laws of the pressure of gases could be considered as a consequence of molecular bombardment of the walls of the container. Clausius soon introduced the important conception of mean free path. It was Maxwell and Boltzmann who were responsible for some of the chief mathematical developments of the theory. Maxwell established the formula for the distribution of energy among the molecules: the molecules, moving and colliding at random, have a wide range of velocity—theoretically from zero to infinite—and Maxwell's distribution law tells us what fraction of them have velocities within a given small range, when the gas is in statistical equilibrium. It was, perhaps, Boltzmann who by his method of treatment founded statistical mechanics, of which my colleague will, no doubt, have something to say. In particular, he showed that entropy could be expressed as the logarithm of a probability, and so tied thermodynamics and statistical methods together. Before leaving the subject, I may perhaps refer to Maxwell's astonishing deduction from the kinetic theory that the viscosity of gases is independent of the pressure, which he proved experimentally. This prediction was a triumph for the kinetic theory.

A great advance was made when the behaviour of real gases, as distinct from ideal gases obeying Boyle's and Charles's laws, was investigated both experimentally and theoretically. Regnault and Natterer had established just before our period opens that certain gases deviated from these simple laws. It was in 1869 that Andrews published his classical work on carbon dioxide, which established the existence of a critical point and made it clear that gases can be liquefied only if below a certain temperature peculiar to each. A few years later J. D. van der Waals developed his theory of real gases in a paper entitled significantly "The Continuity of the Liquid and Gaseous States in Matter". The theory is epitomized in his famous equation, which he was able to compare with Andrews's results. From it he deduced the theory of corresponding states, namely, that if we express the volume, pressure and temperature of a gas in terms of the critical volume, pressure and temperature of that gas, then one equation without arbitrary or experimental constants expresses the behaviour of all gases. It is not, of course, exact, but approximates surprisingly well to reality. Van der Waals's equation was followed, of course, by many other equations of state, of which the best is probably that of Dieterici.

The work of Andrews and van der Waals was, naturally, of great importance for the problem of the liquefaction of gases: it explained the failure of many attempts to produce liquid gases at a temperature above the critical. In 1883 Wroblewski and Olzewski liquefied oxygen, and soon after Olzewski liquefied oxygen, nitrogen, air and carbon monoxide in large quantities, and saw liquid hydrogen in an evanescent way. Just before the end of the century Dewar liquefied hydrogen in appreciable quantities, making use of his beautiful invention, the vacuum flask. Helium stood out until after the turn of the century; but the Leyden Cryogenic Laboratory, where Kamerlingh Onnes achieved this triumph, was founded by him in 1885. The liquefaction of gases is a good example of how experiment and theory alternate, each experimental stage producing a theoretical advance and vice versa. What modern theory owes to the experimental production of low temperatures is well known; I need only mention specific heats and superconductivity.

Round about 1890 the ether seemed to be the chief outstanding problem of physics: otherwise everything was in very fair order and nice and quiet. The index of *Nature* about that time collects the entries that are taken to refer to the subjects physics and chemistry. Taking two consecutive volumes I find in the index 29 lines referring to physics and about 240 to chemistry, and turning the pages of these volumes seems to show the same peaceful atmosphere in our subject. However, a burst of new discoveries—I do not say entirely unheralded—was about to break upon the scientific world. In his presidential address to Section A at the Edinburgh meeting of the British Association in 1892 Schuster remarked: "The most puzzling fact, however, connected with the discharge of electricity through gases"—a subject that interested him—"consists in the absence of symmetry at the positive and negative poles". That was the key to one great advance about to be made, the discovery of the electron as the result of the study of the low-pressure discharge.

As early as 1874 Johnstone Stoney, from the facts of electrolysis, had concluded that electricity was atomic in nature and had later (1891) suggested the name electron for the unit. The history of the actual establishment of the electron is a complicated matter. Perrin established the negative nature of the cathode stream. J. J. Thomson in 1897 showed that the ratio mass to charge of the particles, if particles they were, was about a thousandth of that for the hydrogen ion in electrolysis, but did not conclude as to the magnitude of the charge. Lenard, from his experiments on the passage of cathode rays through metals, concluded that the particles must be much smaller than atoms. Townsend in 1897 and 1898 attempted a direct determination of the electronic charge and obtained a value about two-thirds of the true figure. H. A. Lorentz showed that the effect discovered by Zeeman in 1897 could be explained on the assumption that the light emission was due to a particle with the properties of the electron. We can say that by the end of the century the existence of the electron was generally accepted, although its charge had not been very well established.

But these last years of the century were full of excitement, full of discoveries which came to full fruition in Born's period. In 1895 Röntgen discovered X-rays, as he named them. further, he himself established with astonishing rapidity their chief properties. They caused a popular sensation by enabling the bones of the human hand to be photographed through the flesh; but in the physical laboratories the ionization which they produced was the chief study. The photoelectric effect had been established by Hallwachs in 1888: in 1899 Lenard proved that the negative electricity released from metals by light consisted of electrons, as independently demonstrated by J. J. Thomson shortly after. In 1896 Henri Becquerel discovered that uranium salts emitted rays which affected a photographic plate, and that it was the uranium atom itself that was responsible for the radiation. This was the beginning of the study of radioactivity. Rutherford's first paper on the subject, which was an impressive piece of work, appeared in January 1899 under the title "Uranium Radiation and the Electrical Conduction produced by it". Meanwhile, in France, Marie Curie had discovered polonium and in 1898 Pierre and Marie Curie made the sensational discovery of radium. In the same year, Schmidt and Marie Curie independently established the radioactivity of thorium. The year after, Debierne produced actinium, and the first emanation, that of thorium, was discovered in the last year of the century. The study of radioactivity was, then, well launched in the early years. Finally, perhaps, if we are speaking of the birth of modern physics, reference ought to be made to the discovery of the positive canal rays, the father of isotopes, by Goldstein in 1886. Corpuscular physics, with its vast possibilities, was born in those last five years of my period.

I realize only too keenly how imperfectly I have surveyed the field. Every physicist here will accuse me, and accuse me with justice, of having made no reference to matters and men of capital importance. I have said, for example, nothing of the great work of Lord Rayleigh on sound—nominally on sound, but the mathematical methods and results exposed in his great book have far wider import, and have, for example, recently been used for problems connected with wave guides. I have said nothing of the discovery of the rare gases, I have said nothing of a vast and significant body of experimental research on heat and light, particularly on spectroscopy: nothing of the determination of the gravitational constant. I can only plead that forty minutes is a short time in which to deal with so much of really prime importance.

PHYSICS IN THE LAST FIFTY YEARS

By Prof. MAX BORN, F.R.S.

THE following review is based on personal recollections and cannot claim historical accuracy and completeness. I shall tell you what has impressed me most, since I attended, in 1901, my first lecture at the University of Breslau, my home city. We were taught what is called to-day classical physics, which was at that time believed to be a satisfactory and almost complete description of the inorganic world. But even Maxwell's theory of the electromagnetic field was, about 1900, not a part of the ordinary syllabus of a provincial German university, and I remember well the impression of bewilderment, admiration and hope which we received from the first lecture on this subject given to us by the then young and progressive lecturer Clemens Schaefer (still active at Cologne).

The first great event of a revolutionary character happened in 1905 with Einstein's theory of relativity. I was at that time in Göttingen and well acquainted with the difficulties and puzzles encountered in the study of electromagnetic and optical phenomena in moving bodies, which we thoroughly discussed in a seminar held by Hilbert and Minkowski. We studied the recent papers by Lorentz and Poincaré, we discussed the contraction hypothesis brought forward by Lorentz and FitzGerald and we knew the transformations now known under Lorentz's name. Minkowski was already working on his four-dimensional representation of space and time, published in 1907, which became later the standard method in fundamental physics. Yet Einstein's simple consideration by which he disclosed the epistemological root of the problem (the impossibility of defining absolute simultaneity of distant events because of the finite velocity of light signals) made an enormous impression, and I think it right that the principle of relativity is connected with his name, though Lorentz and Poincaré should not be forgotten.

Although relativity can rightly be regarded as the culmination of nineteenth-century physics, it is also the mainspring of modern physics because it rejected traditional metaphysical axioms, Newton's assumption about the nature of space and time, and affirmed the right of the man of science to construct his ideas, including philosophical concepts, according to the empirical situation. Thus a new era of physical science began by an act of liberation similar to that which broke the authority of Plato and Aristotle in the time of the Renaissance.

That result of relativity which later proved to be the most important, namely, the equivalence of mass and energy as expressed by the formula $E = mc^2$, was at that time considered to be of great theoretical, but scarcely of any practical, interest.

In 1913 Einstein's first attempt on general relativity became known; it was perfected two years later. It is the first step not only beyond Newtonian *meta*physics, but also beyond Newtonian physics. It is based on an elementary but so far unexplained fact—that all bodies fall with the same acceleration. To this day it is this empirical foundation which I regard as the corner-stone of the enormous mathematical structure erected on it. The logical way which led from this fact to the field equations of gravitation seems to me more convincing than even the confirmation of the astronomical predictions of the theory, as the precession of the perihelion of Mercury, the deflexion of light by the sun and the gravitational shift of spectral lines.

Einstein's theory led to a revival of cosmology and cosmogony on an unprecedented scale. I am not competent to judge whether it was the theory which stimulated the astronomers to build bigger and more powerful instruments, or whether the results obtained with these, like Hubble's discovery of the expanding universe, stimulated the theoreticians to still loftier speculations about the universe. The result, however, is undoubtedly that our astronomical horizon to-day, in 1951, is vastly wider, our ideas about the creation vastly grander than they were at the beginning of the period. We can estimate the actual age of the world (some thousand millions of years), its present size (determined by the receding nebulæ reaching the velocity of light) and the total number of nebulæ, stars and atoms, and we have good reasons for assuming that the laws of physics are the same throughout this vast expanse. The names of Friedmann, Lemaître, Eddington and Robertson must here be mentioned.

But after this boast let me conclude this section on a note of modesty. The fundamental problem of connecting gravitation with other physical forces, to explain the strange value of the gravitational constant, is still unsolved in spite of Eddington's obstinate, ingenious attempts. The most promising idea seems to me that of Dirac, developed by Jordan, that the gravitational constant is not a constant at all, but a scalar field quantity, which like the other ten, the components of the metric tensor, undergoes a secular change and has acquired its present value in the course of time elapsed since the creation of the universe.

Before speaking about the most characteristic features of modern physics, atomistics and the quantum concept, I have to dwell for a short time upon classical physics which, of course, has not suddenly ceased to exist, but continues and flourishes to such a degree that I should venture to say by far the greatest part of the time and effort of physicists is still devoted to problems of this kind, even of those, frequently found in the United States, who believe that nuclear research is the only decent pursuit deserving the name of physics.

In fact, the progress and success since 1900 in ordinary mechanics, elasticity, acoustics, hydro- and aero-dynamics, thermodynamics, electrodynamics and optics is spectacular enough. You have only to remember that in 1900 the internal combustion engine was in its infancy, motor-cars often brought in by horses and the aeroplane a fantastic dream. It would be impossible to attempt even the crudest sketch of these and other technical developments due to physics. Let me only mention a few characteristic points.

The first is the adoption of a more realistic attitude. In the nineteenth century the mechanics of solids and fluids were beautiful mathematical theories well suited for providing examination papers. To-day, they tackle actual problems of daily life and technology, for example, in hydrodynamics, boundary layers, heat transfer, forces on moving rigid bodies like the wings of aeroplanes, the stability of these, even for supersonic velocities. Among the pioneers whom I personally knew are G. I. Taylor, Prandtl, Kármán. In elasticity we have a similar development; the narrow field of problems accessible to analytical solutions has been enormously extended by numerical methods (Southwell's relaxation method), and the results are checked by photoelastic observations on transparent models.

This trend has been strongly assisted by the invention of mechanical and electrical computing machines. The speed and power of the modern instruments based on electronic valves has stirred the imagination of the world and given rise to a new science, cybernetics, the advocates of which expect a revolution of human civilization from these artificial brains—a belief which I do not share.

Acoustics, the branch of elasticity dealing with the propagation of waves, was confronted by numerous problems through the invention of the gramophone, the telephone and broadcasting. Here again the electronic valve was a powerful tool. Ultrasonic vibrations have been used for studying the elastic properties of crystals, for signalling and for time-keeping. The clock controlled by the oscillations of a piezo-quartz crystal seems to be more accurate and reliable than ordinary pendulum clocks.

Prof. Andrade has given an account of the origin and the development of thermodynamics which in 1900 was considered to be complete, with its two fundamental theorems (conservation of energy, increase of entropy). But this complacent conviction was wrong here as in many other cases.

In 1907 Nernst added a third theorem concerning the behaviour of substances at zero temperature. Of its numerous applications to physics and physical chemistry I can only mention the prediction of chemical equilibria and reactions, as exemplified by Haber's method of fixing nitrogen from the air (1914). The experimental approach to absolute zero made great strides. Keesom arrived in 1931 at 0·7° K. with the help of liquid helium. Giauque and MacDougall devised in 1933 a new method for cooling, using the demagnetization of paramagnetic salts. The absolute scale of temperature was extended below 1° K. by Kurti and Simon (1938) and others. Strange phenomena were discovered in this region, the supraconductivity of metals by Kamerlingh-Onnes in 1911, and the superfluidity of liquid helium by Keesom and Wolfke in 1927, Allen and Misener, Kapitza and others.

Even at higher temperatures new phenomena were found, for example, in the field of highly concentrated electrolytic solutions where the names of Bjerrum, G. N. Lewis, Debye and Huckel must be mentioned.

An approach to extreme conditions from another angle was made by Bridgman (since 1905), who systematically investigated the properties of matter under high pressure, reaching more than 100,000 atmospheres. His latest triumph is the observation of the breakdown of the electronic shells of alkali atoms under pressure.

Of great importance seem to me the recent investigations started by Onsager in 1930 and continued by Casimir, Prigogine, de Boer and de Groot, by which thermodynamics is generalized so as to apply to irreversible processes, by combining the classical laws of flow with one single result of statistical mechanics, the so-called principle of microscopic reversibility. The results seem to have a bearing on the understanding of the processes going on in living organisms.

The progress of electrodynamics is obvious to everybody in technical applications: improvements in the production of power and its transmission over long distances; telecommunication methods, such as telegraphy, telephony and wireless transmission. In 1900 electromagnetic waves were a laboratory experiment. Since Marconi's success in 1895 broadcasting has become a powerful factor in human affairs.

Electromagnetic waves comprise the whole of optics, but it would be quite impossible to give an account of the progress in all branches of optical research and practice. The improvements and refinements of all kinds of optical apparatus, of the experimental and theoretical investigation of diffraction, refraction, absorption and scattering are enormous. Let me mention only a few outstanding achievements in spectroscopy because of their bearing on atomic physics: the discovery of the Zeeman and Stark effect, the disentanglement of spectral series by Rydberg, Paschen, Runge, Ritz and others, the Raman effect, the extension of the spectrum towards the ultra-violet and infra-red, and finally the closing of the gap, still existing in 1900, between the longest light or heat waves and the shortest radio waves. The pressure of war helped to develop the method known as radar. In the laboratory it provided the magnetic resonance effect, used for the study of atoms, molecules, crystals (Cleeton and Williams, 1934; Griffith, 1948), and even for the determination of nuclear spin and quadrupole moments (Rabi, 1938). It has also enriched our knowledge of the world at large by the application to the ionosphere (Appleton and Barnett, Breit and Tuve, 1925) and to celestial bodies. Reflexions have been obtained from the moon (U.S. Signal Corps, 1948) and from meteors (Hey and Stewart, 1946), and waves coming from the Milky Way (Janski, 1931) have been observed. This new radio-astronomy will have a profound influence on cosmology.

We now come to atomistics. Although firmly established in the nineteenth century, there were still, in 1900, some distinguished physicists who did not believe in atoms. To-day, such people would be regarded as 'cranks', since the evidence for the atomistic structure of matter is overwhelming.

There are two different but closely interwoven problems to be answered by atomistics: (1) What is the nature of the atoms? (2) How can the behaviour of matter in bulk be accounted for in terms of the collective action of atoms?

Let us begin with the latter question as it has been answered for a special type of matter already in the nineteenth century; I mean the kinetic theory of gases and its extension to more general systems in statistical equilibrium through Gibbs's statistical mechanics. This was in 1900 a reasonable hypothesis. But Einstein's explanation of the Brownian movement in 1904 and Smoluchowski's consecutive work in 1906 provided direct physical evidence for the correctness of the kinetic theory and led Perrin in 1909 to a reliable value of the number of atoms in the gram-molecule.

The theory of compressed gases and condensation started by van der Waals in 1873 has been much improved and modernized by Ursell (1927), Mayer (1937) and others.

A statistical treatment of paramagnetism was given by Langevin in 1905, and extended to ferromagnetism by Weiss in 1907. This was the first example of a type of statistical problem dealing with so-called order–disorder phenomena, to which, for example, the properties of alloys belong. These methods are to-day of great practical importance.

The logical foundations of statistical mechanics were critically examined by Paul and Tatyana Ehrenfest (1911) and its mathematical methods vastly developed by Darwin and Fowler (1922).

While a satisfactory kinetic theory of liquids, in spite of great efforts, is still lacking even to this day, our knowledge of the solid state has been greatly increased. This work is closely connected with research on X-rays. The nature of X-rays was controversial until 1912. Selective absorption and polarization discovered by Barkla in 1909 indicated wave structure. A year later W. H. Bragg found evidence for corpuscular structure. In 1912 Pohl and Walter obtained diffraction at a slit from which Sommerfeld estimated the wave-length. The dispute was finally settled in favour of waves when Laue and his collaborators found, in 1912, diffraction of X-rays by crystals, demonstrating at the same time the atomistic nature of solids, the lattice structure of crystals, which had been hypothetically assumed for a long time.

In the hands of W. H. and W. L. Bragg this method opened a new science, atomistic crystallography, which abounds in ingenious experiments and mathematical considerations, as the systematic application of group theory initiated by Sohnke as early as 1879 and perfected by Schonflies and Fedorow in 1891.

Upon this empirical geometry of crystal lattices there has been erected a dynamical theory which actually started as one of the first applications of quantum theory with Einstein's work of 1907 on the specific heat of solids at low temperatures, and its refinements by Debye and by Kármán and myself in 1910, which, however, has also a large field of application in the classical domain, predicting relations between elastic, thermal and optical properties of crystals. While for a time the ideal lattice was the central object of study, we begin to-day to understand the reasons why actual crystals do in many ways deviate from this ideal pattern.

Many of these investigations are independent of a detailed knowledge of the atoms themselves, using only some crude averages of their geometrical and dynamical properties, like diameter, charge, dipole moment, polarizability, etc.

The problem that remains is to understand these averages; that means, to investigate the nature of the atoms themselves.

The research in the structure of the atom is intimately connected with radioactivity. The discovery of radioactivity belongs to the nineteenth century. Its rapid development is mainly due to one man—Lord Rutherford. He demonstrated the atomistic character of the α- and β-radiation by counting the particles, using first the scintillation method of Crookes (1903), later the Geiger counter (1908). In the later development of counting methods a decisive factor was the amplifying electronic valve, invented in its simplest form (diode) by Fleming in 1904 and improved (triode, pentode, etc.) by de Forest in 1907 and Langmuir in 1915.

Let me mention here some other experimental techniques of great importance which enable us not only to count but also actually to see the tracks of particles: C. T. R. Wilson's cloud chamber (1911) and its refinement by Blackett (1937), the counter-controlled cloud chamber. Then the method of photographic tracks discovered by Blau and Warmbacher in 1937, which through the improvement of emulsions has become a most efficient tool for studying atomic processes.

The first revolutionary results, obtained with the then available primitive experimental technique, by Rutherford and Soddy about 1900, were the laws of radioactive disintegration which shattered the belief in the invariability of the chemical elements. These laws differ from the ordinary deterministic laws of classical physics, being intrinsically statistic and indeterministic.

At the same time ample proof for the existence of isotopes was found among the radioactive elements. Later, in 1913, J. J. Thomson discovered the first example of isotopy among ordinary elements (neon) by electromagnetic deflexion. From here came on one hand Aston's mass spectrograph (1919), the renewal of Prout's hypothesis and the modern version of the Periodic Table with its arrangement of the atoms according to nuclear charge (atomic number Z) as opposed to mass (mass number A); on the other hand, the separation of isotopes in bulk as performed to-day on an industrial scale for the production of fissionable material.

The distinction between these two numbers Z and A is mainly due to Rutherford's second great discovery (1911), the nucleus, obtained through the observation of scattering of α-rays. The result that Coulomb's law is valid down to nuclear dimensions suggested to Rutherford the planetary model of the atom, with the nucleus in place of the sun, and electrons in place of the planets. A welcome confirmation of this was soon (1913) provided by Moseley with the help of X-ray spectra. But formidable theoretical difficulties arose because of the lack of stability of such systems according to the laws of classical mechanics.

In fact, atomic research had reached here a point where progress was not possible without a radical change of our fundamental conceptions.

This revolution of thought was already in progress. It had started in 1900, just at the beginning of this period of review, when Planck convinced himself that the observed spectrum of black bodies could not be accounted for by classical mechanics, and put forward the strange assumption that finite quanta of energy ε exist which are proportional to the frequency, $\varepsilon = h\nu$.

The physical world received this suggestion with great scepticism as it did not fit at all into the well-established wave theory of light. Years passed without much happening. But in 1905 Einstein took up Planck's idea and gave it a new turn; he showed that by assuming the light to be composed of particles, later called photons, a quantitative explanation of the photoelectric effect in metals and of similar phenomena is obtained. Using Einstein's interpretation Millikan (1910) derived from measurements of the photo-effect a value of h in excellent agreement with Planck's original one.

Further evidence for the existence of quanta was given again by Einstein in 1907 through his theory of specific heat, mentioned already, which not only removed some very disquieting paradoxes of the kinetic theory, but also served as a sound foundation of the modern theory of molecules and crystals.

The final triumph of quantum theory was Bohr's application to Rutherford's planetary model in 1913. It solved the riddle of atomic stability, explained the mysterious spectral series and the main features of the periodic system.

Bohr was, right from the beginning, quite clear that the appearance of the quantum meant a new kind of natural philosophy, and so it has turned out. Yet at the same time Bohr was anxious to keep the connexion with classical theory as close as possible, which he succeeded in doing with the help of his principle of correspondence.

There followed a period of about twelve years in which Bohr's ideas were confirmed and developed. Here are a few outstanding events:

Franck's and Hertz's experiments to demonstrate the existence of stationary states with the help of electronic collisions (1914). The disentanglement of the multiplet spectra, including X-rays, by numerous authors, theoretically guided by Bohr and Sommerfeld. Landé's formula for the Zeeman effect (1921) which led finally to the suggestion of the spinning electron by Uhlenbeck and Goudsmit (1925). The confirmation of Sommerfeld's "quantization of direction" by Stern and Gerlach (1921). The refinement of the theory of the periodic system by Bohr himself, confirmed at once by the discovery of one of the missing elements, hafnium, by Coster and Hevesy (1922). Then—most important—Pauli's exclusion principle (1924), which gave a theoretical foundation to important features of observation. Finally, the Compton effect (1923), which demonstrated the usefulness of Einstein's conception of photons.

Thus the paradoxical situation had to be faced that both the undulatory and the corpuscular theory of light were right—in fact, Planck's formula $\varepsilon = h\nu$ states a relation between these contradictory hypotheses.

This challenge to reason came to a climax through de Broglie's famous thesis of 1924 in which this duality wave-corpuscle was, by a purely theoretical argument, extended to electrons. The first confirmation was given by Elsasser (1927) with the help of experiments on electron scattering on metals made by Davisson and Germer (1927), and soon these authors, and independently G. P. Thomson, the son of the discoverer of the electron as a particle, produced diffraction patterns with metal foils which established definitely the existence of de Broglie's waves.

May I mention here in parenthesis that the idea of the electron microscope is considerably older than this theory; it was first suggested in 1922 by H. Busch on the grounds of considerations analogous to geometrical optics. After de Broglie the wave theory of optical instruments became applicable and the resolving power could be determined. I cannot dwell on details, but I wish to remind you that to-day not only bacteria and viruses but even big molecules can be made visible and photographed.

The duality wave corpuscle made an end of the naive intuitive method in physics which consists in transferring concepts familiar from everyday life to the submicroscopic domain, and forced us to use more abstract methods.

The first form of this new method was mainly based on spectroscopic evidence which led Kramers and Heisenberg to the conviction that the proper description of the transition between two stationary states cannot be given in terms of the harmonic components of these states separately, but needs a new kind of transition quantity, depending on both states. Heisenberg's quantum mechanics of 1926 is the first formulation of rules to handle these transition quantities, and these rules were soon recognized by myself as being identical with the matrix calculus of the mathematicians. This theory was developed by Heisenberg, Jordan and myself, and independently, in a most general and perfect manner, by Dirac.

Again, independently Schrödinger developed in 1926 de Broglie's wave mechanics by establishing a wave equation valid not only for free electrons but also for the case of external fields and mutual interaction, and showed its complete equivalence with matrix mechanics.

Concerning the physical interpretation, Schrodinger thought one ought to abandon the particle conception of the electron completely and to replace it by the assumption of a vibrating continuous cloud. When I suggested that the square of the wave function should be interpreted as probability density of particles, and produced evidence for it by a wave theory of collisions and other arguments, I found not only Schrodinger in opposition, but also, strangely enough, Heisenberg. On the other hand, Dirac developed the same idea in a mathematically brilliant way, which was soon generally accepted, also by Heisenberg who produced a most important contribution by formulating his uncertainty relations (1927). These paved the way for a deeper philosophical analysis of the foundations of the new theory, achieved by Bohr's principle of complementarity, which replaces to some degree the classical concept of causality.

In a very short time the new theory was well established by its successes. I can mention only a few points: Pauli's matrix representation of the spin and Dirac's relativistic generalization (1928) which led to the prediction of the positron, actually found by Anderson in 1932. Then came the systematic theory of the electronic structures of atoms and molecules and their relations to line and band spectra, to magnetism and other phenomena. Wigner showed in 1927 how the general features of atomic structures could be found with the help of group theory. Hartree, Fock, Hylleraas and others developed numerical methods. The theory of collisions of atoms with electrons and other atoms was started by myself and developed by Bethe, Mott, Massey and others, from which finally sprang a general theory of the penetration of particles through matter by Bohr.

Further, the derivation of the nature of the chemical bond, initiated by Heitler and London in 1927, was worked out by Hund, Slater, Mulliken, Pauling and others. Even the complicated phenomena of reaction velocities, including catalytic acceleration, have been reduced to quantum mechanics.

Finally came Dirac's most important theory of emission, absorption and scattering of electromagnetic radiation which led to the first systematic attempt of formulating quantum electrodynamics by Fermi, Jordan, Heisenberg and Pauli (1929), and later to the general theory of quantized fields and their interaction (Wentzel, Rosenfeld, from 1931).

The last period of our fifty years is dominated by nuclear physics. Although the importance of nuclear research is probably greater than that of any other branch of physics, I shall be rather short about it for it is the most recent phase of our science and scarcely yet history.

The first breaking up of a nucleus was achieved by Rutherford in 1919, by bombarding nitrogen with α-rays. Artificially accelerated particles were first used by Cockcroft and Walton in 1930. At that time the nucleus was believed to be composed of protons and electrons. But this led to difficulties if one tried to derive the angular momenta of nuclei from the spins of the component particles. In 1932 Chadwick discovered the neutron, and those difficulties disappeared if the nucleus was assumed to consist of protons and neutrons, or charged and uncharged 'nucleons'. Fermi showed in 1932 that neutrons are most efficient in disrupting nuclei as they are not repelled by the nuclear charge. Many of the residual nuclei were found by Irene and Frederic Joliot-Curie in 1934 to be radioactive themselves.

The continuous β-ray spectrum offered great difficulties to the understanding until Pauli, in 1931, suggested the existence of the neutrino and Fermi developed, in 1934, the neutrino theory of the β-decay where the laws of conservation of energy and momentum are preserved. The line spectrum of β-rays was recognized to be of secondary origin, namely, due to the expulsion of electrons from the electronic cloud by γ-rays emitted by the nucleus.

The need for fast projectiles was first supplied by the use of cosmic rays. These had been discovered by Hess already in 1912 and their study has grown to-day into a vast science, covering not only nuclear physics but also geophysics, astronomy and cosmology.

The artificial production of fast particles has made enormous strides through the construction of powerful accelerating machines, as that of van der Graaf (1931), Lawrence's cyclotron (1931), Kerst's betatron (1940) and combinations of these, like the synchrotron.

The clue to the interpretation of nuclear transformations is Einstein's formula $E = mc^2$, or more precisely, the relativistic conservation laws of energy and momentum. I am not an expert in the new awe-inspiring science of nuclear chemistry and shall make no attempt to describe it. I can say only a few words on the theoretical problems of nuclear physics. It is remarkable how many important facts can be understood by extremely simple models, as, for example, Gamow's crater model (1928), which explains the α-decay and the Geiger–Nuttal relation between α-energy and life-time; and the liquid-drop model, suggested by von Weizsacker in 1925, to explain the mass defect (nuclear energy) curve and later used successfully by Bohr (1935) to explain the mechanism of capture, re-emission and fission. A great amount of work has been done on exact quantum-mechanical calculations of the structure and properties of light nuclei (in particular the deuteron) and of the effect of collisions, with the aim of learning something about the nuclear forces. Important results have been obtained, but altogether the situation is not satisfactory.

Quite independently of detailed theories, the empirical values of the nuclear masses (internal energies) indicate that the light nuclei have the tendency to fuse, the heavy ones to disintegrate; hence all matter, except the elements in the middle of the periodic system (iron), is in principle unstable. But reaction velocities are, under terrestrial conditions, so extremely slow that nothing happens. It is, however, different in the interior of stars; Bethe showed in 1938 that one can account for the heat developed in the sun and the stars by a nuclear catalytic chain reaction, the fusion of four nucleons to form a helium nucleus.

The opposite phenomenon, the fission of the heavy nucleus of uranium into almost equal parts, discovered by Hahn and Strassmann in 1938, has initiated a new era in the sociological situation of our science and very likely in the history of mankind. Here is a list of events:

The establishment in 1939 of the possibility of a self-supporting chain reaction by different authors (Joliot, Halban and Kovarski; Fermi; Szillard); the construction of the first nuclear reactor or 'pile' under the direction of Fermi in 1942, and, finally, the harnessing of the industrial power of the United States to produce the atom bomb.

The political and economic implications of this development are too formidable to be discussed here; but I cannot refrain from saying that I, personally, am glad not to have been involved in the pursuit of research which has already been used for the most terrible mass destruction in history and threatens humanity with even worse disaster. I think that the applications of nuclear physics to peaceful ends are a poor compensation for these perils.

However, the human mind is adaptable to almost any situation. So let us forget for a while the real issues and enjoy the useful results obtained from the pile. In physics the remaining few gaps of the Periodic Table have been filled and five or six transuranium elements (among them fissionable nuclei like neptunium and plutonium) discovered. Innumerable new isotopes of known elements have been produced. Some of these can be used as 'tracers' in chemical and biological research, as first suggested by von Hevesy in 1913; others as substitute for the expensive radium in industrial research and in the treatment of cancer.

From the point of view of natural philosophy the most important achievement of the past decade seems to me the discovery of the meson, theoretically predicted by Yukawa in 1935, which showed how far we are still removed from a knowledge of the real fundamental laws of physics. Yukawa became convinced that the forces between nucleons are at least as important as the electromagnetic forces, and by applying the field concepts in analogy to Maxwell's theory was able to predict a new particle which has the same relation to the nuclear field as the photon to the electromagnetic field, but has a finite rest-mass, which from the range of nuclear forces could be estimated to be about 300 electron masses. Soon the existence of mesons was experimentally confirmed in cosmic rays by Anderson and Neddermeyer in 1936 and later with particles produced by the cyclotron in California in 1948. The method of photographic tracks has, in the hands of Powell (from 1940) and others, produced a wealth of new results, for example, the spontaneous disintegration of the meson of about 300 electron masses into a lighter one of about 200 electron masses and a neutral particle. A meson of about 900 electron masses has been fairly well established, and it is not unlikely that still more types exist.

It is obvious that to understand all this a much deeper research in the theory of quantized fields and their interaction is necessary. A revised and modernized quantum electrodynamics was published independently by Schwinger in the United States and Tomonaga in Japan in 1947, and from this has sprung a considerable amount of literature, aiming at the elimination of divergence difficulties and calculating effects of higher order, inaccessible to the older theory. A great success was the explanation of an observation made by Lamb and Retherford in 1947, which showed that Dirac's celebrated theory of the hydrogen spectrum is not quite correct. But it becomes more and more clear that all these mathematical refinements do not suffice, and that a far more general theory has to be found, in which a new constant (an absolute length—or time, or mass) appears and which ought to account for the masses found in Nature. I wish to end this outlook into the future with a remark I have recently heard from Heisenberg. We have accustomed ourselves to abandon deterministic causality for atomic events; but we have still retained the belief that probability spreads in space (multi-dimensional) and time according to deterministic laws in the form of differential equations. Even this has to be given up in the high-energy region. For it is obvious that the absolute time interval restricts the possibility of distinguishing the time order of events. If this interval is defined in the rest system it becomes large in a fast-moving system according to the relativistic time expansion (in contrast to the contraction of length). Hence the indeterminacy of time order and therefore of cause–effect relation becomes large for fast particles.

Thus experience again leads us to an alteration of the metaphysical foundations of a rather unexpected kind. In fact, traditional philosophy has provided the leaders of our science, like Einstein, Bohr and Heisenberg, with problems in so far as it failed to supply answers agreeing with experience. I am convinced that although physics free from metaphysical hypotheses is impossible, these assumptions have to be distilled out of physics itself and continuously adapted to the actual empirical situation. On the other hand, the continuity of our science has not been affected by all these turbulent happenings, as the older theories have always been included as limiting cases in the new ones. The scientific attitude and the methods of experimental and theoretical research have been the same all through the centuries since Galileo and will remain so.

PHILOSOPHY OF PHYSICS, 1850–1950

By PROF. H. DINGLE

THE history of physics is recorded in the publications of the recognized scientific bodies; it is there to see, and cannot be altered. Also, except for the most recent part of our period, there is little doubt and no difference of opinion concerning what is most important in that history; our best text-books differ only slightly, if at all, in what they select as now surviving out of the vast output of the past century. Consequently, in listening to Prof. Andrade and Prof. Born we have been listening almost exclusively to the authentic voice of physics itself.

In the nature of the case, my credentials are less firmly established. The published documents to which I can refer scarcely exist: the *British Journal for the Philosophy of Science* first appeared in May

1950. There were, it is true, isolated writings on the subject throughout the century—mostly from men who, having deservedly acquired a high reputation for their contributions to physics, were more or less forced by popular demand to try to interpret those discoveries in philosophical terms. The results in most cases have fallen into the oblivion they deserve. Reading them is something like listening to a spider discoursing on civil engineering or a seagull formulating the principles of aerodynamics. The unfortunate consequence is that in order to give an account of the philosophy of physics during a period of unexampled physical progress I have to depend very largely on what I can deduce from the implications rather than the direct statements of the writings of the time.

Nor does this exhaust my difficulties. It is not easy to express, with the rigour expected of Section A in the year A.D. 1951, even what is meant by the phrase 'the philosophy of physics'. What I propose to do, therefore, is to give a general idea of what I mean by it. By the philosophy of physics, then, I shall mean the general outlook on experience that one adopts, whether consciously or unconsciously, in terms of which he automatically interprets the discoveries and generalizations of physics and gives them meaning. It is the wider framework of conceptions or instinctive beliefs into which one fits the state of physics at any particular time. One may, in principle at least, form such a philosophy in either of two ways. The first is in terms of what I may call *a priori* notions to which one makes the progress of physics conform. Thus, for example, one may start with the common-sense outlook—what philosophers call *naïve realism*—or with a view of the nature of things fundamentally determined by his religious experience and what seems to him its most natural rational expression, or with the supposed laws of movement of society resulting from economic forces, as the Marxists do, or with some other non-physical set of principles, and look on the successive achievements of physics as completing in one direction the description of the world which that philosophy demands. . The other possibility is that of ridding one's mind so far as possible of all such preconceptions, taking the world-picture suggested by physics as one's starting-point, and generalizing it to form the all-comprehensive world-picture into which it most naturally fits.

Until recently, as intellectual history goes, the former alternative was the only possible one. True, the subject-matter of physics—the elementary awarenesses of movements, of heat and cold, of sound and sight, and so on—were among the earliest and most immediately noticeable elements of our experience; but for that very reason it was imperative to attain to a purely practical, rather than a strictly rational, understanding of them in order merely to survive. The luxury of calm, philosophical contemplation could be indulged best in those realms now given over to psychology and biology and even to phenomena scarcely yet generally recognized as ripe for scientific exploitation—with the result that of what we now call physical laws of Nature, nothing was known before the seventeenth century, and what was thought to be known was but a subsidiary element of a great world-scheme that owed its primary inspiration to other things. But now the situation has changed. The new attitude to philosophy which was inaugurated by Galileo and developed by Newton has spread so rapidly and brought within a few general principles such a vast body of physical experience that no one, whatever his predilections, can fail to recognize that it forms by far the largest and most comprehensive homogeneous body of rationally organized knowledge that we possess. If a stranger to our planet and to our whole type of experience were suddenly endowed with the power of observation and fully developed rational thought, and were to examine the systems of knowledge which we have through the ages succeeded in building up, he could not fail to notice that in magnitude, in coherence, and in the certitude that comes from general agreement, the physical scheme is overwhelmingly ahead of all others. If he wished to obtain a complete rational co-ordination of his experience he would inevitably choose physics as his starting-point, and pursue the path through physics to philosophy.

This fact, however, was only just beginning to be realized about a hundred years ago; it is far from being generally realized yet. During the Middle Ages the predominant world-picture was compounded of elements drawn from Greek philosophy and speculation and Christian dogma, and into that picture such discoveries as were made were fitted without fatal distortion. The scientific revolution of the early seventeenth century coincided with a philosophical revolution, led independently by Bacon and Descartes, which resulted in the substitution for the medieval scheme of what may be called common-sense philosophy, in that it took for its fundamental dogma the Cartesian division of the object of investigation into extended things and thinking things, or, briefly, matter and mind. Of these, when Galileo and Newton had shown the way, matter was relatively easy to study, mind almost impossible. The result was that the physicists, who were the successful explorers of Nature, tended to leave mind out of the field of things to be investigated and to regard it simply as the means of investigation. The world, then, was the world of matter—or of *substance* as, by adoption of a scholastic term, it came to be called. Its constituents moved about in space and time, which accordingly could, in a sense, be called a part of the world, though not a part needing any particular attention. Euclid had once for all formulated the laws of space, and time was obvious enough, so one could devote his whole attention to the nature of matter and the laws of its behaviour. The so-called 'scientific method' of Galileo and Newton was, as its name implied, a means of studying this material or substantial world. It had at its command two instruments—observation, in the form of experiment (that is, observation under controlled conditions), and reason, usually in the form of mathematics.

This philosophy, as I say, was a common sense philosophy. It was derived, not from a study of the practice of Galileo, Newton and their successors, but from the age-long common-sense belief in an 'external world', that 'existed' whether it was observed or not, and that caused observations by acting in one way or another on the sense organs of the observer. The Cartesian dualism was conformable to that belief, which accordingly took on the dignity of a philosophical system but was none the less a simple naïve realism, and so far as men of science were concerned it was for the most part held unconsciously rather than openly acknowledged. Throughout the eighteenth and early nineteenth centuries, men of science were doing things. The question what exactly it was that they were doing did not disturb them; but if asked they would have said they were discovering the contents and laws of behaviour of the external world. They would have been perfectly honest in saying this, and most of them, in fact, would have been astonished if told that any other description of their actions was possible; but it was not a belief arrived at from an actual examination of those actions. The prior existence of the external world was accepted as unquestionable, apart altogether from the practice of science. 'Scientific method' was only a particular way of learning its structure and behaviour—the best way, of course, and perhaps the only trustworthy one, but still just one among others. What physicists were discovering had to be fitted into that framework, and up to the year 1851 at least it found a natural place there without the slightest distortion.

It was roughly about this time, however, that the first explicit attempts to formulate a philosophy of science, starting from science itself, became discernible. I believe the first book to take this as its avowed object was Whewell's "The Philosophy of the Inductive Sciences", which was published in 1840. True, there is little enough in the philosophy of this book that would not have been there had the author been writing as a philosopher of the traditional type rather than as a man of science; but the way in which the ideas are presented does take its shape from the necessity to accommodate the physical science of the time, and one can almost see the author's pen being unconsciously guided by the impulse to exhibit as eternal truth the picture of the world that justified most indubitably the prevailing state of physics. And, indeed, it was not difficult to do this. The Newtonian ideal—that of ascribing all phenomena to precisely specifiable forces acting on a perfectly inert substance according to strictly causal laws—had been uninterruptedly in course of realization; it fitted the Cartesian philosophy so far as material substance was concerned, with the slight difference that the fundamental property of matter, which Descartes had taken to be extension—the power of occupying space—was now thought to be mass; and the method of induction from experiment, which was the hallmark of science, had established its value almost beyond reasonable expectation. One could therefore pursue the scientific adventure with complete confidence that it not only conformed to the accepted principles of philosophy, but even confirmed and exemplified those principles.

The subsequent history of physics is the story of the uprooting of that confidence. There are two broad aspects of this process, corresponding to the physical progress that has culminated in quantum theory and in relativistic field physics, respectively, but before describing the effect of these lines of research I ought to mention that, quite apart from the further development of physics itself, the essential inadequacy of the current philosophy was at least suspected by a few physicists because of its unsatisfactory foundations. Newtonian mechanics, for example, indubitably worked, and was able not only to account for the phenomena that came within its scope but also to make predictions of new phenomena which were duly verified—the discovery of Neptune is a case in point; but the fundamental equations of motion, on which the whole scheme rested, involved logical difficulties that could not be regarded without uneasiness by logical minds. Newton's absolute space, for example, could not be clearly conceived, and there were difficulties in framing the second law of motion in a form that did not include a circular argument. Moreover, as the century progressed, the contradictory properties that had to be assigned to the ether to enable it to fulfil its various functions, culminating in those laid on it by Maxwell's electromagnetic theory of light, led some physicists to doubt whether the simple philosophy that represented physics as an objective study of a given external material world was altogether justifiable. Such men as Kirchhoff, Hertz, Mach, Pearson, Poincaré, in their various ways, gave voice to these doubts and expressed the view that the achievements of physics were not properly represented as the discovery of the nature of an external world. The world they were supposed to be elucidating looked irrational, and they did not wish to study the irrational. Accordingly, they sought a re-formulation of the aims and practice of physics that would make sense of what they and their colleagues were doing. But all this had little effect on the progress of physics as a whole. The building was going up and the parts were fitting together perfectly: why bother about foundations? Let the work proceed and leave the first principles to be justified in time by those who cared for such things. The important thing was to press forward, not to trouble one's self about the point at which the process began.

So it came about that the overthrow of the nineteenth-century philosophy of physics was left to be brought about by the development of physics itself. It would scarcely be true to say that the building collapsed. Rather, a point was reached at which progress stopped. Further bricks were coming to hand, but they could not be fitted into the existing structure without disaster; the foundations were not firm enough to support them. As I have said, the trouble arose in two distinct departments of physics—particle physics and field physics, respectively. I can, of course, give only an outline of what has happened, and I will take the two departments separately, though historically their development overlapped. To put the matter briefly, the undermining of the older philosophy came about gradually in particle physics, beginning with the reduction of matter to elementary particles, the acceptance of which became established doctrine about the beginning of our period, and ending with quantum mechanics, which is one of the highlights of its end. Relativity theory, on the other hand, gave that philosophy a sudden death-blow about the middle of the period. Let me take the gradual process first.

The kinetic theory of matter sought to explain all the manifest properties of bodies in terms of the movements of ultimate indivisible and unalterable particles obeying the Newtonian mechanical laws. What particular forces acted on them remained to be found out, but that some strictly specifiable forces did act, to which they were in absolute subjection, was taken for granted, and the mass movements, colours, temperatures, chemical reactions, and all the rest of the sensible reactions of bodies that make up our apprehension of the world, were believed to be derivable from the mechanical behaviour of the molecules, as they were usually called. These molecules were the reality; what was observed was only appearance, and the problem of physics thenceforth was to find out all that could be discovered of the reality.

This could be done, of course, if one could discover the forces acting on the molecules, and the positions and motions of the molecules at some single instant.

Since these things could not be observed, however, they had to be arrived at by inference, and the way to discover them was anything but clear. But a most important discovery was made. It was possible to describe many of the properties of bodies—and especially gases—in terms of molecules without, in fact, knowing anything at all about the behaviour of any single one of them, except that it possessed a few conceptual properties such as motion, momentum, elasticity. Curiously enough, although the molecules were conceived to be the ultimate reality of the material world, they were at first denied the fundamental Cartesian property of matter, namely, extension; they were conceived as Euclidean points. This was later rectified when it was found that the assumption of definite dimensions extended the range of usefulness of the theory, but it affords an interesting illustration of the essential indifference of physicists to philosophical requirements and exemplifies the fact, which I mentioned before, that a highly abstract conception like mass had displaced a manifest quality like extension as the fundamental characteristic of matter.

The result of this discovery was that the development of kinetic theory took a statistical form and was directed to the interpretation of observations (that is, appearances) in terms of the collective behaviour of multitudes of conceptual molecules. Now it is not difficult to see that this was a betrayal of the true mission of physicists according to the accepted philosophy. They were dedicated to the investigation of reality, and that had become the investigation of the nature and behaviour of the molecules; and instead of pursuing that they occupied themselves in showing how their ignorance of reality could be used in order to describe mere appearances. They could account for the temperatures of bodies, their pressures, viscosities, thermal conductivities, and so on—properties which had no meaning when applied to individual molecules but were significant only with regard to groups of many millions of them; and they were pleased with these achievements. What they were doing was finding rational relations between their observations, and using the molecules merely as counters, as dummies, as useful conceptions by means of which to extend the scope of those relations. And so indifferent were they to the incompatibility of their practice with their philosophy that they were for the most part quite unaware that they were doing anything irregular at all. To give an account of the gas laws in terms of molecular movements was a great triumph. If anyone had said: "But we knew those laws before in a much simpler form: you have merely made them abstruse", they would have replied: "No; we have shown what really goes on in the gas". If then their critic had said: "Well, what does really go on? What is the nature of these molecules? Where is any one of them at any particular moment, and how does it move afterwards? Why do the molecules behave as they do and not otherwise?", the reply would have been, "Well, we don't know those things yet, but no doubt we shall some day". If the critic had then persisted: "So what you have actually done is to find a cumbersome, but possibly fruitful, way of expressing relations between appearances, and left reality to look after itself", they would no doubt have said: "Sir, I perceive that you are a philosopher; we are physicists".

The matter, of course, came to a head when means really were found of investigating the nature of individual molecules. They were reduced first to atoms, then to what are called 'fundamental particles'—electrons, protons, neutrons, and a good many more; the number is indefinite. These are now the ultimate realities. And what do we know about them? Nothing. Not only so, but we believe that we have proved that we *can* know nothing. The utmost we can do is to calculate the probability that one of them will be at a given place at a given time. Of the picturable properties that one would expect small bits of matter to have they have none at all. We cannot even count them—that is to say, not that the task is too difficult, like that of counting the stars in a stellar system, but that they do not admit of being counted; they have not the individuality that formerly would have been regarded as so essential a property of a real particle as to be more fundamental than even extension or mass. We can make them serve our purpose of describing the relations between phenomena only by making them obey statistical laws impossible with objects that can be counted individually. We nevertheless do this, and thereby acknowledge the fact that we are no longer interested in 'reality' so long as we can find rational relations between our observations. We are satisfied to say that a particle, once the ultimate reality of the universe, has no individuality, may be anywhere at all, though it is more probably here than there, and has a future indeterminable from our present knowledge, for it observes no causal laws. The pursuit of reality has ended as a greyhound race ends, with the disappearance of the hare underground. And the only intelligible conclusion is that the object of the whole business is not to catch the hare but to run the race. The only philosophy that accords with the whole history of physics is that which represents physics as the establishment of rational relations between phenomena, not the penetration of phenomena to reach a hidden reality that causes them.

Let me turn now to relativity theory. I am, of course, not going to describe the steps that led to it, but only to consider the nature of the problems involved. In accordance with the philosophy of the time, the real material world, whether regarded as consisting of molecules or of gross bodies, was conceived to possess its properties by intrinsic right. Thus its constituents had a size, a mass, a velocity, and so on. These properties could, in principle at least, be determined; one of the objects of physics, in fact, was to determine them as completely as possible. But even if the attempt to determine them was unsuccessful, they unquestionably existed. The mass of a body was such and such, whether we knew it or not; its length was such and such, whether we knew it or not. Now the basic requirement of the theory of relativity was that all these properties were almost completely indefinite. Take any object—a stick of chalk, for example. Its length is, say, two inches or anything at all less than that, according to the velocity which it has, and that velocity can be held to be anything from zero up to the velocity of light. The higher the velocity, the smaller the length, and no one velocity can be said to be more really correct than another. One may be more convenient than another in a particular problem, but it will be less so in a different problem; fundamentally, the chalk may be said to have any velocity at all between the limits I have mentioned, and no one value is truer than another.

Now it happens that all our measurements depend in one way or another on the measurement of length, and the result is that *all* physical properties of a body depend on this arbitrary velocity. Its mass, for example—the fundamental property of the materialistic philosophy—may be anything from a few grams up to infinity. There is no single quantity that is not almost infinitely arbitrary, having no assignable value at all until you have decided how the body is to be regarded as moving, and the choice of that lies entirely with you; Nature has nothing whatever to do with the matter.

This again is now accepted physical belief. It is not something imposed on physicists from without, but something unavoidably arrived at by them in the normal exercise of their practice. In particle physics we saw that while we were learning less and less about the nature of the fundamental particles, we were learning more and more about the relations between phenomena by using the particles as terms of expression. In relativity theory we see similarly that by abandoning all attempts to assign any definite property at all to matter we can learn more and more about the relations between phenomena. We succeed in the practice of physics in the same measure as we fail to honour the supposed philosophy of physics.

There are two ways of dealing with this situation. One is to retain the old preconception that we are investigating the nature of a real, external, material world, and to add that we have discovered that it is essentially mysterious and even self-contradictory. If you do retain that preconception the addendum is, indeed, inevitable; the world *is* mysterious and self-contradictory. Personally, I find this a very unsatisfying view. Not only does it end in complete nescience, but also it takes no account of the very great and positive achievements of physics. I prefer to take those achievements as indicating the true nature of physical investigation, and that means that we must regard physics as the progressive establishment of rational relations between the results of our measurements. From this point of view the quantities with which physics concerns itself are not evaluations of objective properties of parts of the external material world; they are simply the results we obtain when we perform certain operations. They are just as objective, of course, in the sense that we have no ultimate control over them: we perform the operation and get the result that comes, not the result we may wish. But we do not add the unnecessary and, as it turns out, frustrating corollary that they are measurements of a pre-existing material world of which in its essence we can never know anything.

On the whole, the tendency of those who have attempted to formulate a philosophy of physics in the light of the new knowledge has been to combine these alternatives. They have, in the main, had to recognize the logical force of the second, but have been unwilling or unable to give up a belief that has seemed so imperative as to be beyond denial. I have time for only one or two examples.

The late Sir Arthur Eddington is an outstanding one. His tragedy was that he was born too soon and possessed too precocious and retentive a mind. Consequently, the belief that physics was the examination of the external world became so fixed in his consciousness before the quantum and relativity theories arose that, although he immediately recognized their fundamental importance, he was forced to adapt them to beliefs with which they were, in fact, incompatible. Thus, in 1923, in his "Mathematical Theory of Relativity", we find him saying, and even italicizing the statement, that "*a physical quantity is defined by the series of operations and calculations of which it is the result*". There was really nothing more to be said about it; but for the reason I have mentioned he could not refrain from adding that it represented what he called a "world-condition", which was, however, essentially unknowable. The mysteriousness of these world-conditions was emphasized by an example. The distance of a star and the parallax of a star are two physical quantities; but they are so related that they are used alternatively in all our calculations. They therefore, he concluded, represent the same world-condition. But now, if one of two stars has twice the distance of the other it has half the parallax. Is then the world-condition of the first twice or half that of the second, or is any metrical relation between them inconceivable? We do not and cannot know. The world which has these conditions was, according to Eddington, "the mysterious background of phenomena". He could not see that it was precisely the same kind of thing as the "mere names", according to Galileo, or "occult qualities", according to Newton, that flourished in medieval thought and, as Newton expressed it, "put a stop to the improvement of natural philosophy".

About the same time as Eddington was formulating these views the movement that has become known as logical positivism originated on the Continent through the formation of the Vienna Circle and, later, the Verein Ernst Mach, the object of which was to cleanse philosophy of all those elements that the development of physics had shown to be hindrances. In some respects this movement ran parallel to the movement of Eddington's thought; in others, owing to its entirely different background, it took a quite different course. Thus Eddington asserted that only through physical quantities could we represent to ourselves a condition of the world. "Any attempt to describe a condition of the world otherwise," he wrote, "is either mathematical symbolism or meaningless jargon." He accordingly recognized three types of ostensible approach to a description of the world—physical investigation, mathematical investigation, and meaningless chatter. The logical positivists sought precision by avoiding all reference to operations and speaking in terms only of the sentences in which those operations and their results were expressed, but they reached essentially the same three-fold classification; they divided all possible word sequences into synthetic statements (that is, those expressing the results of sense observations), analytic statements (those occurring in pure mathematics, which were regarded as tautologies), and nonsensical statements. The parallel with Eddington is complete; but whereas Eddington in his classification restricted himself wholly to the field of physics and did not attempt to say anything about other realms of experience, the logical positivists applied their principles to sentences about anything at all, and were accordingly led to describe every statement about the subject-matter of metaphysics, normative ethics and (except in so far as it could be reduced to physics) psychology as nonsense. I mention this merely to prevent misunderstanding; but it is not our present subject, and, returning to physics, we may say that Eddington and the logical positivists were very largely in agreement on the implications of its later developments. So far as the external world was concerned, however, they were less tied to tradition than he was, though they seem to have been unable wholly to disregard the traditional way of speaking. Formally they recognized the external world merely as a convenient form of expression, though the convenience became more obvious the further one removed one's self from physics, but when they were not actually discussing the question of its status they accorded it much more than the homage due to mere convenience. They insisted, for example, that the only kind of statements that "tell us anything about the world" are synthetic statements, and one does not easily find any characterization of such statements from which reference to "the world" is excluded.

I will not follow the later developments of logical positivism, which seem to have emphasized the positive rather than the logical side of the programme, because, in spite of much that is valuable in this movement, I think it suffers from a dearth of scientific men and a surplus of philosophers. I say this not with any provocative intention; but simply because it is a fact, and one which shows itself very plainly in the course the movement has taken. The logical positivists are concerned chiefly with the 'verification' of sentences, and take great pains to prescribe as precisely as possible what steps have to be taken to ensure such verification. In other words, the sentence itself is their starting-point, and its verification (or falsification) their goal. But the sentences with which they start are not the starting-point but the goal of the physicist. His problem is to proceed from evidence to conclusion, not to start with a 'conclusion' and prove it. Proof may be impossible, for the observations that constitute the evidence may not be repeatable; but the physicist still has the problem of making deductions from them. Hence, whatever may be called verification in such a case may be essentially different from that relevant when repetition is presumed to be possible.

The logical positivists, furthermore, emphasize the unity of science, by which they mean the thesis that all science is reducible to physics. To the men of science this appears to be an arbitrary dogma. They establish it simply enough, by characterizing all sentences that cannot be expressed in the existing physical or mathematical language as nonsensical. The scientist, it is true, may look forward to the unity of science, but he cannot adopt it as a presupposition; it is something to be, if possible, achieved. For the moment he is content to proceed in the different sciences on independent lines, using independent means of observation and independent concepts. He may hope that in time there will be a synthesis of the physical, biological and psychological sciences, just as the originally independent sciences of mechanics and heat have merged into thermodynamics, and magnetism and electricity into electromagnetism. But that is a hope, not a categorical pronouncement, and the concepts of the unified science may be biological or psychological rather than physical, or possibly concepts which are entirely new.

The most satisfactory statement of the philosophy of physics to which the later developments point seems to me to have been begun by Prof. P. W. Bridgman. Like Eddington he regards all physical quantities as the results of operations, but he does not encumber his thought with the useless world-conditions that Eddington had to drag behind him in all his adventurings. Bridgman's work has lain mainly in a progressive revision of all physical concepts in order to ensure that they represent no more and no less than particular precisely describable and practicable operations. The necessity for this work can be realized when it is remembered that the whole theory of relativity arose from the discovery that the concept of absolute simultaneity of events at different places corresponded to no practicable operation. In one respect, however, I think he goes too far, and in another not far enough. He applies his analysis to all physical concepts, whether they are employed as the terms in which physical results are expressed or only as instruments to facilitate the attainment of those results. For example, he examines equally the operational meaning of the concept of viscosity and the concept of action at a distance, and is prepared to brand either concept as illegitimate if the corresponding operation is not discoverable. I admit the necessity for this so far as viscosity is concerned, for that is represented by a symbol in physical equations, and the meaning of those equations is indefinite so long as the operations of which its terms are the products are unknown. But action at a distance is not represented by a symbol in any physical equation. It is merely a concept which enables us to picture the situation represented by the equation in such a way as to suggest what next to do. It may fulfil this function whether it corresponds to an actual operation or not, and since, having discarded the external world, we are in no danger of thinking it the 'truth' about Nature, I see no reason for proscribing it if it serves our purpose.

On the other hand, Bridgman stops short just where, from the wider point of view of science as a whole, his ideas could be most valuable. It is true that every physical concept should correspond to a particular operation—indeed, to an operation of measurement, that is, an operation that yields a number, for physics is definable as the science of such operations. It is essentially an experimental science, where we pay attention only to observations made under narrowly prescribed conditions. But most of our experience is not so carefully prepared for; it comes to us automatically, whether we seek it or not, and the wider task of science is that of finding relations not merely between experiences that we go out of our way to obtain, but between the whole of our experiences. That opens up the larger field that, as I said at the beginning, I regard as belonging to the philosophy of physics.

I think it is one of the most satisfactory features of the modern view, expressed best in Bridgman's form, that it allows of the generalization we need. When physics is regarded as the study of the external world, and the world is regarded as a distribution of matter in time and space, there is little room left for anything else except illusions. But when the external world is forgotten, and physics is recognized as the finding of relations between certain artificially acquired experiences, the generalization becomes inevitable that science as a whole is the finding of relations between all elements of our experience. It is not that the question of the existence of the external world is considered and answered in the negative: the question is seen to be irrelevant and not considered. When I am asked whether I believe in the existence of the external world, I promise to reply when I am told precisely what is meant by the external world and by its existence. I have not yet been called upon to redeem the promise. The fundamental question is: What exactly is it that physicists are doing? That can be answered satisfactorily only in terms of experience, not of the external world. It is in any event undeniable that all we can know of any world at all must come from our experience of it—not necessarily sense experience alone, but experience taken as a whole. If then we describe the task of science in terms of experience we shall describe it more directly than is possible in terms of an investigation of a postulated world. That might have been realized long ago; the physics of the past century has made its realization inescapable.

THE 250TH ANNIVERSARY OF YALE UNIVERSITY

By Dr. JOHN F. FULTON, O.B.E.
Yale Medical Library

THE year 1951 marks the two hundred and fiftieth anniversary of the founding of Yale University, and under the leadership of its energetic new historian president, Mr. A. Whitney Griswold, the University is marking the occasion by a series of ceremonies.

The idea of establishing an institution of higher learning in New Haven was conceived many years before the College was actually established, having first appeared in the mind of the Rev. John Davenport, an Oxford man, who, with a group of his countrymen, founded New Haven in 1638. But New England was already supporting one College—Harvard—and it was not until 1701 that ten Congregational ministers met together, each bringing a gift of books, and made plans to petition the General Assembly of the Colony for a charter for a College, granted later that year.

Through the efforts of the Connecticut Colony's agent in London, Jeremiah Dummer, more books were soon on their way across the Atlantic from such well-wishers of the young College as Sir Isaac Newton, Sir Richard Steele, Dr. Edmund Halley, Dr. Richard Mead, Sir Hans Sloane, Dr. Richard Bentley, the King's Librarian, and many others. Among these books were a first edition of Newton's "Opticks" and a second edition of his "Principia", *Tatlers* and *Spectators*, the works of the Honourable Robert Boyle, Robert Hooke, Nehemiah Grew, Thomas Burnet, John Woodward, and such others as enable Yale proudly now to boast of the finest collection in America of books and manuscripts of eighteenth-century England—including the outstanding Falconer Madan Collection on the history of Oxford (acquired in 1929).

Our patron, Elihu Yale, was among these early friends of the College. The main facts of his life can be found on his tombstone in Wrexham:

> Under this tomb lyes interr'd Elihu Yale
> of Place-Gronow, Esqr; born 5th April 1648,
> and dyed the 8th of July, 1721, aged 73 years.
>
> Born in America, in Europe bred,
> In Afric travell'd, and in Asia wed,
> Where long he liv'd and thriv'd; at London dead.
> Much Good, some Ill he did: so hope all's even,
> And that his soul thro' Mercy's gone to Heav'n.
> You that survive and read, take care
> For this most certain Exit to prepare,
> For only the Actions of the Just,
> Smell sweet and blossom in the dust.

In addition to books, a gift of East India goods which brought £562 12s. in the Boston market came from Governor Yale and prompted the clergymen directing the destinies of the Collegiate School to change its name to Yale College in 1718 in honour of its generous benefactor. The portrait of King George I, which came with the other benefactions and which now hangs in the Yale Art Gallery, is to-day the earliest portrait in continuous ownership in an institution of higher learning in the United States.

In 1743 the Rev. Thomas Clap, the progressive president of the College who in his twenty-six years in office did much to broaden Yale's stature as an educational institution, "with considerable Labour and Pains, prepared a Catalogue of the Books in the Library under proper Heads so that you may Readily know and find any Book, upon any particular Subject". From this list of the books in the Library in 1742, a room has been arranged in the Sterling Memorial Library known as the 1742 Library, and on the shelves in their original order can be found many of the early volumes. Among the medical texts were works by Cowper, Willis, Freind, Cheyne, Sydenham, Sanctorius, Cheselden, Van Helmont, Harvey and Glisson—a noteworthy collection for any American library of that time. The Cowper was probably the gift of Daniel Turner, a London physician, who gave a number of books to Yale, for he wrote: "I have robbed my own library of a book very valuable beyond all others and now, as I know, not procurrable elsewhere, the Great Anatomy of our Cowper, that with it I might adorn yours". Turner's letter contained a postscript: "If your worships consider me worthy of the doctoral degree of Yale Academy and have the diploma sent me, I shall receive it not only as a sign of your gratitude, but I shall consider it an honour as much as though it had been conferred by another university, though of greater note. Farewell . . . and may your academy flourish." Rising to the occasion, the College authorities conferred on Daniel Turner in 1723 an honorary degree, the first medical degree to be granted in the American Colonies.

From Britain in these early days of Yale's existence came not only material gifts but also encouragement and inspiration for those who were interested in science, particularly in astronomy and mathematics. When in 1802 President Timothy Dwight persuaded the Corporation to establish a chair of chemistry and secured a young barrister, Benjamin Silliman, to fill it, it was to England and Scotland (after a year in Philadelphia) that Silliman journeyed to acquire his scientific knowledge. The contacts he made there at that time with many of the leading men of science, and later his *American Journal of Science*, to which British and Continental scientific men contributed, ensured a steady flow of influence and ideas from across the seas. His son-in-law, James Dwight Dana, who rose to eminence as a geologist, carried on in Silliman's tradition as editor of the journal and in the chair of geology.

Another outstanding Yale man of science well known in Britain and on the Continent was Josiah Willard Gibbs. He was a man of extraordinary capacity—shy and retiring as a personality, but possessed without doubt of one of the most gifted minds and one of the most original intellects of any nineteenth-century man of science. His genius was more promptly recognized in Britain than in America; but we are happy to record that a definitive biography of Gibbs has now been written by one of the last of his students, Lynde Phelps Wheeler, and published by the Yale University Press as one of the several volumes that have appeared on the occasion of the two hundred and fiftieth anniversary.

Yale's first gesture to mark the anniversary occurred at Commencement in June 1951, when twenty-five honorary degrees were conferred on outstanding American scholars (the usual number in a given year is eight or ten). One of these was conferred on a British subject, the distinguished Polynesian anthropologist and physician, Sir Peter Henry Buck, a native-born Maori chieftain who is now director of Yale's Bernice P. Bishop Museum in Honolulu. Another colourful degree-recipient was the ninety-two-year-old philosopher and educator, John Dewey, who was described as representing the "experimental spirit of America". The venerable Otto Loewi, Austrian pharmacologist and Nobel laureate, was also among those who received degrees, as was the psychologist Edward C. Tollman, "valiant defender of the freedom of the mind", lately removed from the faculty of the University of California for having, with many others, refused to sign the loyalty oath. Still another was Dr. Gerty Cori, the distinguished biochemist who in 1947 shared the Nobel Prize in Medicine and Physiology with her husband, Dr. Carl Cori.

The formal celebration of the anniversary will take place on October 19. To share in this ceremony the President and Fellows of the University have invited representatives from Oxford, Cambridge and Harvard, the universities from which Yale traces its descent, and in addition representatives from the forty-odd American colleges and universities which were originally administered by graduates of Yale. Prof. E. Ll. Woodward, professor of modern history in the University of Oxford, will be the official delegate from Oxford, and Mr. S. C. Roberts, lately vice-chancellor of the University of Cambridge, will represent Cambridge. There are to be formal addresses by Mr. A. Whitney Griswold as President, by Lord Halifax who will be the guest of the University, and by President James B. Conant, the official representative of Harvard University.

There will be a further occasion on Alumni Day, February 22, 1952, when President Griswold and the chairman of the Yale Alumni Board will award Yale Medals to alumni for outstanding service to the University. The anniversary year will come to an end with the Commencement exercises in June 1952. In the future, as during its first two hundred and fifty years, Yale will be mindful of the fundamental purpose of education, phrased by John Davenport as being "for the better trayning upp of youth in this towne, that, through God's blessing they may be fitted for publique service hereafter, either in church or commonweale".

OBITUARY

Prof. Gilbert Cook, F.R.S.

Gilbert Cook, who died on August 28, was born in Blackburn in October 1885 and he received his early education there and in Todmorden, Yorkshire. He distinguished himself at school, and in 1902 proceeded to Owens College, Manchester, where he studied under Osborne Reynolds. In 1905 he graduated in engineering with first-class honours and was awarded a graduate scholarship and the Freebairn Engineering Prize. After spending some time in the engineering workshops and as a pupil of the late D. C. Rattray, chief engineer to the Lancashire and Yorkshire Railway, he was appointed assistant engineer with that company. In 1910 he was awarded a Vulcan research fellowship at the University of Manchester, where J. E. Petavel was director of laboratories, and there he commenced the investigations which formed perhaps his chief scientific interest throughout his life. With Andrew Robertson he published in 1911 a paper on "The Strength of Thick Hollow Cylinders under Internal Pressure" and in 1913 one on "The Transition from the Elastic to the Plastic State in Mild Steel". They were followed by a number of authoritative publications on associated subjects spread over the years.

At the outbreak of war in 1914, Cook was an assistant lecturer in the Engineering Department of the University of Manchester, and he soon laid aside his university duties to serve first in the Royal Garrison Artillery and later in the technical branch of the mining and mine-sweeping service of the Royal Navy. Service routine did not smother his sense of scientific inquiry, and papers on the accuracy of range finders and on submarine depth meters were the outcome of his war-time experience.

Cook returned to his peaceful pursuits in the University of Manchester in 1919, and soon thereafter gained the award of a D.Sc. There followed in 1921 his appointment to the chair of mechanical engineering in King's College, London, where he enhanced his reputation as a teacher and administrator. It was in 1936 that he received the King's commission to be regius professor of civil engineering and mechanics in the University of Glasgow, and there he takes a worthy place in a succession which includes James Thomson and Macquorn Rankine.

Gilbert Cook was a member of the Council of the Institution of Civil Engineers and for many years a member of the Institution of Mechanical Engineers. The election to the fellowship of the Royal Society came to him in 1940. In Scotland he had given valued service to the Institution of Engineers and Shipbuilders, and he was just completing his period of office as president when he died. He served on many educational and technical committees, to which he gave conscientious service. He was consultant and advisor to the Admiralty Hydro-Ballistic Research Establishment, a member of the Advisory Council on Building Research, of the Board of Advisors in Engineering to the University of London and of the Properties and Mechanics of Materials Committee of the Department of Scientific and Industrial Research.

In the fifteen years of his tenure of the chair at Glasgow, Cook made a place for himself in the councils of the University and in the esteem of his colleagues which now cannot readily be filled. He was an excellent teacher, clear and convincing because he was a complete master of his subject. He was a sound administrator because he brought to the consideration of every issue with which he had to deal a logical mind and a conscientious judgment. He was a good colleague, frank, scrupulous, considerate and loyal. In addition to his great qualities of intellect and character, he had a cultured mind and an interest in music. He is survived by his wife.

NEWS and VIEWS

Imperial College of Tropical Agriculture: Prof. A. B. Killick, C.M.G.

The appointment of Mr. A. B. Killick to the Imperial College of Tropical Agriculture, Trinidad, as professor of agriculture, brings to the College a man whose wide experience in tropical agriculture will be of great value to its students. Mr. Killick was a postgraduate student at the College during the academic year 1923–24 and was appointed to the Department of Agriculture, Uganda, in 1924. He served in that Department until 1936, when he was appointed deputy director of agriculture, Trinidad. In 1939 he was promoted to the post of deputy director of agriculture, Tanganyika, and left there in 1942 to become deputy director of agriculture, Kenya. He was appointed director of agriculture, Uganda, in 1947, and is now retiring from that post. In 1950 he was awarded the C.M.G.

Mr. Killick's Colonial experience has covered a wide range of agricultural systems, from the primitive native tribal systems in Tanganyika to the partly mechanized European methods in the Kenya Highlands. In Uganda and Trinidad his work dealt with advanced peasant agriculture, which is approaching the freehold and leasehold farming methods, and he has also gained experience in plantation agriculture—sugar-cane, coffee, pyrethrum, sisal and cacao. He will, therefore, be able to give his students an overall picture of the type of agricultural problems which they will meet when they leave the College in Trinidad for Colonial territories, and they will also have the benefit of his experience in the economics and agriculture of the cotton industry in Uganda, which is now undergoing economic reorganization in view of its financial importance to the Commonwealth as a whole.

Physical Society: Parsons Memorial Lecture

The 1951 Parsons Memorial Lecture will be given under the auspices of the Physical Society by Mr. F. Twyman in the Anatomy Theatre of University College, Gower Street (not in the Science Museum as previously announced), on October 25, at 5.30 p.m. Mr. Twyman will take as his subject "Sir Charles Parsons and Optical Engineering". The Lecture was instituted in memory of Sir Charles Parsons, to be given in turn on the various subjects in which Sir Charles was interested. These included developments in optical instruments and engineering of all types, including naval. The lectures are thus arranged under the auspices of appropriate institutions, the Physical Society undertaking that concerned with optics. Sir Charles Parsons had a deep interest in the making of optical glass of fine quality, and Mr. Twyman has done much arduous and skilful work in improving methods of making high-quality glass and of testing glass and optical components. He was largely instrumental in the development of the Twyman–Green interferometer for the testing of optical flats and prisms for surface flatness and optical homogeneity, and he developed from it the camera-lens and microscope interferometer. In his book "Prism and Lens Making" are many instances of his ability to devise ingenious methods to improve the making and testing of optical parts. A further outstanding achievement was his making of echelon gratings of higher performance than those made by Michelson.

The Effigy of Robert Boyle

The Hon. Robert Boyle, the famous natural philosopher who was one of the founders of the Royal Society, was born at Lismore Castle, in the south of Ireland, on January 25, 1627, and died at his house in Pall Mall, London, on December 30, 1691. His sister, Lady Ranelagh, with whom he had lived, had died a week previously and they were both buried in the chancel of the old church of St. Martin-in-the-Fields, which was replaced in 1721 by the present building. In a letter in *Nature* of October 6, 1921, the late Sir William Tilden gave an account of his unsuccessful efforts to find any memorial to Boyle and concluded that "it seems probable that the last resting-place of the 'Father of Chemistry' will remain unknown to the end of time". Though this appears to be true, there is an effigy of Boyle as a very small boy in "the very famous, sumptuous, glorious tombe" of black marble and alabaster in St. Patrick's Cathedral, Dublin, erected by his father, the great Earl of Cork, in 1631 in memory of his second wife, who had died in 1629 when Robert Boyle was two years old. Richard Boyle, the first Earl of Cork, was born at Canterbury in 1566. After studying law, at the age of twenty-two he went to Ireland, where he held many important posts and became very wealthy. He was made an earl in 1620. His first wife having died in childbirth, in 1603 he married Katherine Fenton, the daughter of Sir Geoffrey Fenton (1530 ?–1608) and his wife Agnes Weston, and by her he had seven daughters and seven sons, of whom Robert was the youngest. The great monument, which now stands at the west end of St. Patrick's Cathedral, Dublin, has four tiers the highest of which has a recumbent figure of Robert Boyle's great-grandfather, Robert Weston (1515 ?–73), the Lord Chancellor of Ireland, and also dean of St. Patrick's. In the next tier are the kneeling figures of Boyle's grandfather and grandmother, Sir Geoffrey Fenton and his wife, while the third tier contains the recumbent figures of the Earl and Countess of Cork, with some of their children kneeling, and the lowest tier of all has representations of the seven younger members of the family, the effigy of Robert Boyle occupying a central arch in this stage. "It is a curious circumstance," says the official work on St. Patrick's, "that it is the only memorial to a man of science in the Cathedral." Though the great Earl is represented in the monument, he died at Youghal and is buried and commemorated in the parish church there. His death took place on September 15, 1643, when his famous son was but sixteen.

Memorial to John Milne

A movement is on foot to create a memorial to John Milne, who is commonly regarded as the 'father of seismology'. Space has been allotted in the Carisbrooke Museum, Isle of Wight, which is a mile from Shide, where Milne did the greater part of his life's work. Any seismological station having any discarded Milne or Milne–Shaw instrument, or parts, used prior to 1914 is invited to communicate with Mr. E. W. Pollard, Cliftonville, Dorking, Surrey.

Aeronautical Engineering Group of Aslib

Approximately a hundred representatives of the aeronautical industry in Great Britain attended a meeting held at the Royal Aircraft Establishment, Farnborough, on September 27 to inaugurate an Aeronautical Engineering Group of Aslib. This is one of a series of specialist groups which are being formed among members of Aslib to consider the recording and dissemination of literature and technical information in special fields. The following committee was elected to control the work of the Group: Mr. R. G. Thorne, Royal Aircraft Establishment (*chairman*); Mr. C. W. Cleverdon, College of Aeronautics (*secretary*); Mr. A. H. Holloway, Technical Information Bureau, Ministry of Supply; Mr. T. G. Dickson, Rolls Royce, Ltd.; Mr. J. A. Kirk, Short Bros. and Harland, Ltd.; Mr. A. R. Cameron, A. V. Roe and Co., Ltd.; Mr. P. S. Walkins, British European Airways; Mr. F. H. Smith, Royal Aeronautical Society; Mrs. M. Neal, *Engineering*. 'Working parties' were set up to consider the following subjects: abstracting services; classification of aerodynamic data; union catalogue of the holdings of aeronautical libraries. Suggestions for consideration by the Group should be sent to the Secretary, Mr. C. W. Cleverdon, at the College of Aeronautics, Cranfield, Beds, or to members of the Committee. It is intended to hold an open meeting next spring to report on the work of the Group.

Meeting of Phycologists at Bangor

A group of twenty-eight phycologists, the majority of them students of marine algæ, met at Bangor, North Wales, during September 13–20. During the week, excursions were made to the shores at Treaddur Bay, Rhoscolyn, Rhosneigr, Penmon Point and the Menai Straits, and one day was devoted to dredging in the Menai Straits, thanks to the kind co-operation of Dr. Crisp and the staff of the Marine Biological Station. These field meetings gave those attending the opportunity of comparing not only the composition of the flora with that of shores more intimately known to them but also the times of occurrence of reproduction of various common seaweeds. In addition, some lesser-known algæ were found and taxonomic difficulties discussed. Prof. P. W. Richards generously provided laboratory facilities, which were used to the full both for the examination of the freshly collected material and also for a series of valuable demonstrations, illustrating the very diverse types of research in progress. Although some of these had bearings on more than one type of problem, these exhibits could be classified broadly as ecological (Blackler, Moss), taxonomical (Burrows and Lodge, Parke, Powell), morphological (Martin, Richards, Mullahy, Dixon), and another group dealt with methods of culture and results obtained by this type of investigation (Parke, Knight Jones, Droop, Drew).

This informal group of phycologists has decided to hold further meetings, thereby hoping to encourage critical and experimental work on marine algæ, and anyone interested is asked to communicate with either Dr. K. M. Drew, Department of Cryptogamic Botany, University of Manchester, or Mr. H. T. Powell, of the Marine Biological Station, Keppel Pier, Millport. A duplicated news-sheet, containing notes of use to marine phycologists, will be available early in 1952, and the preparation of a check-list of the marine flora of the British Isles has been planned. A meeting of about a week's duration has been arranged provisionally to be held at Plymouth during July 1952 when, in addition to field meetings, consideration will be given to a special topic (possibly techniques used in the preparation of material for cytology and in the culture of algæ) and also to the taxonomy of a single family, probably the Delesseriaceæ. Inquiries about the possibility of a one-day meeting in London, during the first week in January 1952, are also being made.

Mythical Dwarf People in Polynesian Legend

The existence of 'little people' is a belief that is of world-wide, though sporadic, occurrence. For the most part, they are dwarfish, more-or-less benevolent, hard-working in spite of their small stature, nocturnal and dwelling underground or in woods or forests. Such being their attributes, they are very difficult to pin down, as their habits make observation extremely difficult, and accounts of them vary with almost every supposed observer. In the Hawaiian Islands these nocturnal pygmies are known as 'Menehune', and Katherine Luomala, whose researches into Polynesian folk-lore are well known, gives an extensive and fascinating investigation of this subject in a booklet entitled "The Menehune of Polynesia and other Mythical Little People of Oceania" (Bernice P. Bishop Museum, Honolulu; Bull. 203; pp. 95; 1951). Her account of these tiny folk is gathered from many sources and includes their physical and cultural characteristics, their housing and social structure, their relations with other little peoples and their possible origin. All this gives them such a corporal existence that it is quite difficult to believe that they are mythical. They originate, apparently, from the old semi-slave common class of people who did all the hard work and were presumably stunted by toil and privation. The buildings they erected seemed worthy of a tradition, and so by the usual process of exaggerating the size of the subjects of the tradition both down and up (the clever little man and the stupid giant) these Menehune became smaller and smaller as time went on in order that their works might be more glorified. Other Polynesian islands also have their legends of Menehune or similar little peoples, and an account is given of the various myths connected with them.

Tarnish and Corrosion of Silver and Bronze

Two papers in the *Museums Journal* discuss the corrosion of silver and bronze respectively, problems which are of interest to a circle far wider than that of museum curators. The article on silver, by Dr. Bengt Thordeman and Mr. Gillis Olson, of the National Historical Museum, Stockholm, is contained in the February issue of the *Journal* and is a summary of their recent investigations of the well-known black or brownish tarnish of this metal. The present solution of the problem is to cover the cleaned silver with a film of nitrocellulose lacquer. The result of this treatment is not completely successful, for in some cases the protecting film gradually cracks and eventually gives rise to a network of unattractive black lines. The authors now consider that the rapidly developing plastics industry has provided a new method of approach, and a commercial lacquer of the acrylate type called 'Acryloid B7', produced by the Resinous Products and Chemical Co., Philadelphia, has been used. The silver is first cleaned by washing in dilute ammonia and removing the resulting film of black sulphide by contact with zinc or aluminium in a weak solution of sodium carbonate. After washing with distilled water and drying at 50–60° C., the still warm objects are dipped in an approximately 8 per cent solution of the lacquer. After excess of fluid has been drained off, the objects are baked at a temperature of 60–70° C. The other article, in the January issue of the *Journal*, is by Mr. J. F. S.

Jacks and is concerned with the cleaning and preservation of bronze statues. He reviews what occurs during the weathering of bronze, and considers the most effective methods to prevent corrosion and to remove the disfiguring products which result when corrosion has taken place. The ultimate colour varies according to the particular impurity present in the atmosphere. For example, oxygen and chlorine give a pale green chloride or oxychloride, while sulphur will produce a dark brown or black sulphide. Also, since impurities in the atmosphere and climatic conditions vary considerably at different times, the resulting patina is often uneven in colour, and a patchy effect is produced. At present it is considered that the application of a thin coating of lanolin forms the best protection from corrosion.

Australian Timbers and Veneers

The demand for plywood in Australia, as in other countries of the world, considerably exceeds the supply; extending production being accentuated by its wider use for housing, internal fitments, prefabrication and innumerable manufactured articles. In a paper entitled "Suitability of Australian Timbers for Veneers" (Bull. No. 260. Commonwealth Scientific and Industrial Research Organization, Melbourne, 1950), Messrs. A. J. Watson and H. G. Higgins summarize the results of investigations, extending over several years, into the suitability of Australian timber species for conversion into veneer, some fifty species having been examined, some systematically, others in a purely exploratory fashion. Certain of the species described are already in common use in plywood manufacture, others in limited quantities only and not for commercial purposes. It is these latter which should prove of importance, since the available supplies of the commonly used species is declining and it becomes necessary to look for new sources of veneer, both from indigenous forests and from plantations. In the case of the former, it has to be borne in mind that not only must the species be suitable, but also that it must be present in the (often mixed) indigenous forest in sufficiently accessible quantities to prove a commercially workable proposition. The data collected in the Division of Forest Products on the subject have been collated in tabular form. Information is given on some relevant characteristics of the trees and wood of the species examined, on their conversion into veneer from the log form, and on the recovery, characteristics and uses of the veneer. The general experimental methods of pre-treatment, conversion and drying are described in conjunction with certain recommendations to industrial operators, emphasis being laid on methods of determining suitable heating schedules for logs before peeling. Supplementary data are given on species recognized as sources of veneer, but which have not been investigated in the laboratory.

Forestry in British Guiana

From the forestry point of view, British Guiana has, perhaps, best been known for its greenheart; otherwise, although it has had a Forestry Department for nearly a quarter of a century, very little progress has been made, nor was much known about forests in the interior. The report of the Forest Department for the year 1949 (Georgetown, British Guiana) states that the previous year was a memorable one in the history of forestry in British Guiana, for it saw the announcement of the Colonial Development Corporation's forestry development proposals in the Colony, and the introduction for the first time of systematic management conditions into new and renewed timber leases. Complete reorganization of the Department was impossible owing to the difficulties in securing senior professional staff. For almost the first time on record in Colonial administration, the Governor himself gave a clear statement of forest policy proposed for the future. He remarked on the heavy capital expenditure needed for the construction of basic extraction facilities and the orderly exploitation of the forest in a series of contiguous blocks based on a predetermined programme. There must be complete control of felling operations in order to prevent undue waste and ensure retention of immature trees for future exploitation, and the retention of seed-bearers to provide natural regeneration; provision must also afterwards be made for improvement operations to ensure optimum growth of economic species. This certainly appears most promising, and an assurance has been given that the Forestry Department will not be overshadowed by the Colonial Development Corporation but that under its present conservator, Mr. C. Swabey, formerly well known in Trinidad, it will hold the reins of progress.

Fisheries Researches in Singapore Straits

One of the chief difficulties confronting fisheries development schemes in undeveloped and under-developed areas—which, incidentally, are mainly tropical—is ignorance. For the proper exploitation of marine fisheries resources, adequate knowledge of the bionomics of the sea areas supporting those fisheries is essential. Such knowledge, for most tropical regions, is extremely meagre or even non-existent, and the appearance of a booklet, "The Food and Feeding Relationships of the Fishes of Singapore Straits", by Tham Ah Kow (Colonial Office Fishery Publication, 1, No. 1; pp. 35; London: H.M. Stationery Office, 1950; 3s. net), is therefore heartily to be welcomed. This publication embodies the results of an intensive study of the inshore fish fauna of Singapore Straits and of the environmental conditions in which it lives. No new tenets have emerged from this work, nor was any to be expected at this stage; but the application of old and well-tried techniques to a new area has produced useful preliminary knowledge of local conditions which can be amplified and supplemented by further researches of a more fundamental type. We look forward to the appearance of further Colonial Office fishery publications dealing similarly and progressively with this and other tropical regions.

Zoological Publications from Victoria University College, New Zealand

The appearance of the first six Zoology Publications from Victoria University College, Wellington, New Zealand, has already been noticed in these columns (see *Nature*, 166, 1098; 1950), and four further papers are now to hand: No. 7, "A Study of the Marine Spiny Crayfish *Jasus halandi* (Milne Edwards)", by C. A. Bradstock (pp. 38, 1950); No. 8, "Keys and Bibliography to the Collembola", by J. T. Salmon (pp. 82, 1951); and No. 9, "Blood Parasites of Mammals in New Zealand", together with No. 10, "A Contribution to the Study of Fijian Hæmatozoa", both by Dr. M. Laird (pp. 14+15, 1951). No. 7 is an account of this very widespread crustacean based on the examination of 2,126 specimens, and it deals with various aspects of their life-history, ecology, population studies, fishery and utilization and includes observations on autotomy and autoplasty; a large female with a carapace-length of 13·5 cm. is estimated to produce 549,000 eggs. No. 8 is a paper that should prove of use to zoologists everywhere. It contains a bibliography which is complete from Delrus and Linnæus (both 1758) up to and including 1949; it comprises 1,216 entries and is a valuable compilation. There is also a key for the whole of the Collembola carried down to genera; and, as the characters given are only those essential for generic identification, the name of each genus is followed by that of its author, the date and a number in brackets referring to the citation of that publication in the bibliography in which the original definition of the genus is to be found. This work is additionally welcome because it provides the first review of the entire order since the memoirs of Borner in 1906 and 1913.

British Contribution to Television: Convention in London

THE Radio Section of the Institution of Electrical Engineers is arranging a convention on "The British Contribution to Television", to be held in London at the Institution during April 28–May 3, 1952. The whole field of television will be covered in nine sessions, each approximately two hours in duration, at which a survey paper and a number of supporting papers will be discussed. First there will be a historical paper and a broad survey paper to act as an introduction to the whole convention, and this will be followed by sessions as follows: programme origination, point-to-point transmission, broadcasting stations, propagation, receiving equipment (two sessions), non-broadcasting applications, and system aspects. In addition to these technical sessions, there will be a number of visits to industrial and other appropriate organizations. Proofs of all papers should be available shortly before the meeting. The convention will be open to all; those who are not members of the Institution will be required to pay a registration fee. The proceedings of the convention will be published in four issues of Part IIIA of the *Proceedings of the Institution of Electrical Engineers*. Further details can be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have recently been announced: E. F. Allen and E. J. H. Berwick (agricultural officers, Federation of Malaya), senior agricultural officers, Federation of Malaya; H. Gillman (senior agricultural officer, Tanganyika), deputy director of agriculture, Nyasaland; R. W. Kettlewell (deputy director of agriculture, Nyasaland), director of agriculture, Nyasaland; A. B. Killick (director of agriculture, Uganda), professor of agriculture and director of studies, Imperial College of Tropical Agriculture, Trinidad; A. F. Mackenzie (senior agricultural officer, Sierra Leone), deputy director of agriculture, Sierra Leone; De W. N. Scott (agricultural officer, Federation of Malaya), senior agricultural officer, Federation of Malaya; D. Thornton (senior agricultural officer, Tanganyika), chief soil conservation officer, Tanganyika; A. C. Brooks (chief chemist, Federation of Malaya), director of chemistry, Federation of Malaya; I. A. Beveridge (senior assistant conservator of forests, Gold Coast), conservator of forests, Gold Coast; D. C. Duff (assistant conservator of forests, Gold Coast), senior assistant conservator of forests, Gold Coast; J. M. Cave (assistant agricultural officer, British Honduras), agricultural superintendent, St. Vincent, Windward Islands; C. A. Lea (assistant director, Meteorological Services, Federation of Malaya), director, Meteorological Services, Federation of Malaya; N. A. MacHattie (forester, Tanganyika), superintending forester, Tanganyika; R. H. Ball and P. Bradshaw, agricultural officers, Nigeria; D. V. Chambers, R. Frank, W. G. Mathewson and J. Russell, agricultural officers, Tanganyika; T. J. Forbes and K. Landskroner, agricultural officers, Gold Coast; R. N. Green, agricultural officer, Somaliland Protectorate; G. Heys, agricultural officer, Nyasaland; A. J. Jones, entomologist, Tanganyika; R. Knight, plant breeder, West African Cocoa Research Institute, Gold Coast; C. J. Piggott, soil chemist, Sierra Leone; P. B. N. Jackson, scientific officer, Northern Rhodesia; W. N. Scott, veterinary officer, Uganda; E. A. Thomas, veterinary officer, Tanganyika; R. M. Bredon, nutritional chemist (Veterinary Department), Uganda; J. O. Egerton, assistant conservator of forests, Federation of Malaya; J. G. Harris, assistant conservator of forests, Nigeria; G. M. Higgins, agricultural soil chemist, Nigeria; K. A. Hirst and A. B. Law, meteorologists, Northern Rhodesia; W. A. Sands, scientific officer, Termite Research, East Africa High Commission; Miss A. G. Smith, meteorological assistant, Bermuda; T. J. Tanner, meteorological officer, Northern Rhodesia; T. W. Tinsley, plant pathologist, West African Cocoa Research Institute, Nigeria; V. J. Weston, soil scientist, Nigeria; W. R. Williams, senior geologist, Tanganyika; R. A. M. Wilson, geologist, Cyprus.

Announcements

WE regret to announce the death on October 6 of Prof. O. F. Meyerhof, For.Mem.R.S., formerly director of the Kaiser Wilhelm Institute of Physiology, Heidelberg, and recently research professor of biochemistry, University of Pennsylvania.

H.M. THE KING OF DENMARK has bestowed upon Dr. D. A. Allan, director of the Royal Scottish Museum, Edinburgh, the decoration of Knight of the Order of the Dannebrog, in recognition of his work in furthering the knowledge of Danish culture in Great Britain and his co-operation with the Danish national museums and kindred institutions.

THE Council of the Illuminating Engineering Society has awarded the Léon Gaster Memorial Premium for 1951 to Mr. H. W. Cumming, of the Research Laboratories of Siemens Electric Lamps and Supplies, Ltd., Preston, for his paper entitled "The Extension of the Gas Arc Condition".

ON the recommendation of Sir Alfred Egerton, director of the Salters' Institute of Industrial Chemistry, the following awards have been made for the year 1951–52: *Salters' Fellowships*: Dr. A. P. C. Cumming and Raymond Grafton; *Salters' Scholarship*: Malcolm McLeman.

THE Sindicato Vertical de Industrias Químicas is holding a conference in Barcelona during November 8–15 on "Safety and Hygiene in Chemical Industry from the Point of View of the Manager, Technician and Operative". Further details can be obtained from the secretary-general of the conference, Sindicato Provincial de Industrias Químicas C.N.S., Via Layetana, 18 Barcelona.

PHYSIOLOGICAL PROBLEMS OF MINING

ON August 9, at the recent meeting of the British Association in Edinburgh, Section I (Physiology) devoted a whole morning session to a number of papers and discussion on "Physiological Problems of Mining". Dr. G. C. Gooding (Scottish Coal Board, Edinburgh), in his review of the "Effects of Lighting on the Health and Working Efficiency of Miners", said that the development of adequate mine lighting in Great Britain has been hindered by the presence of firedamp. The evolution of the miner's lamp has been slow: the electric cap lamp was a big advance, and, although this is the commonest lamp in use to-day, in many districts other less-efficient lamps have not been replaced. Fixed lighting was first used at a shaft bottom in 1881 and is slowly extending. Installations of fluorescent lighting both at the shaft bottom and the coal face have been tried in the past five years and given promising results. Only a fraction of the light produced is reflected from the coal face and this impairs the illumination.

Miner's nystagmus is a disease, which may be incapacitating, associated with inadequate lighting. This disease is now much less common than it was thirty years ago, yet it has disabled for periods of one or more years more than fourteen thousand miners in the decade 1938–47. In some parts, Scotland for example, the disease appears to be checked though not abolished entirely. Continual caution is necessary, since the disease may exist in latent form, which may be converted to overt disability in adverse social circumstances.

With the best lighting available it is now possible to control miner's nystagmus; but good lighting is much more than prophylactic against this disease. Other benefits arising from improvements in lighting in mines are increased output and increased safety. Some small-scale trials have demonstrated both a reduction of accidents and the production of cleaner coal following improvements in lighting. The benefit which is probably the most important is an improvement in physical comfort and psychological temper. An improvement in lighting, sufficient to convert mines into underground factories, would work a revolution in the psychological climate in the industry. Increased comfort is a legitimate aim, being closely associated with industrial efficiency. The miner's job has been described as dirty, dangerous and dark. Attempts have been made, with at least partial success, to mitigate the dirt and reduce the danger. It is a legitimate aspiration for the industry to attempt to remove the dark, and with it another edge of asperity in the miner's life.

The next speaker, Dr. C. M. Fletcher (Medical Research Council Pneumoconiosis Unit, South Wales), discussed the "Effect of Dust Inhalation on the Working Capacity of Miners". Since statistics have been available, coal-miners (and especially elderly miners) have always been shown to suffer from a relatively high mortality from respiratory diseases other than tuberculosis and a relatively low mortality from pulmonary tuberculosis. This relative freedom from tuberculosis was ascribed by J. S. Haldane to a possible beneficial effect of coal-dust. Modern studies have confirmed that the inhalation of coal-dust modifies the effects of pulmonary tuberculosis and that in some ways this may be beneficial. Yet the serious effect of the inhalation of coal-dust on miners' working capacity has become increasingly apparent, especially as the result of admission of miners to compensation under the provision of the Workmen's Compensation Acts for silicosis, in the first place, and now for pneumoconiosis. The prevalence of pneumoconiosis has been very much greater in South Wales than in the other coal-fields, and the reason for this is not certain.

Pathological studies have shown that dust accumulates in and around the bronchioles where there is a minimal reticulin reaction to its presence. At this stage, simple pneumoconiosis, the dust could not be expected to cause any important disturbance of respiratory function. In elderly coal-workers the lung tissue in the neighbourhood of the deposit of coal-dust may become broken down to form 'focal emphysema'. If there are no complications, this focal emphysema is only occasionally so severe as to interfere with respiratory function. In some cases of coal-worker's pneumoconiosis, collagenous fibrosis occurs in the deposits of coal dust. Collagenous nodules of irregular shape form and later coalesce to form large areas of massive fibrosis which may seriously distort the lung and interfere seriously with its function, and in addition impose a strain on the pulmonary circulation.

Radiological studies enable a distinction to be made in life between simple pneumoconiosis and massive fibrosis, and a system of radiological classification has been developed. A correlation has been worked out between the radiological findings and a test of respiratory efficiency, and from this it is concluded that serious disability in coal-worker's pneumoconiosis is chiefly due to the presence of massive fibrosis.

"Coalminer's Pneumoconiosis: Employment Problems of the Disabled" was the subject of a paper by Dr. A. Meiklejohn (University of Glasgow). While hitherto the main incidence of certified pneumoconiosis has been in South Wales, there is evidence that, for various reasons, the number is increasing in other mining areas. It is not possible to provide satisfactory alternative jobs for these disabled miners. Reluctantly the conclusion has been reached that almost the entire responsibility for the continued employment of pneumoconiotic coal-miners must be accepted by and within the industry. The problem is not rehabilitation of disabled coal-miners, but rehabilitation of unfit coal-mines. In this assignment the main burden must fall on the employers and mining engineers, not on doctors and sociologists. There can be no speedy amelioration without the vital co-operation of the men themselves and their unions. This constitutes a challenge to discipline and leadership.

There are several important prerequisites which must be fulfilled. First, the whole problem must be extracted from 'politics'; secondly, it must be realized that pneumoconiosis of coal-miners is not peculiar to South Wales; thirdly, the fine focus on disease and compensation must give way to the acceptance that existent knowledge of the causation of the disease is already adequate, without further research, to enable effective prevention. Mining engineers in South Wales, by such methods as water infusion, have already made a useful start. The clamant demand is for more coal—higher and greater production. To this end mechanization and more mechanization and more men to work the machine is the invariable answer. Is it quite certain that in some mines more coal-cutters and longer conveyor-belts are not indirectly diminishing output by the deleterious effects on the men ? It has almost become trite among doctors to say this is an engineering problem. Until the disease is controlled so as not to abridge life or seriously impair health in a normal working span, then the medical man must bear his full part in the team. But in this particular field the medical man is simply an expert adviser ; he is not the director in charge of operations. Though the production of dust must be kept to a minimum, considerable dust is unavoidable, and the occurrence and, in certain circumstances, the progression of the disease reflects the extent of the dangerous concentrations of air-borne dust. The medical man has two main duties : first, to assist the engineers to locate the dangerous operations and stations, and secondly, to supervise the health of affected men still at work.

The final speaker, Sir Andrew Bryan (National Coal Board, London), speaking on "Accidents in Coal Mines", said that of all the major industries in Great Britain, coal-mining is the most hazardous. Employing less than one-twentieth of the working population, it accounts for nearly one-quarter of all industrial accidents. The reasons for this high accident-rate lie in the nature of the work of the miner and in the vital differences between his working environment and that of other industrial workers. Mining is for the most part a continual striving against great natural hazards in confined and poorly illuminated spaces.

Up to the present time the attack upon the accident problem has been mainly by statutory regulation and inspection, assisted by scientific research into specific mining dangers and a raising of the standards of education and training of miners ; and, more directly, by improvements in standards of housing, welfare and recreational facilities for the mining community as a whole. That these lines of attack have achieved a considerable measure of success over the years is shown by the progressive reduction in the accident-rates for fatal and serious non-fatal accidents. There is still much to be done along these lines. The attack must continue by way of further regulations as the results of new mining methods, machines and safety practices are devised ; by way of higher standards of education or training for mine managers, officials and workmen; by the general adoption of higher standards of engineering production; and by the expansion of social and welfare activities in all mining communities. But new methods are needed if the progress of accident reduction is to be accelerated ; and for this purpose new methods of investigation are required.

As examples of new lines of approach, the relationship between accident-rate, absenteeism and size of pit has been considered. There is a close correlation with the size of pit and the accident-rate per 100,000 man-shifts. In pits employing less than fifty miners the rate is 63·5, but rises to 166·6 in pits with more than three thousand. The reasons for this require study. Further, it can be shown that a high accident-rate can be correlated with a high pneumoconiosis-rate. Researches into observable features of human behaviour such as accident-rates, and their relation to the size of the groups in which men work, may, in the final result, throw light upon the structure of authority in the pit and the extent to which the men feel themselves to be part of the organization in which they are employed. Coal must always be got by small groups of men working in isolation and under remote supervision. The attitudes of these groups and the extent to which they each identify themselves with the pit as a whole are problems needing urgent investigation that confront the industry.

SENSES AND BEHAVIOUR OF ANIMALS

ON August 13 at Edinburgh the second joint session of Sections D (Zoology) and J (Psychology) of the British Association (the first was at Aberdeen in 1934) was held under the chairmanship of Dr. C. F. A. Pantin, the subject being the "Senses and Behaviour of Animals".

Prof. R. J. Pumphrey (University of Liverpool) spoke of the coming of age of 'ethology', a word recently applied to the study of the behaviour of all animals including man. Ethology, in this wide sense, evidently stems from the "Origin of Species" (1859) and the "Expression of the Emotions in Man and Animals" (1872) ; but its development has been arrested until very recently. This arrest is traceable to the influence of Descartes. In spite of the intellectual acceptance of evolution as a fact of history, a conscious or sub-conscious reservation in favour of dualism led to the persistent separation of a human ethology (psychology) which was rootless and arid, from an animal ethology, which carried the worship of the Golden Calf of objectivity to ludicrous lengths. The many 'languages of objective description' that have been applied to animal behaviour are seen in retrospect to cloak a belief in a physico-chemical etiology of behaviour, and an equation of meaning with statistical significance.

Prof. Pumphrey concluded that the time is now ripe for an integrated ethology with a common language and a common aim. A re-examination of the basic principles of semantics is needed, for semantics is doubly involved in ethology, both in the technique and in the description and interpretation of results.

The next speaker, Prof. J. E. Harris (University of Bristol), pointed out that a physiological and 'mechanistic' treatment is still appropriate to the genesis of behaviour patterns in the embryo. He showed in detail how this genesis can be related to the development of the muscular and nervous systems of young fish and amphibians, and how the first myogenic movements and rhythms are modified as motor and sensory nerve cells, and connexions and tracts become functional until the swimming rhythm is perfected.

Prof. R. W. Russell (University College, London) said that he was a psychologist and necessarily approached animal ethology with the terminology and point of view of human psychology. Nevertheless, he agreed with Prof. Pumphrey about the importance of semantics and the desirability of an integrated ethology with a common language. Such meetings as the present joint discussion and the Cambridge symposium on behaviour two years earlier reflect the desire of psychologists and animal ethologists alike to understand each other and to contribute jointly to an understanding of behaviour.

Prof. Russell then described the extensive field of animal psychopathology which has been explored since the first studies in experimental neurosis in Pavlov's laboratory at the beginning of the century; and he convincingly demonstrated the close resemblance in the symptoms of neurotic behaviour of man and animals and in the situations which produce it. There is a fundamental difficulty in distinguishing 'normal' and 'abnormal' behaviour of animals in laboratory situations which are *ex hypothesi* abnormal. Nevertheless there is a promise, if not more than a promise, that animal and human psychopathology can be unified with significant results for our understanding of human behaviour.

In a review of learning by animals other than man, Dr. F. H. George (University of Bristol) emphasized the extent to which, after the earlier pioneering of Lloyd Morgan and Pavlov, the world was indebted to the United States for investigation in this field and for the elaboration of its somewhat indigestible theory. He emphasized in particular the unsatisfactory theoretical position of 'punishment', Muenzinger *et al.* and Drew having shown that 'punishment' is as effective in reinforcing a right choice as in correcting a wrong one. He outlined the conflicting theories of learning of Tolman and Hull and seemed at least to hint that the conflict is partly verbal and terminological. Like previous speakers, Dr. George stressed the importance of a new semantic approach to ethological problems and suggested that a really comparative attitude is likely to be productive. In the 'comparative' psychology of recent years, 70 per cent of published papers deal only with the Norway rat.

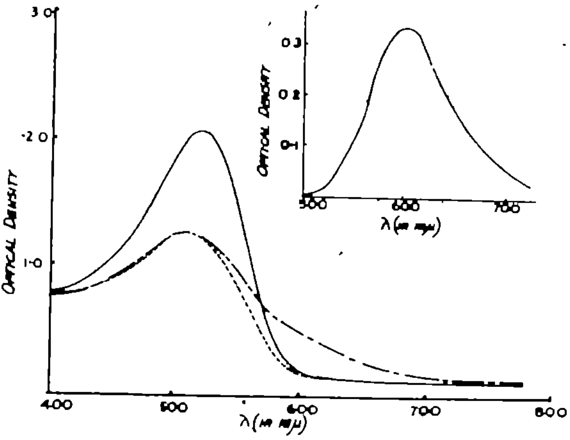
In the subsequent discussion, Prof. H. R. Hewer neatly pointed Dr. George's concluding remarks, and criticized by implication the abstractness and remoteness from reality of much modern work on learning and behaviour. During the Second World War he had been concerned with others in countering the depredations of wild rats. Search of the enormous literature on the behaviour of rats in laboratories had disclosed little that was relevant or useful in the control of wild rats. It was not at that time even known how they ate.

EFFECTS OF X-RAYS UPON PLASTICS

Electronic Processes

IN continuation of our work on systems suitable for the dosimetry of ionizing radiations, and in particular the measurement of three-dimensional dose distributions[1], we have experimented with some coloured plastics. The observed phenomena, while indicating some applicability to the measurement of radiation, have aspects of more general interest.

It was found that of a series of thirty-two samples of commercially available polymethylmethacrylate ('Perspex'), coloured with various materials, three samples showed an appreciable change of colour when irradiated with X-rays. Similar results could be obtained using a plastic prepared by polymerization of an acrylic monomer coloured with benzene-azo-benzene-azo-β-naphthol (Sudan III). These colour changes are more intense than the slight colour changes shown by uncoloured 'Perspex', and of a different spectral composition. In addition, they are completely different from the slight bleaching caused in the same materials by ultra-violet light. The X-ray effect consisted in each case of the development of an absorption band at a wave-length longer than the absorption band of the basic dye, and manifested itself visually in a darkening of the colour. At the same time the optical density in the original absorption band of the dye decreased (see diagram).



Absorption spectrum of 'Perspex Red 400'
Curve 1, —— before irradiation; curve 2, —·— immediately after irradiation; curve 3, ---- 6 days after curve 2, in the presence of oxygen (complete penetration). Inset: Absorption band produced by the radiation (difference of curves 2 and 3)

The optical density in the new band produced by a given dose of radiation increases with the concentration of the dye in the plastic, and is also dependent on the concentration of oxygen. In the absence of oxygen the change in absorption coefficient is proportional to the dose (approximately 0·02 per cm. per 1,000 r. in 'Perspex Red 400'), whereas in the presence of dissolved oxygen in equilibrium with 1 atm. of the gas, scarcely any change occurs for the first 10^6 roentgens, and the rate of change increases at higher doses to approximately the same value as obtained in the absence of oxygen. If, after irradiation, oxygen is permitted to diffuse into the plastic, a partial reversal of the phenomenon occurs, so that the new absorption band due to the irradiation disappears; but the absorption at the original peak does not return to its normal value. A thermal back-reaction is also observed, which is very slow at room temperature, taking several months for completion.

These results are interpreted as showing that some of the electrons liberated from the lattice by radiation become trapped by and attached to the dye, the proportion depending on competition for the available electrons between the dye and other acceptors in the lattice. As a result of the irradiation, a system of positive holes and negative ions is formed. The phenomenon is analogous to the production of colour centres in alkali halide crystals. The system would not normally be chemically stable, but is evidently 'frozen' into the plastic lattice, and decomposes or recombines only very slowly at room temperature. This is a noteworthy difference from, for example, aqueous solutions, where the primary processes are presumably identical, but are followed much more readily by secondary chemical reactions.

Oxygen evidently competes for the electrons, forming O_2^-, and owing to its greater electron affinity is capable also of effecting an electron transfer from the dye:

$$\text{Dye}^- + O_2 \rightarrow (\text{dye} \ldots O_2^-),$$

where electron transfer has occurred, but the two species may be held together by the residual electron affinity of the dye.

The odd ions formed in these processes should exhibit paramagnetic resonance, and this has been found to be the case[2]. These coloured plastics are therefore solid systems, in which one has some control over the nature and number of the electron trapping sites. At the same time, the velocity of the thermal back-reaction is sufficiently small to permit accurate observation. The effect may be related to the increased conductivity[3] and fluorescence of plastics under irradiation[4] previously reported. It seems, therefore, that these systems might yield useful information on electron capture processes in solids. Further experiments on the chemical and physical aspects are in progress.

We wish to thank Imperial Chemical Industries, Ltd. (Plastics Division), for specimens of 'Perspex', Mr. W. A. Jennings for valuable comments, and Dr. F. T. Farmer and Dr. Joseph Weiss for their interest and support.

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May 26.

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* Now at the Hebrew University, Jerusalem.

[1] Day, M. J., and Stein, G., *Nature*, 166, 146 (1950); *Nucleonics*, 8, No. 2, 34 (1951).

[2] Schneider, E. E., Day, M. J., and Stein, G. (see following communication).

[3] Farmer, F. T., *Brit. J. Radiol.*, 18, 148 (1945).

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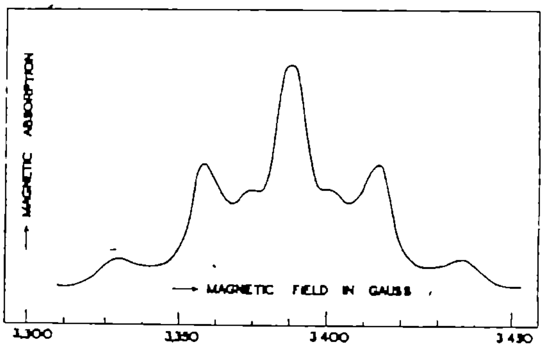
Paramagnetic Resonance

Using the sensitive micro-wave apparatus described recently[1], operating at 9,500 Mc./sec., sharp paramagnetic resonance spectra have been obtained with a number of plastics after irradiation in a 200-kV. X-ray therapy set. The main experiments have been carried out with specimens (2 cm. diameter × 0·3 cm.) of coloured polymethylmethacrylate ('Perspex')[2] and of clear uncoloured 'Perspex'. The observed intensities and widths of the resonance absorptions and their increase with X-ray dosage, which was varied between 10^6 and 10^7 roentgens, are in accordance with the assumption that the magnetic centres are electrons produced as the result of irradiation and trapped in the plastic lattice.

The structure of the resonance is the same for both types of specimen, consisting of a central peak symmetrically surrounded by a number of satellites (see graph). There is, however, a marked difference between the coloured and clear 'Perspex' in the position of the resonance spectra, providing evidence of differences in the nature of the trapping sites. In the coloured specimens the centre of the resonance lies at a magnetic field corresponding to a g-factor within 0·1 per cent of the free spin value, whereas in the clear 'Perspex' the resonance pattern is shifted down-field by some 20 gauss ($g = 2·014$), indicating interaction of the trapped electrons with surrounding atoms. The symmetry of the resonance pattern of the dyed 'Perspex', in which no trace of the displaced clear 'Perspex' lines is detectable, suggests further that the presence of the dye molecules provides electron traps which are considerably deeper than those in the plastic host lattice. Other results point to the same conclusion, such as the stability of the trapped electrons in the dyed as compared with the undyed specimens shown by resonance experiments at long periods after irradiation, and the less severe competing effect of oxygen demonstrated by resonance observations at small X-ray doses with specimens of varying oxygen content. It should be noted that the electrons captured by oxygen molecules, and the positive holes, that is, the sites in the plastic lattice which have lost electrons during irradiation and consequently have unpaired electron spins, are assumed to produce no resonance effects detectable with the present apparatus. With this qualification the resonance experiments have gone far in supporting the arguments on the effects of X-rays on plastics presented in the preceding communication as the result of optical measurements.



Magnetic resonance spectrum of irradiated 'Perspex'

The remarkable fine structure of the paramagnetic resonance of the observed resonance spectra is of even more general interest, since it appears to reflect characteristic properties of the structure of plastics. In the 'Perspex' resonances obtained at small X-ray dosage, lines are detectable at ± 12 and ± 46 gauss from the centre, besides the main satellites at ± 25 gauss. Resonances having a similar pattern have been observed with irradiated polystyrene; here the main satellites are at ± 18 gauss. It is believed that the satellite resonances are caused by regularities in the spacing in the plastic lattice of the trapping sites for the magnetic units (electrons and possibly positive holes). Magnetic dipole interaction between neighbouring spins would thus lead to a non-random distribution of the internal magnetic field acting on the resonating electron spins. Considering only the effect of nearest neighbours and neglecting the statistics of their spatial distribution, a crude estimate of a characteristic minimum separation r_0 between adjacent spins can be obtained by identifying the field separation of the main satellites from the resonance centre with the internal field μ_e/r_0^3 produced by a single adjacent spin. The values for r_0 of 17 A. and 19 A. derived from the observed resonance spectra for polymethylmethacrylate and polystyrene respectively may be related to one of the regular 'identity periods' derived for the specific plastics from X-ray diffraction measurements[3].

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Gabriel Stein

May 26.

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[1] Schneider, E. E., and England, T. S., *Physica*, 17, 221 (1951); *Nature*, 166, 437 (1950).

[2] Day, M. J., and Stein, G. (see preceding communication).

[3] Mark, H., "The Chemistry of Large Molecules", 33 (New York, 1943).

A METHOD FOR MAKING ULTRA-THIN TISSUE SECTIONS FOR ELECTRON MICROSCOPY AT HIGH RESOLUTION

By FRITIOF SJÖSTRAND
Department of Anatomy, Karolinska Institutet, Stockholm

DURING recent years, some techniques for making tissue sections for electron microscopy have been worked out which make it possible to prepare sections about 0·2 μ thick[1-7]. The resolving power of the electron microscope at this specimen thickness is estimated as 100–200 A., being different in different structures of the tissue cells because of differences in electron scattering power of the structures.

There seems to be a definite limitation of the techniques tried, due to compression and breaking of the sections when cut. In order to make use of the whole resolving power of modern electron microscopes, the thickness of the sections has to be only a few hundred angstroms or less. The demands regarding the thickness are determined by the size of the structural elements to be studied.

In order to obtain sufficiently thin sections for electron microscopy at high resolution, a technique has been worked out, the principle and first trials of which were published in 1943 [8-10]. The idea was to prepare sections without interference of the limiting factors mentioned above. This is possible by the use of a double sectioning technique. First of all, sections 0·5–1 μ thick of double-embedded (collodion–paraffin) material are cut on a Spencer microtome (No. 821) using the technique of Hillier and Gettner. Ribbons of serial sections are re-embedded in collodion on the accurately plane surface of a piece of glass. The surfaces of this glass are made to meet the same criterion for parallelness as are fulfilled by the well-known Johansson gauges, and in addition they are optically polished.

This glass 'measure' is placed in a specially constructed microtome on the plane upper surface of the advance mechanism, where it is kept in place simply through the cohesion between the plane surfaces in contact. A specially sharpened razor blade is used as knife, the edge of which travels parallel to the upper surface of the advance mechanism. The deviation from a parallel advance is 50–100 A. per mm. advance.

With this knife a greater part of the embedded sections is cut away and discarded, and the remaining part is mounted for examination in the electron microscope. This remaining part can be made extremely thin, as it has not been deformed during sectioning. The principle of cutting is illustrated in Fig. 1.

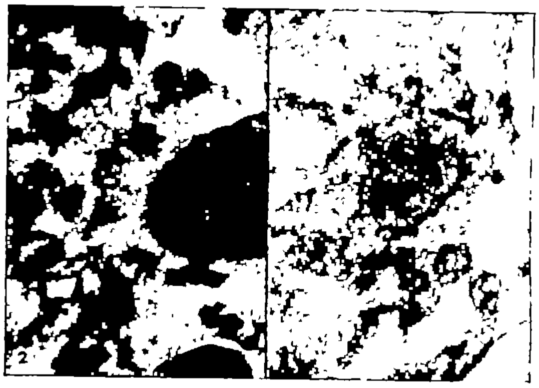

Fig. 2. Thicker region (about 0 2 μ thick) of section from mouse liver, fixed in 2 per cent osmic acid for 24 hr. 5,000 ×
Fig. 3. Adjacent thin region from the same section. In this picture the contrast has been much enhanced during photographic printing. 5,000 ×

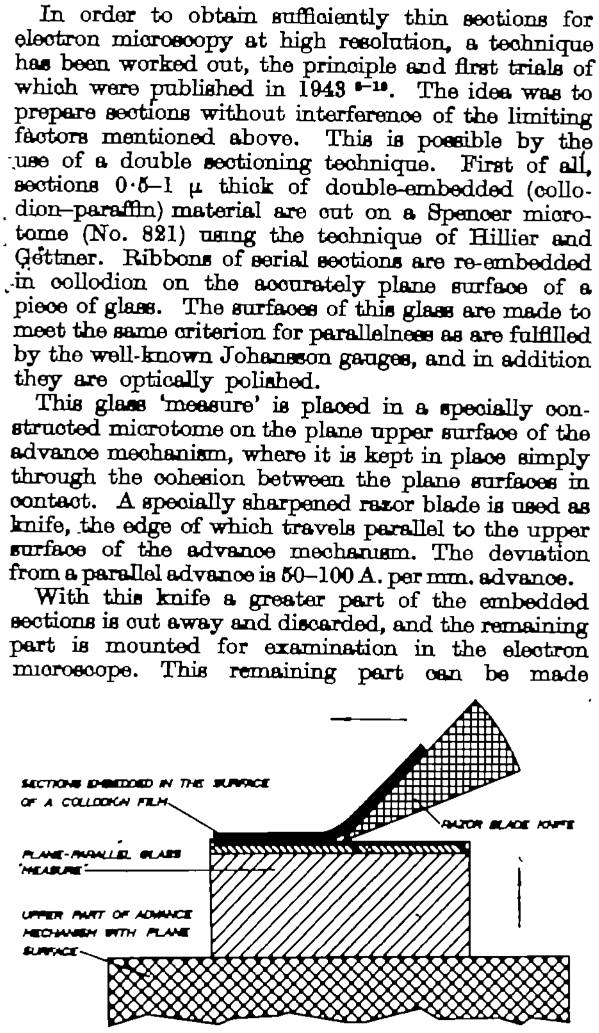
SECTIONS EMBEDDED IN THE SURFACE OF A COLLODION FILM
RAZOR BLADE KNIFE
PLANE-PARALLEL GLASS 'MEASURE'
UPPER PART OF ADVANCE MECHANISM WITH PLANE SURFACE

Fig. 1. Principle of the double sectioning technique

In order to control the thickness of the sections, the thickness of the original sections has to be known and must not vary too much. The advance mechanism also must allow a very precise and accurate movement relative to the knife-edge. This movement is directly registered in angstrom units with an accuracy of better than 250 A.

The chances for getting sections of the right thickness are increased with experience of the processes of embedding and sectioning. From each ribbon of sections mounted on one glass 'measure' several sufficiently thin sections are obtained to allow the use of this technique as a routine method for the study of a large number of sections without an unreasonable expenditure of time.

For the analysis of the sections, an RCA *EMU 2 c* electron microscope with compensated standard objective pole-piece and the standard objective aperture was used. The pictures have been obtained with minimal electron bombardment. Fig. 2 shows a thick part of a section through a mouse liver. The thickness of this part of the section is estimated to be about 0·2 μ, judged from experience regarding the electron scattering of that kind of sections.

Fig. 3 shows an adjacent thin part of the same section, with the contrast highly accentuated during the photographic printing. The most characteristic feature of the thin sections is the very low scattering power, with a decrease of contrast differentiation of the larger structural elements of the cell when compared to the thick sections. On the other hand, the resolution is much improved and makes it possible to explore the ultra-structure of the cell organelles.

Fig. 4 shows a part of a section through the nerve myelin sheath from the sciatic nerve of a guinea pig at a magnification of 135,000. Periodic striations, the period of which is 50–80 A., are visible, presumably corresponding to a concentric arrangement of the membranes observed on fragmented nerve[11-13]. Indications of such a periodic structure in sections were first noticed by H. Fernandez-Moran[13].

The tissues were fixed in 2 per cent osmic acid (24 hr.). The conditions of fixation are critical when ultra-thin sections of this kind are prepared. The artefacts introduced through the fixation, embedding and sectioning will be systematically studied.

Fig. 4. Section through myelin sheath from guinea pig sciatic nerve, fixed in 2 per cent osmic acid for 24 hr. 185,000 ×

It is impossible to measure the thickness of these sections; but judging from the contrast of the sections as compared to the contrast of the supporting film when doubled at folds and ruptures, the thickness of the thinnest parts of the sections is estimated to be of the same order of magnitude as the supporting films ordinarily used, or a few hundred angstroms.

A more detailed description of the technique will be published elsewhere. [May 15.

[1-7] Fullam, E. F., and Gessler, A. E., *Rev. Sci. Instr.*, 17, 23 (1946). Pease, D. C., and Baker, R. F., *Proc. Soc. Exp. Biol. and Med.*, 67, 470 (1948). Newman, S. B., Borysko, E., and Swerdlow, M., *J. Res. Nat. Bur. Stand.*, 43, 183 (1949). Gettner, M. E., and Hillier, J., *J. App. Phys.*, 21, 67 A (1950). Hillier, J., and Gettner, M. E., *J. App. Phys.*, 21, 889 (1950), *Science*, 112, 520 (1951). Latta, H., and Hartmann, J. F., *Proc. Soc. Exp. Biol. and Med.*, 74, 436 (1950).

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[11-13] Sjöstrand, F., *Nature*, 165, 482 (1950); Proc. Conf. Electr. Micr., Delft, 144 (1950).

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RESEARCH DEPARTMENT OF THE BRITISH BROADCASTING CORPORATION

NEW SITE AT BANSTEAD

IN the early days of broadcasting in Great Britain, the British Broadcasting Corporation soon found itself faced with a variety of technical problems which could not be resolved by the engineering maintenance and operating staff. A Research Department was formed in 1929, and five years later this section of the Corporation was housed at Nightingale Square, Balham. When, after the War, the normal work of the Department was resumed, it became clear that larger premises were necessary to deal with an enhanced programme of research. A suitable building, standing in twenty-seven acres of ground, was found at Kingswood Warren, Banstead, some twenty miles south of London. The mansion itself has been adapted to the needs of the Research Department staff with laboratories, offices and restaurant facilities. In addition, there is ample space for outdoor experimental work, as well as for the erection of two new laboratory blocks, one of which has been completed.

An 'open day' at this new site of the Corporation's Research Department was held on June 20, at which a number of exhibits and demonstrations were available for inspection to illustrate the work of the Department. On this occasion, also, an illustrated brochure, entitled "BBC Research Department, Engineering Division, 1951", was issued. This publication shows that the Department is organized into four Sections at Kingswood Warren, in addition to the Electro-Acoustics Group, which is still housed at Nightingale Square.

Among the most interesting activities at the present time is that of the Television Section, which deals with investigations into the electrical and optical performance of camera tubes as developed by the radio industry, and with the properties of the various circuits used in television technique. In addition, work is directed to an appraisal of the various problems involved in colour television, including its fundamental physiological aspects. The recording of television programmes on film is an item of investigation about to be undertaken.

The very limited number of frequency channels available for sound broadcasting has made it necessary for some time past for the Field-Strength Section of the Department to study the propagation of radio waves within the service area of each transmitting station. This work has recently been extended from medium frequencies to those involved in television and very-high-frequency sound broadcasting. Closely associated with this is the work of the Aerial and Transmitter Section, which is concerned with the development of aerial systems designed to give the largest local-service area of coverage or, in international broadcasting, to direct the programmes to the zone or country in which reception is desired. The Receiver and Measurements Section keeps abreast of developments in the design of broadcasting receivers and carries out tests on typical commercial products. It also designs receivers for special purposes, such as, for example, the standard receivers being used in tests on the relative merits of amplitude- and frequency-modulation in transmissions at very high frequencies.

At Nightingale Square, the Acoustics Section is responsible for experimental work connected with the design of studios and the basic principles of reverberation. Techniques have been developed in which the response of a studio to transient sounds is displayed on a cathode-ray oscillograph. A new method, not so far used elsewhere, makes use of a pulsed gliding tone, in which the frequency of the tone is gradually increased, and the changing form of the oscillograph display is photographed on slowly moving film. In the Recording Section, a thorough investigation of the disk-recording process has led to the design and construction of a disk-recording machine, since no equipment available commercially provides all the facilities required while meeting the standard of fidelity considered essential. Investigations in magnetic recording now absorb the major part of the Section's effort.

To assist in all this work, the Research Department has built up its own model shop, which is fully equipped to undertake the construction of the majority of the apparatus required; this is of a varied nature and may be of mechanical, electrical or optical type. As a normal part of its activities the Department maintains close touch with other broadcasting authorities, with research organizations and with industry. Finally, great importance is attached to the publication of the results of research work; and the staff are encouraged to prepare papers for reading before scientific societies, or for publication in scientific and technical journals and in the *BBC Quarterly*.

NUFFIELD FOUNDATION

ANNUAL REPORT

THE outstanding feature of the sixth report of the Nuffield Foundation*, covering the year ended March 31, 1951, is the passage in which is considered the prospect of some curtailment of scientific research through rising costs, and whether the resources of such charitable trusts as the Nuffield Foundation should be used for sustaining academic activities thus endangered or for encouraging novel projects which may find it even more difficult to secure support. The present report indicates that, for the remaining three years of its present programme, the Foundation will continue to give preferential support to fundamental biological and social studies. This policy is succeeding, but its other main preference for the period—the encouragement of specialists in various fields to apply their knowledge and techniques to the study and solution of practical contemporary problems—has not attracted the same support. In addition, the Foundation continues to assist research of exceptional merit in any branch of science, and its schemes of training fellowships and travel grants are being expanded, and from the year's income of more than £550,000, some £55,250 was allocated for new or continuing schemes of this type, with a further £88,000 to be met from succeeding years. Of new grants totalling £386,194, £20,950 was used from the Oliver Bird Fund and other resources for research in rheumatism, £46,640 for fundamental biological and £111,000 for sociological research in the United Kingdom and £71,500 for research overseas within the Commonwealth. The original contribution of £500,000 to the National Corporation for the Care of Old People is not yet exhausted, and medical research on ageing is still similarly financed from an earlier allocation; no new grants have been necessary. As provision for a new headquarters when the Foundation is required to vacate its present premises, £135,000 has been set aside this year.

In continuation of its past programme the Foundation has increased by £3,650 the grant to the University of Bristol for Dr. C. R. Burch's work on the development of the reflecting microscope. Patents covering the present processes of manufacture offered to the Foundation are being put before the National Research Development Corporation for development in the national interest. In the medical sciences, the Foundation has made a grant of £750 for an additional full-time worker for epidemiological and bacteriological studies in the 'thousand-family' investigation being conducted by the Department of Child Health, University of Durham. In the social sciences, the Foundation is continuing its aid to Political and Economic Planning on the diminishing scale of £4,500 over the years 1951–53, while an additional grant of £1,000 has been made to the Caldecott Community to enable the children's reception centre to follow up the children who have passed through the centre or been 'placed' on its advice.

A gift of 1 kgm. of cortisone was made by Merck and Co., Inc., jointly to the Medical Research Council and the Foundation, and a new joint committee was set up to examine projects of clinical trial and research and allocate supplies both of cortisone and adrenotropic hormone. A three-year grant totalling £5,000 has been made to the Department of Human Ecology at the University of Cambridge for a medico-social survey of the Fen district of East Anglia covering the types and prevalence of rheumatic disease. A grant of £4,000 has been made to the Department of Chemistry, University of Birmingham, for the study of tendons, cartilage and tissue components and their structural chemistry, and £1,000 to the Medical School, University of Leeds, for special equipment for chromatographic techniques in the study of pathological collagen, while a grant of £1,050 a year for two years has been made for the appointment of a senior and a junior research fellow to work under Dr. D. M. R. Barton at Birkbeck College, London, on the synthesis of cortisone by the ergosterol route. The grant to the rheumatic unit at the Department of Medicine, University of Edinburgh, has been increased to £2,364, and that to Mr. A. Law, of the Orthopædic and Accident Department, London Hospital, for perfecting techniques of reconstructive surgery in chronic arthritis of the hips and spines, was renewed, as well as that to the South-West and Oxford Regional Research Unit, Bath.

New grants for fundamental research include £5,340 over five years, for a research assistant and technician under Prof. F. G. Young at the School of Biochemistry, University of Cambridge, for the perfection and running of the mass-spectrograph, and £1,000 a year for five years to the Physiological Laboratory at the same University for equipment and materials for workers under Prof. E. D. Adrian. A five-year grant totalling £20,000 has been made to Prof. C. Rimington, of the Department of Chemical Pathology, University College Hospital Medical School, London, for a small unit to continue and develop his investigations on the chemistry and biochemistry of hæm and other pyrrole pigments, and a grant of £500 for equipment and £400 a year for two years for a technical assistant has been made to Dr. E. Wangermann to enable her to continue at University College, Leicester, the work initiated under Prof. E. Ashby at Manchester on growth-rates of populations of common duckweed (*Lemna minor*) under controlled conditions. A further grant of £1,000 a year for five years has been made for an additional research worker to collaborate with Dr. C. Causey in work on certain aspects of nerve-cell body and axon as part of the work under Prof. J. Z. Young on the physiology of learning at the Department of Anatomy, University College, London, in which Mr. F. Roberts has now devised and built a 'flying-spot' microscope which has novel possibilities both for magnification and for counting and measuring particles of living tissues. A grant of £10,000 over the next five years has been made to the Department of Zoology and Comparative Anatomy, University of Oxford, for research under Dr. E. B. Ford on the evolutionary genetics of wild populations.

In the sociological field, the Foundation has offered a grant of £2,000 to the University of Birmingham to complete, under Prof. Charles Madge, the survey of a Midland market-town commenced in the Department of Social Science, and one of £4,000 to the Department of Social Studies, University of Leeds, for a two-year project to examine the changing relationships between the family and the community in an industrial village within easy reach of Leeds. The Foundation is also providing £3,750 for a survey by the Department of Social Science, University of Liverpool, of social relations in the dock-working community; under the general direction of Prof. T. S. Simey, this survey is intended to cover the relations between individuals and social groups which develop informally and spontaneously at work-level; between the subordinate and his immediate superior; and between individuals and social groups and officials and institutions with which they are brought into contact. An additional grant of £1,250 has been made to the London School of Economics and Political Science for the establishment of a Division of Research Techniques, and £100,000 over ten years for two additional fellowships, to be called Nuffield readerships, at Nuffield College.

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* Nuffield Foundation. Report for the Year ending 31 March 1951. Pp. 113. (London: Nuffield Foundation, 1951.)

New grants for research overseas include £900 a year for two years for a research fellowship for Dr. F. Douglas Stephens at the Children's Hospital, Melbourne, for research on problems of child surgery; up to £3,500 to the University of Melbourne, for appointment of a medical biochemist for two or three years in the Department of Biochemistry; £1,500 for special equipment for neuro-anatomical research in the Department of Anatomy, Histology and Embryology at the Christian Medical College, Vellore, and £300 a year for two years for a programme of meteor research at the Department of Physics, Canterbury University College, New Zealand.

The Foundation is also providing up to £12,000 for a review, jointly sponsored with the Secretary of State, of the policy and practice of education in the Colonial territories in Africa. The group investigating methods of work measurement used by industry in Great Britain is beginning inquiries as to why progressive managements continue to use time-study practitioners; what it is that management values, and why, in the existing methods; and what information industry would like to get from such techniques that existing methods do not supply. Fundamental scientific research into the measurement of human performance on skilled operations is also being initiated.

New fellowship and scholarship schemes during the year include a small number of biological scholarships and bursaries for graduates of the United Kingdom normally resident there, and sociological scholarships and bursaries for special training in sociological subjects, and a visiting studentship for a South African physiologist. Four United Kingdom medical fellowships were awarded; but there was even less response than in 1949 to the Foundation's offer of dental fellowships and scholarships. A final award of six fellowships, four postgraduate scholarships and ten vacation scholarships brought the total awards under the scheme for the advancement of extraction metallurgy to 23 fellowships, 21 postgraduate and 49 vacation scholarships. The scheme for travelling scholarships for young farmers is now extended to the whole United Kingdom. Only one travelling fellowship for the Home Civil Service was awarded in 1951; but India, Pakistan and Ceylon have now accepted the Foundation's offer of five, three and one fellowships respectively for study in Great Britain. Two further travelling scholarships were awarded to farmers of Southern Rhodesia for 1951.

For research into ageing, the Foundation has made a grant of £1,000 a year for two years to Dr. Alex. Comfort to work in the Department of Zoology, University of Birmingham, with a capital grant of £650 for apparatus and recurrent grants of £200 to the University for the costs of research. A grant of £2,600 over two years has been accepted by the University of Oxford for an examination, in the Nuffield Department of Surgery, of the changes in the blood-vessels of the brain as a result of ageing. An offer of £1,250 a year for a three-year trial period has been accepted by the Australian Committee of Vice-Chancellors for a full-time secretariat. A grant of £1,300 a year for three years has been made to the Scientific Department of the National Gallery to assist an examination, by the reaction to low-voltage soft X-rays, of the characteristics of organic materials, particularly synthetic resins, with the aim of discovering what can be learnt about condition and about picture structure as such, and also an examination of the swelling and solvent action of organic solvents on natural and synthetic varnishes and pigmented linoxyn films. A grant of £4,000 has been made to the Royal Institution towards the cost of reconstructing and re-equipping a modern workshop in the Davy Faraday Research Laboratory.

CHILDREN'S LEISURE

THE findings of a survey, carried out by the Social Survey Division of the Central Office of Information, into the out-of-school interests and activities of school children has recently been published*.

Information was obtained from the parents—chiefly mothers—of about 1,600 children, forming a representative sample of school-age children of England and Wales, and also from 840 older children themselves by means of a questionnaire which they filled in at school.

The survey was undertaken to assist the Central Advisory Council for Education (England), which, in 1947, was asked by the Ministry of Education to investigate the natural interests and pursuits of children out of school hours, the provision made for them, and the extent to which school work could help to develop these interests.

Thinking chiefly in terms of children's play, one in every two mothers (51 per cent) said that there was not enough for children to do in their districts. 36 per cent of the mothers were quite satisfied with existing facilities and 13 per cent gave qualified answers. Fewer mothers in rural districts (26 per cent) were satisfied than in urban districts (38 per cent).

The main cause of dissatisfaction was that the children had to play in the street; 47 per cent of the mothers said that their children usually played in the street. 46 per cent of the mothers said that there was no park available within easy reach of the children and 52 per cent said that there was no playground. As many as 52 per cent of the children in the sample did not go to any parks and 68 per cent did not go to a playground. Play-centres were almost unknown; only 2 per cent of the younger children (up to the age of ten) and 4 per cent of the older ones ever went to one.

The majority of the children lived within twelve minutes journey from school, so that, allowing for the usual school closing times, children appear to have approximately three to four hours in the evening, as well as the week-end, for their leisure interests.

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* "Children out of School", by Joy C. Ward. 10s. net.

But children have a good many calls on their leisure-time. Almost all (96 per cent) of the children at grammar schools had homework to do in the evening; 52 per cent of the boys and 39 per cent of the girls did more than one hour per evening. Only one in four of the children at secondary modern and technical schools did any homework, and the majority did less than one hour. Grammar school children—particularly the girls (42 per cent)—had other studies as well, music practice taking up most time.

Apart from homework, both boys and girls had considerable duties at home, the girls more than the boys. Shopping headed the list of duties: 80 per cent of the girls and 68 per cent of the boys did some shopping. Helping at home came next: 78 per cent of the girls and 59 per cent of the boys had some duties at home, which ranged from small tasks like setting meals to being responsible for the family's evening meal. 43 per cent of the girls and 32 per cent of the boys looked after younger children in the family.

Investigating membership of clubs and organizations among the children, Miss Ward reported that children are 'club-minded' by the age of ten, although most youth clubs do not open their doors to children below their 'teens'.

Three-quarters of the children of 11–15 years belonged to one or more club or other organization. Cinema clubs were mentioned more than any other and were most popular at the age of 10–11 years; 22 per cent of the boys and 18 per cent of the girls belonged to them. 13 per cent of the boys were Scouts or Cubs and 16 per cent of the girls were Guides or Brownies. The highest proportion of membership was among the 11–12 year olds.

From the age of thirteen upwards social clubs of various kinds were the most popular clubs and increasingly so with age. Church social clubs began to be important in the 8–10 year age-group (boys 11 per cent, girls 10 per cent). Other social clubs did not show comparable membership until the age of thirteen. Only 1 per cent of children in rural areas belonged to youth clubs compared with 7 per cent in towns.

A small proportion of the 11–15 year old children belonged to clubs which were devoted entirely to sports. More boys (10 per cent) than girls (3 per cent) belonged to these.

Cinema-going was the largest single activity among the children: only one in five did not go at all and those that did not go were mostly the very young ones. Only 6 per cent of the children of eleven and over did not go and less than 1 per cent of the 14-year olds. Most frequent was the weekly visit to the cinema, but 30 per cent of the older boys (11–15 years) and 25 per cent of the older girls went more than once a week. Grammar school children went less than those at secondary modern and technical schools. It seemed that boys and girls went equally as often, though there was evidence to suggest that girls at grammar schools went less than the rest of the children. Boys in the lower economic groups went more frequently than those in the middle and higher groups.

Membership of cinema clubs was found to be strongly associated with frequent visits to the cinema; compared with other children nearly twice as many of the children who belonged to cinema clubs went to the cinema once a week and more than once a week. The films the children (11–15 years) liked best were 'thrillers', murder and mystery films. The girls' second choice was 'musicals', and the boys' second choice was comedies.

Only 6 per cent of the 11–15 year old children said that they did not listen to the radio; one in three listened on the evening prior to the interview with the investigator. Among the younger children 14 per cent of the 5–7 year olds and 8 per cent of the 8–10 year olds did not listen in. Most of the older children (11–15) had hobbies of some sort; only 9 per cent of the boys and 12 per cent of the girls did not mention any.

Reading was more popular with girls than with boys, at all ages. Only 8 per cent of the 11–15 year old children said that they did not read. 28 per cent of the children in the sample belonged to the public libraries.

Football and other games were by far the most popular activities of the boys. 77 per cent mentioned it as one of the four things they liked doing best out of school. Next to this, playing out of doors, walking, and cycling were mentioned by 52 per cent of the boys, and (heading the girls' list) by 59 per cent of the girls. Other interests were considerably less popular with boys, but the girls' interests, lacking a predominating factor such as football, were more evenly divided. Besides playing out of doors, girls liked reading (53 per cent) and indoor activities such as knitting, sewing and playing 'indoors'. The girls' interests were found to lie much more at home than the boys'. Seven out of ten of the boys sought their leisure-time interests away from home compared with about one in three of the girls.

The investigator also made detailed analyses into the interests and activities of children at grammar schools, on one hand, and those at secondary modern and technical schools on the other. Apart from better facilities for play—such as more parks in their own district—the grammar school children's time was more fully occupied. They had, on an average, a slightly longer journey from school, and the majority did more than an hour's homework each night. Many of the girls, in addition, had music practice and other lessons to do. On the other hand, as many grammar school girls helped at home as secondary modern and technical school girls, although more of the latter had to look after younger children in the family. More grammar school girls belonged to the Girl Guide movement, and more played games. Wider interests of grammar school girls were shown also in the fact that membership of such societies as the Young World League and Dr. Barnardo's League was confined almost entirely to them. Membership of hobbies clubs was confined almost entirely to grammar school children; 30 per cent belonged, compared with 12 per cent of the children at secondary modern and technical schools.

Children at secondary modern and technical schools went to the cinema more often than grammar school children, and twice as many of them belonged to cinema clubs. More of the boys and girls at secondary modern and technical schools belonged to no other clubs apart from the cinema clubs.

Some differences were found also in the kind of films and radio programmes which the children liked, though the favourite radio programmes—'Quiz' and 'Variety'—were liked equally by girls and boys at both types of schools.

Since this survey was carried out in the winter months, it is possible, as Miss Ward suggests, that different findings would be made if investigations were continued in a summer period.

LETTERS TO THE EDITORS

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Electron Microscopy of Chick Embryo Membrane infected with *PR*-8 Influenza

PREVIOUS studies[1] of tissue sections with the electron microscope have shown masses of particles having the dimensions of the elementary bodies of influenza virus associated with infected cells. These particles have been the expected mixture of spheres and rods with diameters of c. 100 mμ. As seen in the sections, they have seemed to be developing out from, rather than within, cells. This manner of growth and the ease with which it can be observed make influenza-diseased tissues one of the more fruitful objects for the study of how viruses grow.

In the earlier investigation, the virus-like particles were observed both on the chorio-allantoic membrane of chick embryos and in the lungs of mice. They have, however, been found more easily on membranes. A striking feature of infections with freshly isolated strains of virus has been the rapid necrosis that has followed infection, and the difficulty of finding virus particles in the slimy masses of disintegrating tissue that result. For this reason it has seemed worth while, as a next step towards seeing how influenza virus proliferates, to examine the infection of chick embryo membranes using a long-established and well-adapted strain of virus such as *PR*-8.

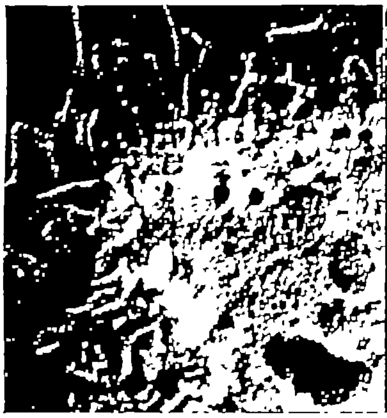
For these experiments the membranes from inoculated embryos were harvested after 48–72 hr. incubation, washed with saline and fixed by immersion for one hour in neutralized 4 per cent formalin–saline. Pieces were dehydrated by passage through pyridine–water mixtures and then embedded in methacrylate[2] polymerized in an oven at 45° C. Sections cut from such blocks were mounted on 'Formvar'-covered grids, the methacrylate was removed with amyl acetate and the resulting preparation lightly shadowed with palladium for examination under an RCA type *EMU* microscope.

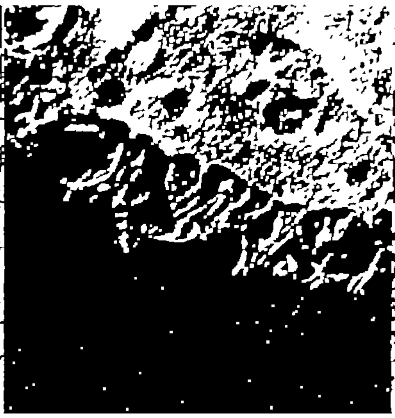
Masses of filaments and spheres having the diameter of virus are to be seen at many points along surfaces of these membranes (Fig. 1). Many of the filaments appear segmented into the spheres. Filaments develop both out from the limiting surface of the membrane (Fig. 2) and between cells. As this latter growth proceeds, it isolates adjacent cells more and more completely from one another; a cell thus desquamated is shown in Fig. 3.

It is obviously of primary importance to try to establish whether the filaments are protoplasmic protrusions from the affected cells or parasitic growths along its borders. It has been difficult to find convincing evidence in the photographs for one or the other of these possibilities; but it is noteworthy that where sectioning has cut through attached filaments, their contents seem continuous with the cellular cytoplasm (Fig. 2). To this degree the filaments and spheres shown in the figures can be thought of as extruded and detached bits of this cytoplasm.

The question naturally arises as to whether these objects actually are the virus particles. After formalin-fixation, they invariably have had the diameters (c. 100 mμ) of the infectious units found in purified suspensions. Large areas of infected tissue were scanned during the present experiments; the particles illustrated could not be found in all membranes, but no other objects the size of virus were anywhere recognized. Healthy membranes have not contained them, but similar particles have been numerous in sections through membranes infected with Newcastle disease virus[3]. In two or three out of several hundred membranes, filaments of the diameter in question have been seen along the borders of membranes that were not diseased with either of these viruses. It is not yet known what were the conditions that produced them.

Using dark-field optical microscopy, Hoyle has seen indications in pieces of excised normal and influenza-diseased chorio-allantoic membrane[4] of what may be the cellular protuberances shown here. It is hard to make too close a comparison between the dark-field observations and the electron micrographs, because particles the size of influenza virus are so small that optical microscopy cannot portray them in their true dimensions even though it may indicate their presence. Nevertheless, the electron microscopic observations thus far made suggest a picture of





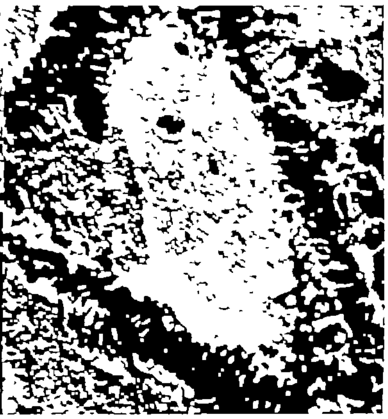


Fig 1. Rods and spheres the diameter of influenza virus along the border of a diseased cell. A few of the rods seem to be segmenting into the spheres. Note the spongy texture of the filaments. × 10,000

Fig 2. Filaments developing out from the periphery of a *PR*-8 diseased cell Where the filaments, too, have been sectioned their contents seem continuous with the cytoplasm of the cell. × 10,000

Fig. 3. Remains of a cell isolated from its neighbours by the filaments that have developed around its borders. × 6,500

developing influenza virus which resembles in many respects that proposed by Hoyle. If the elementary infectious units of influenza actually are cellular fragments, as the electron micrographs indicate they may be, this defines within narrowing limits the views that can be maintained concerning the fundamental nature of influenza virus. The study is being continued.

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Action of Living Cells on Cortisone Acetate Crystals

In the course of experiments designed to study the effect of cortisone upon the growth of fibroblasts in hanging-drop tissue culture, it was observed that the cortisone acetate crystals dissolved in the plasma clot.

One drop of fowl plasma and one drop of embryonic extract, both diluted with Gey's saline solution in the proportion of 1 : 2, were mixed with one drop of cortisone acetate (Merck) suspension. This mixture of the three drops was spread out on a cover slip, and a piece of chick embryo tissue 1 mm. in diameter was placed in the centre of it. The cover slip was then affixed to a depression slide, sealed and incubated at 38° C.

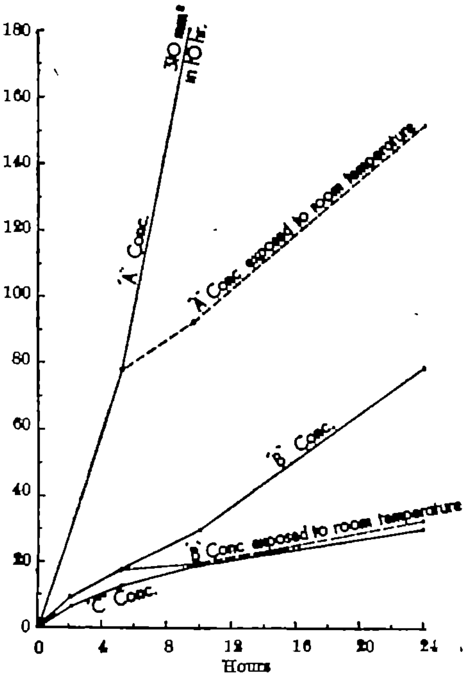

Fig. 1

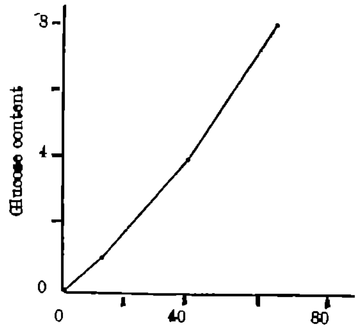

Fig. 2

When a higher concentration of cortisone acetate is used, the plasma clot appears macroscopically turbid, and under the microscope the crystalline form of cortisone acetate may be seen discretely suspended in the otherwise clear plasma clot. With lower concentrations of cortisone it was found that the crystals disappeared after 24 hr. incubation; but in the higher concentrations, only a circular zone around the tissue was cleared of crystals. It was further observed that there was extensive vacuolation of the growing cells which, according to Fisher (1947), may be a sign of depletion of glucose. As a result of this observation, and in view of the fact that a related compound, deoxycorticosterone, is known to be soluble as a glucoside, further series of tissue cultures with increasing amounts of glucose were set up.

The cortisone acetate (Merck) used in these experiments contains 25 mgm./ml. and was diluted with Gey's saline solution containing 0·2 per cent glucose. Cortisone concentrations of 10 per cent (*A*), 20 per cent (*B*) and 40 per cent (*C*) were used. The size of the area cleared of cortisone crystals around the implant up to 24 hr. is recorded in Fig. 1. The series containing 10 per cent cortisone (concentration *A*) cleared rapidly, and after about 12 hr. all the cortisone crystals had dissolved in the plasma clot.

With 20 per cent cortisone (concentration *B*), during the first 24 hr. up to an area approximately 9 mm. in diameter around the implant was cleared and did not change on further incubation. With 40 per cent cortisone (concentration *C*) the area cleared was limited to 5 mm. in diameter.

After 5 hr. incubation, some preparations of each series were taken out of the incubator and further observed at room temperature. As is shown in Fig. 1, the process of clearing was slowed down considerably at the lower temperature. The reason for this may be the slower metabolism of the living tissue at sub-optimal temperature.

In order to observe the effects of increased glucose content, another series of hanging-drop cultures was set up, each containing the 40 per cent cortisone suspension, but the Gey's solution used to dilute the cortisone contained 0·2, 0·8 and 1·6 per cent glucose.

It was found that the higher the glucose content, the greater was the area cleared around the implant. Fig. 2 shows this to be a nearly linear relationship.

When dead tissue instead of living tissue was embedded, the above-described phenomenon did not take place. Cholesterol crystal suspensions used instead of cortisone were not dissolved by the living tissue culture.

These observations indicate that the dissolution of the cortisone acetate crystals is dependent upon chemical changes associated with living tissue, and the fact that glucose is essential to, and promotes, the process suggests that the resultant compound may be cortisone glucoside.

The cortisone used in this experiment was part of a gift kindly made by Merck Co. (Inc.) to the Medical Research Council and the Nuffield Foundation.

Detailed experimental results will be published elsewhere in due course.

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The 1·5-A. Reflexion from Proteins and Polypeptides

In a recent issue of *Nature*, Pauling and Corey[1] have raised certain points in connexion with the 1·5-A. reflexion which I reported to be present in proteins of the α-keratin type, in an artificial polypeptide and in hæmoglobin, and to be absent in feather rachis[2]. To their remarks I should like to make the following comments.

Occurrence and significance of the reflexion. In their most interesting and stimulating paper, Pauling, Corey and Branson[3] have given powerful arguments to show that, of all the possible models of polypeptide chain, their newly discovered 3·7- and 5·1-residue helices have the lowest free energy, from which they conclude that these two configurations are the ones most likely to occur in Nature. They have also reported that one of these chains, the 3·7-residue helix, gave favourable agreement with published X-ray data of fibrous proteins and artificial polypeptides of the α-keratin type, and of hæmoglobin. Pauling, Corey and Branson's solution of the stereochemical problem seemed convincing; on the other hand, Bragg, Kendrew and I[4], and others before us, had found that some of the alternative models also fitted X-ray data reasonably well, and it seemed to us that such correlation as Pauling and Corey had obtained with the 3·7-residue helices did not rigorously exclude those other models.

These doubts led me to predict that the 3·7-residue helix, if present in all proteins and polypeptides of the α-keratin type, should give rise to a reflexion at 1·5-A. spacing when the fibre axis is inclined at equal angles to the incident and diffracted rays. None of the models previously proposed would give a reflexion at this spacing. So far my prediction has been borne out by experiment. In addition to the substances for which the reflexion was first reported, Huxley and I have now found it in wool, myosin and actomyosin, Astbury in epidermin[5] and Brown in poly-γ-methyl-L-glutamate[6]. It is interesting that while the exact spacings of all other α-keratin reflexions vary slightly in different substances, this reflexion appears always at the same spacing of 1·50(± 0·01) A. This suggests constancy of the configuration of the main polypeptide chain, no matter what the side-chains are.

MacArthur, in the course of his detailed X-ray studies of fibrous proteins, discovered a reflexion at 1·49 A. in African porcupine quill, but not in Canadian porcupine quill, nor in any other fibre[7]. I did not regard the appearance of this reflexion in African porcupine quill alone as decisive evidence, because this fibre is now known to contain a substantial fraction of a protein of the β-type[8]; to which this reflexion might possibly have been due, and also because MacArthur[7] and Astbury[9] had interpreted the meridional reflexions of porcupine quill in terms of the repeat of different kinds of amino-acids at regular intervals along the chain. I selected polybenzylglutamate as a test case, first because Ambrose and Elliott[10] had shown it to contain predominantly chains of the α-type, secondly because diffraction effects due to the regular repeat of different kinds of amino-acids can be excluded in a simple polymer, and thirdly because the intensity of the reflexion should be high in a substance where all the side-chains are of the same kind. This expectation was confirmed by results.

The points brought out in the communications by Huxley and myself in *Nature*, which I believe to be new and important, are the universal appearance of this high-angle reflexion, in an artificial polypeptide, in such poorly organized fibres as hair and muscle, and in a crystalline protein; its remarkably constant spacing; its disappearance in the β-form; and its decisive character, not in proving the 3·7-residue helix to be correct, but in excluding models which do not have a repeat of 1·5 A. or a multiple of that spacing. I think it is fair to claim that none of these points had been previously realized. Had the existence of this high-angle reflexion in all fibres of the α-keratin type been discovered earlier, there is little doubt that it would have excluded many models of chain which have been put forward and probably led directly to a solution of the type at which Pauling, Corey and Branson arrived largely by stereochemical reasoning.

Reflexions at multiples of 1·5 A. Pauling and Corey[11], and in the statement quoted in their later communication[1], say: "We would expect that side-chains of different kinds on the α helix would repeat at an integral number of residues, corresponding to an integral multiple of residue lengths along the helix axis, about 1·53 A., and that accordingly those orders of basal plane reflexions for which the spacing approximated closely to certain multiples of 1·53 A. would be enhanced in intensity". This would be a quite different feature of the chain from that indicated by the universal and constant 1·50-A. spacing, and one which still appears to require proof. It would require the repeat of the same or similar amino-acid residues at regular intervals, for example, every other or third residue having a large side-chain. The results of partial hydrolysis of proteins, however, do not indicate that such regularities are a feature of protein structure.

Huxley and I have therefore re-investigated the appearance of these reflexions, and our results to date, combined with those of previous investigators, have led us to the following conclusions. (*a*) In polybenzylglutamate and in homogeneous proteins of the α-keratin type, such as myosin and fibrinogen[12], these reflexions are absent. They are also absent in our specimen of porcupine quill, although this does show the 1·5-A. reflexion itself. (*b*) Systems such as hair and porcupine quill which Ambrose and Elliott[8] have recently shown to contain mixtures of α- and β-proteins do show reflexions at spacings which are approximately, but not exactly, small multiples of 1·50 A. Horse hair shows a wide meridional arc at 3·08 A. which is almost certainly due to β-keratin, as its spacing is the same as that of a strong meridional reflexion in feather rachis. The reflexions at 3·08 and 6·19 A. which MacArthur observed in

African porcupine quill both correspond to strong reflexions in feather rachis and may have the same origin. (c) Astbury[13] and MacArthur[7] have shown that reflexions from frog muscle at approximate multiples of 1·50 A. are due in part to collagen and in part to actin. Bear's clam muscle (type II) gives reflexions similar to those of frog muscle which may be accounted for in the same way[14]. In clam muscle (type I) Bear does not list any meridional reflexions below 18·2 A. (apart from the 5·1-A. reflexion)[15]. When such high multiples of 1·50 A. are considered, spacings would have to be known with great accuracy before a correlation could be definitely established.

Feather rachis keratin. I agree with Pauling and Corey that the absence of the 1·5-A. reflexion does not necessarily exclude the presence of 3·7-residue helices. Their remarks have led me to re-examine the X-ray diffraction pattern of feather rachis. Oscillation photographs taken about the normal to the fibre axis indicate that the strong reflexion at 3·07 A. has a structure factor which is about twice as large as that of any other meridional or near-meridional reflexion. The reflexion at 5·53 A., quoted by Pauling and Corey in support of the presence of 3·7-residue helices, is weak and consists of two separate reflexions the normals of which make an angle of about 22° with the meridian. There is no reflexion at 0·75 A., such as would be expected on the basis of the structure proposed by Pauling and Corey[1]. These results suggest that the correct solution may be of the type originally proposed by Astbury and Woods, with chains of the β-type playing a dominant part in the crystalline fraction of the fibre[16].

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Action of Terramycin and Chloromycetin on Cholera Vibrio in Mice

Terramycin hydrochloride (Pfizer) was tested in mice inoculated with *Vibrio cholera*. The animals were inoculated intraperitoneally with a suspension of 1 ml. of an 18-hr. old culture; the suspension contained 50 × 10^6 organisms per ml. and 5 per cent mucin (Armour)[1]. These inoculations were fatal in 48 hr. Four strains (Ogawa 41, Inaba 35 and 29, and a Mediterranean Inaba strain) were employed.

In the first series of experiments, in which the antibiotic was administered intraperitoneally in single graduated doses half an hour after the infection, 15 out of 15 animals, infected with the Inaba strains, recovered after treatment with 5–10 mgm./kgm. of terramycin. The strain Ogawa 41 was more resistant and required 15 mgm./kgm. in order to produce a 100 per cent survival.

Larger doses of antibiotic were required to control the infection when administered five hours after inoculation: 15 mgm./kgm. in the case of the Inaba 35 strain, 30 mgm./kgm. for the Inaba 29, the Mediterranean Inaba, and the Ogawa 41 strains. With these quantities, all 15 animals of the series survived.

A period of five hours seems to be the limit of time after infection in which the terramycin is effective. In experiments with the Inaba 35 strain, even 300 mgm./kgm. was ineffective after seven hours from the time of infection.

If administered half an hour after the infection, chloromycetin (Parke, Davis and Co.) was curative in doses of 25 mgm./kgm. in the case of Inaba 35, of 50 mgm./kgm. in the case of the other two Inaba strains, and of 100 mgm./kgm. in Ogawa 41. These results are in agreement with those reported by Gauld *et al.*[2].

Five hours after the infection, 250 mgm./kgm. of chloromycetin was still effective in the case of the Inaba 29 and the Mediterranean Inaba strains (20 mice; 100 per cent survival), but was only partially effective against the Ogawa 41 and Inaba 35 strains (10 mice; 30 per cent survival).

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Caulobacter versus *Bacillus* spec. div.

The study of sessile freshwater bacteria induced Henrici and Johnson[1] to draw up a preliminary taxonomic system comprising many sessile species. They brought all these together in one order, Caulobacteriales; *Caulobacter* being the name given to one of the genera. This genus is characterized by the presence of a stalk connecting one end of the elongated bacterial body to a solid substrate and by multiplication by transverse binary fission. The first to describe such a bacterium, without giving it a name, was Jones[2].

Some strains, probably all to be classified as one species of this genus, have been isolated at Delft from tap water. The development of *Caulobacter* can be promoted by adding peptone water to the tap water so as to make a 0·01 per cent solution. The bacterium will then be found at the lower end of its stalk hanging down from the surface of the water. If a thin collodion film, such as is used as a specimen-carrier in the electron microscope, is made to float on the surface, the bacterium attaches itself to the film. To obtain a preparation suitable for the electron-microscope, one merely has to lift the film with a specimen carrier and to rinse it with distilled water[3].

Isolated in pure culture, *Caulobacter* may be cultivated on 1 per cent peptone agar; but single colonies always remain very small. In 1 per cent peptone water the bacteria produce irregular long forms; in 0·1 per cent peptone water more-normal single individuals are obtained. Stalks, however, are very short in a pure culture, and growth is less abundant than might be expected.

Much better growth is obtained if the medium is inoculated simultaneously with some *Bacillus* sp. (for example, *Bac. subtilis* or *Bac. megaterium*). In a combined culture of *Caulobacter* and *Bac. subtilis* strain 'Marburg' in 0·1 per cent peptone water, the latter species is abundant after one day. Gradually, however, *Caulobacter* gains a dominating position. The bacillus serves as a support for *Caulobacter*: one, two, or as many as ten or more may settle on one cell of the bacillus. It is noteworthy that the spores of the bacillus always remain free from *Caulobacter.*

Electron micrographs give a better insight into the relationship of the two species. Occasionally a seemingly healthy bacillus with one *Caulobacter* attached to it is encountered (Fig. 1); most of the bacilli, however, look unhealthy. Finally, little but the cell membrane and the flagella—and in some instances only the flagella—is left (Fig. 2).

The fact that the micrographs give evidence that the stalk is tube-shaped, and apparently contains protoplasm, suggests that it acts as a sucking proboscis, which would imply that *Caulobacter* acts as a parasite to its host bacterium.

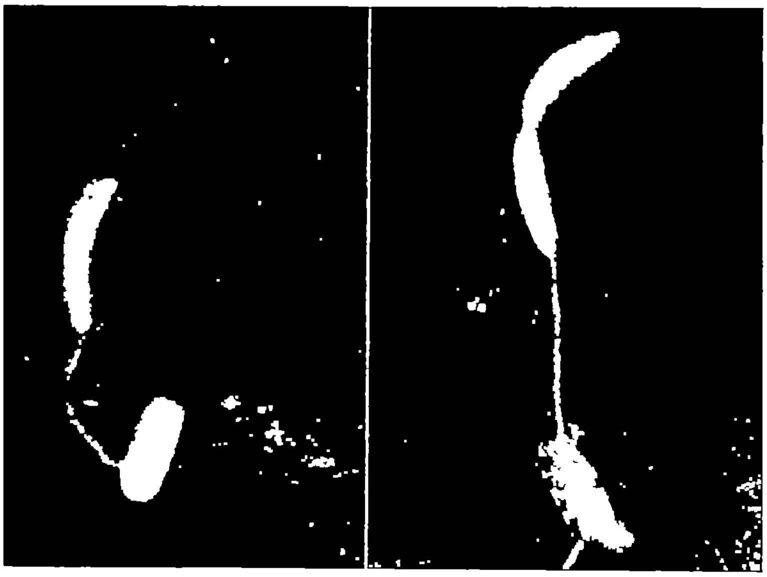
Caulobacter, when about to divide, grows a flagellum at its free end. The daughter cell thus is motile and swims rapidly before settling down. After this, a new stalk is formed. Since the flagellum of a sessile specimen, if present at all, is found to be inserted at the terminal end of the stalk, one may assume that a young *Caulobacter* attaches itself with the flagellated pole, and then grows away from the substrate it settled on by narrowing its basal end so as to form a stalk.

The *Caulobacter–Bacillus* relationship is certainly more complicated than can be described in this brief communication.

In more concentrated media, *Bacillus* species can adversely affect the growth of *Caulobacter* up to the point of suppressing it altogether; this is apparently due to chemical alteration of the medium by the metabolism of the bacillus, possibly including liberation of antibiotics.

It is noteworthy that all evidence is in favour of the view that *Caulobacter* is not a cannibalistic bacterium.

A further account of these observations will be published elsewhere. This work is being supported by a grant from the Netherlands Organization for Pure Research (Z.W.O.) to the Technical Physics Department T.N.O. and T.H., Delft.



Caulobacter parasitizing *Bacillus subtilis.* × 7,500

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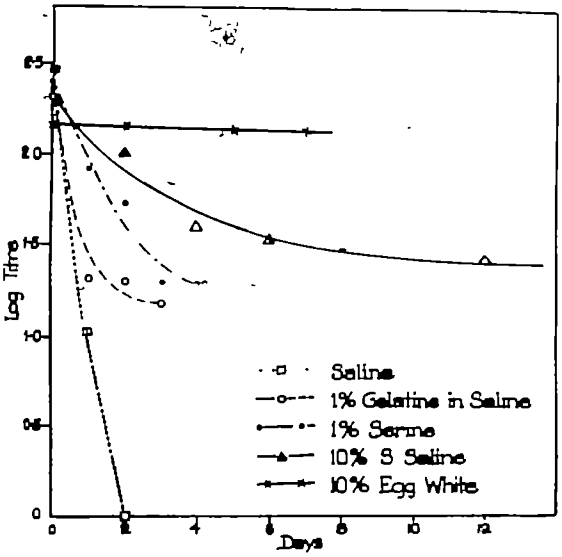
An Improved Diluent for the Production of African Horse-sickness Virus Vaccine

It is the general practice among virologists to use 10 per cent normal serum saline as the diluent of choice for the preparation of virus emulsions. In keeping with this practice, horse-sickness vaccine consists essentially of suitably prepared emulsions of selected virus strains in 10 per cent normal horse serum diluted in the same fluid to contain per dose an adequate number of infecting doses of these strains. Since the efficacy of the vaccine is dependent entirely upon the injection of living virus, it is essential that the diluting fluid should be one which favours longevity of the virus. Of a number of media tried, the 10 per cent horse serum saline was found to be the most desirable (Alexander, personal communication).

For various reasons, which will be discussed in a subsequent publication, it was decided to reinvestigate the problem. Tests were carried out using different concentrations of salts, salt mixtures, sugars, gelatine, amino-acids and egg-white. Viability of the virus on storage at 35° C. for periods of seven to twelve days as determined by *in vivo* virus titrations was used as the criterion of suitability of the various diluents.

It was found that solutions of inorganic salts and sugars have a pronounced lethal effect upon the virus. Gelatine and a number of amino-acids in a concentration of 0·1 per cent did not inactivate the virus; but none favoured viability to the same extent as 10 per cent serum saline. Ultimately, it was found that 10 per cent egg-white in $M/50$ phosphate buffer pH 7·5 was the diluent of choice.

In the accompanying graph are given the viability curves in different media of one strain of horse-sickness virus (strain 1,180), one of the least stable of the strains investigated. In the curves, the logarithm of the virus titre is plotted against the time in days of storage at 35° C. It will be seen that over a period of seven days the virus titre in 10 per cent egg-white phosphate buffer remained practically constant, whereas a variable reduction in titre down



to complete inactivation occurred with the other media tested. These results have been confirmed in other experiments.

This preliminary report is submitted in the hope that use of this medium may be of value to other workers in the field of viruses, particularly those handling the more fragile viruses such as influenza and rinderpest, or those engaged upon the preservation of virus emulsions by freeze-drying or other means.

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Erythrocyte Antibodies as a Cause of Abortion in Cattle

It is well established that bacterial antibody does not cross the bovine placenta, and that although bacterial antigens can leave the non-pregnant uterus and enter the blood stream[1], it is unlikely that they would normally leave the pregnant uterus. The barrier to antibody and antigen transfer is generally ascribed to the effect of the multi-layered epitheliochorial placenta of the bovine and the large size of the molecules concerned. Because of this it has been generally thought that hæmolytic disease of the fœtus was unlikely to occur in cattle; but hæmolytic disease of the new-born might follow sensitization of red blood corpuscles by colostral antibody as it does in the mare[2,3]. Although in cattle hæmolytic disease has not been recognized, there are a number of conditions of the fœtus such as some forms of early abortion, macerated fœtus, hydrops fœtalis, and premature still-birth, which have not been explained on other pathological grounds and which show certain features not altogether dissimilar to human hæmolytic disease. Normal agglutinogens comparable to the *ABO* groups of humans are believed to occur only rarely in cattle[4]; but a very large number of erythrocyte antigens have been defined by the production of immune sera in cattle and rabbits[5].

In view of these latter facts, and because it seems that another entrance of antibody to the fœtus than that via the vessels of the fœtal placenta may not be impossible[6], an investigation of the possible occurrence of hæmolytic disease in cattle was commenced. Sera from cows in several herds were tested by means of the ordinary *Rh* saline agglutination technique[7] against the red blood corpuscles of bulls to which they were or had been in calf. In the first herd (*A*), where a large number of abortions had occurred which had not been explained after thorough investigation, six positive sera out of forty-four were found. Four positive sera were found in a second herd (*B*) of ten animals where there had been long irregular œstrous cycles but no recognized abortions. A third group (*C*) of nine cows which were infertile, but the œstrous cycles of which had been regular, showed only one positive serum, and ten cows (*D*) which had all become pregnant at the first insemination from the same bulls as were used in herds *B* and *C* showed only one positive serum.

An immune serum was then made to the red blood corpuscles of a bull (*R*) which was of low fertility but which was producing apparently normal semen, and in which no infectious disease could be detected. This serum was produced in a heifer following successive intravenous injections of whole citrated blood. The maximum titre obtained was 1/160 in saline, and 1/640 in albumen[7]. The antibody-level fell rapidly, but could be raised by further injections, although not to the original high level. Tests with this serum indicated that the red blood corpuscles of the bulls *P* and *G* of herd *A* were probably antigenically similar to those of bull *R*. Two females, the red blood corpuscles of which were not agglutinated by the artificial immune serum, were mated to bulls *P* and *G* and became pregnant. Two others whose red blood corpuscles reacted similarly were mated and became pregnant to bull *R*. Sera from these animals were tested weekly as before against the erythrocytes of bull *R*. Three of them agglutinated the red blood corpuscles of bull *R* at some tests; but the reaction took place only in undiluted serum, except on one occasion in one animal when the titre rose to 1/2, and on another in another animal when it rose to 1/4. The remaining animal which was pregnant to bull *P* was transfused on the 100th and 115th days of pregnancy with 500 c.c. and 250 c.c. of citrated whole blood from bull *R* with no effect except a rise in the serum agglutinin titre to 1/16 after two weeks. The titre fell to 1/4 after a further week. This animal, and that pregnant to bull *G*, were each transfused on the 185th and 191st days of pregnancy respectively with 250 c.c. of citrated whole blood from bull *P*. Signs of commencing milk secretion were observed six days later in the former animal. The transfusions were repeated nine days later using 25 c.c. of blood for the animal pregnant to bull *P* and 225 c.c. for that pregnant to bull *G*. Two days later both animals aborted. No unlysed red blood corpuscles could be found in one fœtus. In the heart blood of the other there was an abnormally large number of erythroblasts. The serum agglutinin titre in both cases was 1/4 at abortion and rose after two weeks to higher than 1/32 (beyond which it was not titrated). The two animals which were pregnant to bull *R* were each transfused with 250 c.c. of his citrated whole blood on the 125th, 131st, 145th and the 103rd, 109th and 123rd days of pregnancy respectively. The serum titre of the former rose to 1/8 and she aborted eight days after the third transfusion. That of the latter rose to 1/128 after the third transfusion and she aborted three days later. In each case the heart blood of the fœtus contained large numbers of erythroblasts.

Examination of the colostrum from these animals showed that the antibodies were concentrated by the udder. Typical examples are those where the serum titre was 1/4 and the colostral titre 1/20, and where the serum titre was 1/128 and the colostral 1/640. The colostral antibody was transferred to a calf's blood by feeding colostrum during the first two days of life.

Titration of the sera in saline against bull *R*'s erythrocytes with rabbit complement added gave hæmolysin titres similar to those of the agglutinins.

Throughout these experiments steps were taken to exclude infection and other factors as causes of abortion. The physical reaction to transfusion was in no case very great, being limited to a slight and transient dyspnœa and pyrexia, and it does not seem likely that abortion was due to transfusion *per se*.

From the evidence obtained it would appear that maternal circulating erythrocyte antibodies can cause abortion. The mechanism by which this is brought about may either be a reaction at the cotyledons or the result of an actual transference of antibody to the fœtal circulation. The antibody evidently becomes concentrated in the colostrum and is capable of being absorbed by the new-born calf. The interpretation of the full significance of these observations in relation to disease of the fœtus and young calf must depend on further investigation.

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Transfer of Bacterial Antibodies from the Hen to the Chick

During an investigation on the transfer of antibodies against *Salmonella pullorum* from the hen to egg yolk, non-agglutinating antibodies as well as agglutinins were found in the hen's serum and in the yolk. The non-agglutinating antibodies were detected in serum by the method of Morgan and Schutze[1]. The serum was diluted serially, and an equal volume of antigen added to each dilution; after 18 hr. at 53° C. any agglutination was noted, and the antigen in those tubes in which there was no agglutination was washed; to each of those tubes was added anti-avian-globulin serum. If the antigen had been sensitized by the unknown serum, it was agglutinated in the presence of the anti-avian-globulin serum. Antibodies of this type are referred to as non-agglutinating antibodies.

Egg yolk was tested for the presence of this type of antibody by first preparing an extract of the yolk: After exposing the antigen to serial dilutions of this extract, it was mixed with the serum of a rabbit which had been inoculated with yolk livetin. Samples of both serum and egg yolk from a small flock of hens that had been inoculated intravenously with killed *Salm. pullorum* were tested for antibodies. The titres of non-agglutinating antibodies in both sera and yolks were 7 to 34 times greater than the corresponding agglutinating titres.

A similar experiment has been carried out in which serum and yolk samples from three groups, each of four hens, inoculated either intravenously, subcutaneously or intramuscularly, were examined for agglutinating and non-agglutinating antibodies. In hens inoculated intravenously, the titres of non-agglutinating antibodies in serum and in yolk were approximately equal, but the agglutinin titre of yolk was much lower than that of serum. The sera of the hens inoculated by the subcutaneous and by the intramuscular route contained agglutinating and non-agglutinating antibodies to about the same titre as in those inoculated intravenously; but there was practically no antibody of either kind demonstrable in yolk. The difference in the titres of the yolks of eggs from the hens inoculated by the subcutaneous or intramuscular route as compared with the intravenous route was consistent and very marked. During an experimental period of sixty days the yolks of seventy-six eggs from intravenously inoculated hens all had non-agglutinating titres varying from 80 to 2,560. During the same period more than ninety eggs from hens inoculated intramuscularly and subcutaneously were similarly examined; the yolks of the majority of these eggs had titres of less than 10 and the remainder had titres of only 10 or 20.

Preliminary observations on a limited number of embryos and newly hatched chicks have indicated that antibody passed from the egg to the chick is largely of the non-agglutinating type.

The method by which protein accumulates in the rapidly developing hen's ovule is not clearly understood[2]; but there is evidence to suggest that the protein molecule is hydrolysed by proteolytic enzymes as it passes through the follicular epithelium into the ovule[3]. Similarly, the transfer of protein from the yolk to the developing embryo is associated with proteolytic enzymes in the yolk, particularly cathepsin, which reaches maximum activity at about the fifteenth day of incubation. Rosenheim[4] has shown that under suitable conditions trypsin, pepsin and papain destroy *Salm. typhosum* 'O' agglutinins in horse serum.

With these considerations in mind, experiments have been carried out on the action of trypsin on both

EFFECT OF TRYPSIN ON AGGLUTINATING AND NON-AGGLUTINATING ANTIBODIES IN HEN SERA

Serum No.	Test	Control	Concentration of trypsin				
			0·005 per cent	0·05 per cent	1·0 per cent	2·0 per cent	4·0 per cent
1007	*A*	40	10	10	0		
	NA	80	80	20	0		
1004	*A*	80	0	0	0		
	NA	>160	80	80	0		
1285	*A*	640	640	640	0	0	0
	NA	20,480	20,480	20,480	20,480	20,480	10,240
1280	*A*	160	160	160	0	0	0
	NA	5120	5120	5120	5120	2560	5120

A = titre of agglutinating antibody; *NA* = titre of non-agglutinating antibody.

agglutinating and non-agglutinating antibodies to *Salm. pullorum* in hen's serum. The results of some of these experiments are shown in the accompanying table. By mixing a suitable concentration of trypsin with serum and incubating at 37° C. for one hour at a *p*H of 8·5, it was possible to reduce and even destroy all demonstrable agglutinins without affecting the titres of non-agglutinating antibodies.

Details of experiments on the transfer of antibodies from the hen to the chick via the egg and the relationship between agglutinating and non-agglutinating antibodies will be published elsewhere.

I am much indebted to the Scientific Director of the Animal Health Trust and to the Director of the Trust's Poultry Research Station for their kindness in releasing me from my routine duties to undertake this work in Cambridge.

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Glucose and Lysogenesis in *Bacillus megatherium*

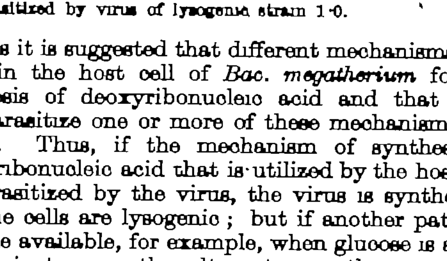
Cells of *Bacillus megatherium* strain 1·0 can carry on metabolic activity, including multiplication, simultaneously with virus formation, for an infinite time; this balance between the cells and their virus is called lysogenesis. Evidence that lysogenic *Bac. megatherium* strain 1·0 can return to the normal uninfected state on a glucose nutrient medium was presented by Ehrlich and Watson[1]. Further study of this phenomenon showed that other sources of carbon, such as fructose, maltose, sucrose, glycerol, pyruvate and succinate in the basal medium all cause recovery from the lysogenic state. In postulating an explanation for this behaviour, it was thought that the virus and the source of carbon might compete for organic phosphate and that the virus was the weaker competitor. The work of Kozloff and Putnam suggested such a hypothesis[2]. However, initial studies showed that this hypothesis could not explain the effect of glucose on lysogenic *Bac. megatherium* strain 1·0.

Glucose in alkaline nutrient agar at *p*H 8·0 was found to inhibit the growth of the lysogenic strain, whereas the uninfected parent strain was not inhibited. Of other sources of carbon that were added to the alkaline medium, only glucose-6-phosphate had an inhibitory effect on growth of the lysogenic strain. Fructose, fructose-6-phosphate, hexose diphosphate, α-glycerophosphate and glycerol did not inhibit growth. Evidence that at least some of these intermediates of glycolysis can be utilized rests in part on the fact that resting-cell suspensions oxidized hexose diphosphate, glucose-6-phosphate, fructose-6-phosphate and phosphoglycerate. Also, 0·01 *M* sodium fluoride prevented the formation of lactic acid from glucose by resting-cell suspensions of uninfected *Bac. megatherium*.

These results suggest the following explanation for the effect of glucose. When glucose is present in a medium that contains a full complement of organic nitrogen compounds, as in nutrient agar, deoxyribonucleic acid might be synthesized via a degradation of glucose-6-phosphate to gluconate-6-phosphate, arabinose-5-phosphate, deoxyribose-5-phosphate, and deoxyribose-1,5-diphosphate, thence to nucleotides and nucleic acid. Such a degradative pathway has been suggested, at least in part, by Dickens[3]. If glucose is present in a synthetic medium, or if the cells are grown on nutrient agar without glucose, the deoxyribose in the deoxyribonucleic acid is probably synthesized by a condensation pathway involving two and three carbon compounds. In fact, Racker[4], and Marmur and Schlenk[5] have shown that certain bacteria can form pentose by a condensation of two and three carbon compounds. Thus, if the virus in lysogenic strain 1·0 of *Bac. megatherium* parasitizes the condensation pathway to deoxyribose and not the degradation pathway, lysogenicity will be lost when glucose is added to nutrient agar at *p*H 7·0, and the degradation pathway is opened. If the glucose nutrient agar is at *p*H 8·0, the virus with the help of the high *p*H can prevent the host cell from utilizing either the degradation or condensation pathway, and growth is prevented. As expected, this inhibition occurs with glucose-6-phosphate but not with other intermediates of glycolysis.

Theoretically, it should be possible to isolate a strain of *Bac. megatherium* which will remain lysogenic in the presence of glucose in nutrient agar. Indeed, eight such strains have been isolated from nutrient agar containing 0·01 *M* glucose. These strains yield virus after repeated transfers on glucose nutrient agar and are resistant to infection with stock virus. However, these strains remain lysogenic on nutrient agar without glucose.

Proposed Pathways for the Synthesis of Deoxyribonucleic Acid by the Host Cells of *Bacillus megatherium*



* Parasitized by virus of strains that remain lysogenic on glucose agar but not of strain 1·0.

† Parasitized by virus of lysogenic strain 1·0.

Thus it is suggested that different mechanisms may exist in the host cell of *Bac. megatherium* for the synthesis of deoxyribonucleic acid and that virus can parasitize one or more of these mechanisms (see chart). Thus, if the mechanism of synthesis of deoxyribonucleic acid that is utilized by the host can be parasitized by the virus, the virus is synthesized and the cells are lysogenic; but if another pathway is made available, for example, when glucose is added to nutrient agar, the alternative pathway will be used and lysogenesis will be lost.

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Occurrence of Antifungal Substances in *Brassica rapa*, *Brassica oleracea* and *Beta vulgaris*

SINCE roots and tubers contain different substances which are easily assimilable by many micro-organisms, the question arises whether the mechanical protection by the few outer cell layers of the cortex is sufficient to prevent infections from the surrounding soil, or whether the plant produces antibacterial and antifungal substances to increase its resistance against microbial invasion.

Antifungal substances have been isolated from the tubers of *Brassica rapa rapifera*, *Brassica oleracea gongylodes* and the fleshy roots of *Beta vulgaris*. In the first two cases, the presence of the active substances was strictly limited to the superficial cell-layers, whereas the interior parts were practically free from it; this seems to point to the hypothesis of antimicrobial protection referred to earlier.

In the case of *Brassica rapa* the substance, which we have called 'rapine', could be isolated by disintegrating the peelings in a blendor and subjecting the mass to steam distillation. From the distillate a yellow oily substance could be extracted with ether; the yield amounted to 4 mgm. per 100 gm. of fresh peelings. The substance had the characteristic penetrating smell of turnips. The solubility in water was low and, mixed with malt agar, a concentration of 1 : 10^5 was sufficient to prevent the growth of different fungi and yeasts. At this concentration, rapine did not possess any antibacterial activity against *Escherichia coli*, *Micrococcus aureus* and *Bacillus subtilis*. This specific antifungal activity of rapine was used to check so-called pure cultures of phytopathological fungi for the presence of bacteria, which otherwise is sometimes rather difficult.

As *Trichophyton rosaceum*, a typical parasite of man and various animals, is readily inhibited by rapine, the pharmacological activity of this substance will be a matter of further examination. The following fungi were tested: *Aspergillus niger*, *Aspergillus oryzea*, *Botrytis* sp., *Ceratostomella pilifera*, *Fusarium oxysporum*, *Fusarium solani*, *Penicillium notatum*, *Rhizopus nigricans*, *Trichophyton rosaceum* (growing on Sabouraud agar), *Verticillium cinnabarinum*. Of these, *Fusarium oxysporum* proved to be the most susceptible. The yeasts tested were: *Saccharomyces cerevisiae*, *Saccharomyces lactis* Dombrowski, *Schizosaccharomyces* Pombe, *Cryptococcus lattila* and *Cryptococcus utilis*, all of which were readily inhibited by a concentration of 1 : 10^5 of rapine.

The active principle from *Brassica oleracea gongylodes* was prepared in the same way as rapine. It proved to be a yellowish, solid substance, also slightly soluble in water and with an intense smell of Swedish turnips. It inhibited the growth of the same micro-organisms as did rapine; its activity, however, seemed to be somewhat less pronounced, as in the cases of *Penicillium notatum* and of *Fusarium oxysporum* the critical concentration was [illegible] : 10^4.

From *Beta vulgaris* a crude preparation was made which was especially inhibitive against *Fusarium* sp. This substance was not volatile with steam, was not deteriorated by boiling, was soluble in water and insoluble in ether. It could be extracted from the cortex as well as from the inner part of the root.

Further studies in this field are in progress.

Thanks are due to the Central Bureau voor Schimmelcultures, Baarn, for supplying us with pure cultures of a number of the above-mentioned fungi.

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'Lactobacillin', an Antibiotic from Lactobacilli

A SURVEY of streptococci has already shown that the lactic group are the most powerful antibiotic producers[1]. It was of interest to see whether antibiotics are also produced by lactobacilli, especially since Grossowicz, Kaplan and Schneerson[2] have already reported the existence of such substances. Young Gruyère cheese samples from different areas of France were used as one of the sources of these lactobacilli. 40 antibiotic-producing strains, about 3 per cent of the total number of strains tested, have been isolated in pure culture. These gave zones of inhibition 20–30 mm. in diameter when assayed by the cylinder plate method with *Staph. aureus* as the test organism.

One of these organisms, which is homofermentative and resembles *L. helveticus*, is being investigated in further detail. In peptone–glucose broth, containing 0·01 per cent Tween 80, which appears to be essential, supplemented with tomato juice, whey or malt extract, it grows well at 30° C., 37° C. and 43° C., the lower temperatures are, however, more conducive to good yields of antibiotic. Yeast–glucose broth supports good growth at 43° C., but the yeast extract is inhibitory to growth at lower temperatures, and inhibits production of antibiotic at all temperatures of incubation.

With dilution assays in plain nutrient broth, in which the test organism grows well but the lactobacillus does not grow, titres of 1/1,280 were frequently obtained. Against *Staph. aureus* this culture-fluid appears to be about twenty times more powerful than nisin[3]; it is, however, very heat-labile.

We are greatly indebted to G. Mocquot, of the Station Centrale de Technologie Agricole, Paris, for supplying the samples of Gruyère cheese.

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Urease Metabolism in *Citrullus*

SINCE the speculations by one of us[1] as to the function of urease in *Citrullus* seeds appear to have aroused interest, we feel we ought to report that further work has shown the original hypothesis (that urease is a reserve protein) to be untenable. We remain unconvinced that the metabolism of urease in *Citrullus* is connected with the metabolism of urea or its derivatives; but it does not appear to be a normal seed-reserve. First, we find that the protein content of the cotyledons of seedlings grown in a nitrogen-free culture medium may fall in eight days to about half its initial value; but the urease content may remain unchanged. Secondly, if seedlings are grown under optimal conditions in soil, we find in the cotyledons no appreciable change in major nitrogen fractions over ten days; but a reduction in urease begins to be apparent at about the fourth–sixth day, followed by a rapid fall almost to zero at about the eighth day. The rapid rise in water-content from about the fourth day shows that this is the time when cell-extension and vacuolation begin; and since Brown and Broadbent[2] have shown that this is a time of considerable metabolic activity, it seems likely that disappearance of urease is connected with its onset.

Moreover, examination by Granick's[3] histochemical method shows that the urease is retained in the bundle-sheaths (the cells of which enlarge relatively little) long after it has disappeared from the mesophyll; detached cotyledons, which expand more slowly than do cotyledons attached to the seedling, also lose their urease more slowly; and etiolated seedlings, the cotyledons of which do not expand, retain their urease for at least thirteen days. In general, the urease metabolism appears to be bound up with the development of the cotyledons rather than with that of the seedling as a whole; and we are attempting to identify more closely the particular process with which it is associated.

We should like to express our gratitude to the Ferry-Morse Seed Co. of California for their generous gift of the seeds used in this investigation.

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Extraction of Chloride from Mammalian Skin

In the course of an investigation into the distribution of chloride between blood plasma and skin in the cat, difficulty was encountered in determining the chloride content of the skin. Digestion of the tissue in concentrated nitric acid is impracticable owing to loss of chloride; the tissue proved to be too tough to be ground in trichloracetic acid, which is the standard procedure with other tissues. Freezing before grinding had no helpful effect and cutting the tissue into very small fragments before grinding was, though successful, both laborious and time-consuming; mincing was impracticable owing to the relatively small samples which could be used.

By chance, it was found that a sample of skin which had been dried for 18–24 hr. at 105–110° C. for determination of its water content was quite readily macerated if left in 10 per cent trichloracetic acid a few minutes before being ground. The same effect was produced by drying cat's skeletal muscle, which in the fresh state is much more resistant to maceration than is frog's muscle. On the other hand, liver and kidney, which can be readily macerated in the fresh state, were considerably toughened by the drying process. Thiocyanate was also stable in skin during the drying process and could be determined in the trichloracetic acid filtrate. Since the ease with which a tissue can be handled undoubtedly affects to some extent the amount of attention which is bestowed upon it, the observation now made may be of use to others.

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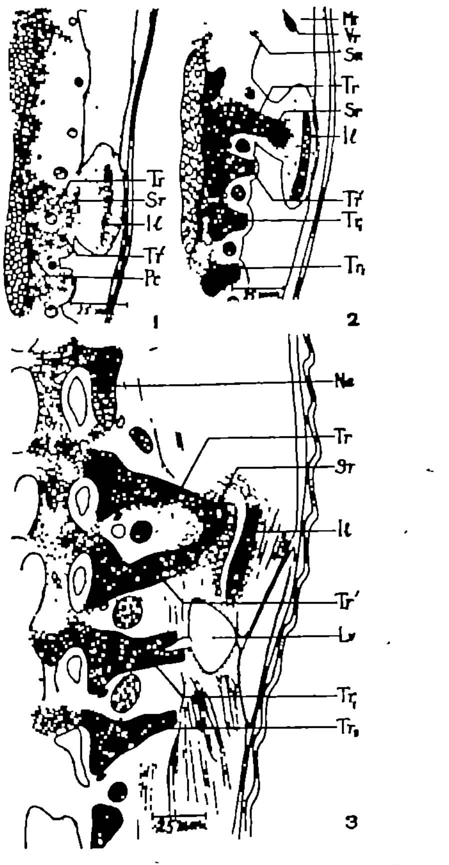
Sacral Ribs of Lacertilia

The sacral ribs of Lacertilia have been for many years the subject of discussion by zoologists. Some consider that the transverse processes of the sacrum are homologous with the ribs of the presacral region[1,2]. Siebenrock[3] made a thorough study of this subject and came to the conclusion that the first sacral vertebra of Lacertilia possesses ribs instead of transverse processes. Moodie[4], however, states quite clearly that there are no sacral ribs in modern lizards. According to him lizards "occupy an isolated place among all other known reptiles in not having any sacral ribs whatever". He considered the processes carried by the sacral vertebræ as transverse processes and not ribs. A similar conclusion was arrived at by Huene[5]. Later, Moodie[6] referred to this view again,



Il, Ilium; *Lv*, large vesicle opposite the transverse process of the first tail vertebra; *Mt*, Myotome; *Ne*, neural arch; *Pc*, primary centrum; *Sn*, spinal nerve; *Sr*, sacral rib; *Tr*, *Tr'*, *Tr₁*, *Tr₂*, transverse process of the sacral, secondary sacral, first caudal and second caudal; *Vr*, ventral rib and suggested that a study of the stages of chondrification might show evidence of the presence of sacral ribs in lizards. In spite of this suggestion by Moodie, most workers in this field have accepted Moodie's earlier conclusion as definite and maintained that there are no sacral ribs in Lacertilia. El-Toubi[7], however, has reported evidence of sacral ribs.

In view of this controversy, the study of the ribs of the sacral region of *Chalcides ocellatus* was suggested by the late Prof. Naef. Different embryos of *C. ocellatus* varying in length from 14 to 45 mm. have been studied in transverse as well as in horizontal sections. I find that the sacral ribs are quite distinct and separate from the transverse processes (Fig. 1). Each rib is a compound one formed from a dorsal rib rudiment and a ventral rib rudiment which fuse early in the connective tissue stage, forming the sacral rib, which extends downwards and backwards. Thus, the sacral rib chondrifies and becomes united with the transverse process of the sacral vertebra (Fig. 2).

At the same time the transverse process of the secondary sacral vertebra extends anteriorly and downwards and thus becomes connected with the sacral rib. Thus the two transverse processes of the sacral and the secondary sacral become united by the sacral rib, which articulates with the ilium (Fig. 3). A detailed account of this work will be published elsewhere.

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Structure of $Cu_{32}Al_{19}$

POWDER photographs show that the deformed gamma structure $Cu_{32}Al_{19}$ has 51 atoms in each of the pseudo-cubic unit cells; it is closely related to the cubic structure of Cu_9Al_4 with 52 atoms per unit cell[1]. Whereas the latter is found with 21/13 or 22/13 electrons per atom, the deformed structure takes up to 89 electrons to 51 atoms. The complex quantities may be approximately simplified to the ratios 5/3 and 7/4 respectively; these improper fractions correspond to the monotonic sequence[3] $(2n - 1)/n$. (Cu is monovalent, Al trivalent.)

The loss of atoms follows the simple rule that each additional electron per unit cell replaces one atom[4]. It is achieved by the substitution of one atom of aluminium for two atoms of copper. Thus we have the following sequence:

Formula	Symmetry	Atoms	Electrons
$Cu_{34}Al_{18}$	cubic	52	88
$Cu_{33}Al_{18\frac{1}{2}}$	monoclinic	$51\frac{1}{2}$	$88\frac{1}{2}$
$Cu_{32}Al_{19}$	monoclinic	51	89
$Cu_{31}Al_{19\frac{1}{2}}$	rhombohedral (?)	$50\frac{1}{2}$	$89\frac{1}{2}$
$Cu_{30}Al_{20}$	rhombohedral (?)	50	90

The total number of atoms and electrons remains constant at exactly 140. The numbers of atoms in the monoclinic phase falls from $51\frac{1}{2}$ to 51, while the rhombohedral phase contains $50\frac{1}{2}$ or 50 atoms per unit cell. The Brillouin zone is the same as for Cu_9Al_4, the number of electrons per unit cell rising to a maximum of 90, which agrees exactly with the number of states required to fill the first zone.

All the copper and aluminium atoms in $Cu_{32}Al_{19}$ have definite locations, and it is this fact which leads to the abnormally low symmetry. The extremely peculiar mode of atomic distribution cannot possibly be explained by the size factor, as copper and aluminium atoms are too nearly equal for it to have any effect. The real explanation is to be sought in the electronic factor, each individual free valence electron occupying a definite lattice site[2]. Thus for a complete elucidation of the structure, it is necessary to locate 32 copper atoms, 19 aluminium atoms and 89 electrons.

So far as can be ascertained at present, it appears that the free valence electrons are grouped around the aluminium rather than the copper ions, so that on the whole each aluminium ion retains three negative charges while each copper ion retains one negative charge, but they are usually shared by neighbouring atoms. Thus the structure remains electrically neutral at every point.

The space-group is in all probability *Cm*, and this means that the crystal unit must be doubled, a second set of 51 atoms being required in order to complete the full symmetry with a translation (000, $\frac{1}{2}\frac{1}{2}0$). The true monoclinic cell of $Cu_{32}Al_{19}$ therefore contains 102 atoms, of which eleven groups of four atoms and ten groups of two atoms are copper and seven groups of four atoms and five groups of two atoms are aluminium. (These groupings are subject to confirmation by a complete structure analysis.)

The symmetry degradation is most easily considered as occurring in stages, thus:

$$P\,\bar{4}3\,m \to P\,\bar{4}2\,m \to C\,\bar{4}\,m\,2 \to C\,mm \to C\,m.$$

The pseudo-tetragonal indices of the cubic line 72 (660, 822) on the cobalt powder photograph are readily ascertained. There are three successive reflexions comprising 660 α_1, (660 α_2 + 606 α_1) and 606 α_2. 822 is too weak to be observed. For tetragonal symmetry ($P\,\bar{4}2\,m$) line 48 (444) would not be resolved, but in the orthorhombic unit cell ($C\,mm$) this becomes 804 and 084 and the reflexions are blurred. A detailed examination is required using vanadium radiation, in order to obtain the exact dimensions of the unit cell, and the monoclinic angle (β).

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May 29.

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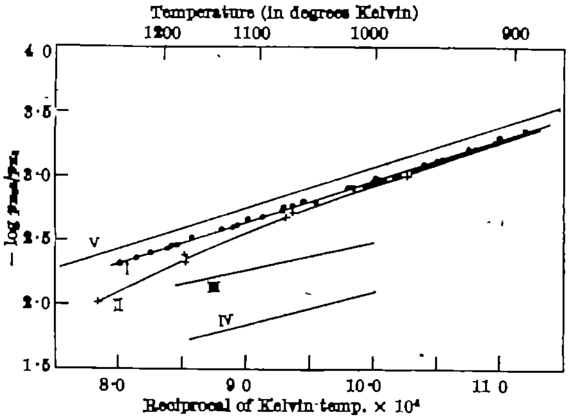
Thermodynamics of Ferrous Sulphide

THE free energy of formation of β-ferrous sulphide has recently been investigated by us as part of a wider study of the thermodynamics of metal sulphides and sulphide mixtures. In view of the metallurgical importance of ferrous sulphide, the results so far obtained are reported here, although it is intended to publish the results of the whole investigation when completed.

The procedure adopted was to measure the composition of gas mixtures of hydrogen and hydrogen sulphide in equilibrium with powdered iron and ferrous sulphide heated to temperatures ranging from 720° to 1,258° K. The gases were circulated over the solids in a closed system, at such a rate that the steady concentration of hydrogen sulphide produced was unaffected by a twofold change in the flow rate, in either direction. Errors due to thermal segregation were therefore avoided.

Radiosulphur was used so that the gases could be analysed continuously by gas counting. It was thus easy to follow the attainment of equilibrium, and the effect of rate of flow on the segregation of the gases in traversing the thermal gradient from the even zone of the furnace to the counter, which was at room temperature. It was found that, even at the lowest temperature used, equilibrium between the gas and solid phases was rapidly attained.



I, Present work; II, Cox, Bachelder, Nachtrieb and Skapski; III, Jellinek and Zakowski; IV, Britzke and Kapustinski; V, Kelley

The results above 890° K. are shown in the accompanying graph, together with those of other workers who have used this equilibrium[1-3]. The values of p_{H_2S}/p_{H_2} are considered accurate to ± 3 per cent, the errors in the counting, analysis and temperature measurement all being included. When combined with data for the free energy of formation of hydrogen sulphide[4], our results yield the following equation for the free energy of formation of two moles of β-ferrous sulphide from iron and diatomic sulphur gas,

$$\Delta G^{\circ}_{720-1,261^{\circ}\text{K.}} = -71,820 + 25\cdot12\,T \text{ cal.}$$

It will be seen that the results of Cox, Bachelder, Nachtrieb and Skapski[1] agree closely with ours, except at the higher temperatures. We consider that this difference is mainly due to thermal segregation at their rate of flow[5], the error attributable to this being 25 per cent in the H_2S/H_2 ratio at 1,200° K. Under static conditions, the error due to segregation would be about 100 per cent at 1,200° K., and this would be sufficient to account for the results of Jellinek and Zakowski[2] at 1,183° K. We cannot account for their results at 1,003° K., or the results of Britzke and Kapustinski[3], on the basis of thermal segregation errors alone.

Kelley[4] has developed an equation for the free energy of formation of ferrous sulphide on the basis of the heat of formation and heat capacity data available in 1936. Curve V in the figure shows that the results derived from this are in fair agreement with our own.

The work reported here was done when we were on the staff of the British Iron and Steel Researcl Association, and we are indebted to its Director fo permission to publish these results.

C. B. Alcock
F. D. Richardson

Nuffield Research Group in
Extraction Metallurgy,
Royal School of Mines,
London, S.W.7. May 28.

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Rotatory Dispersion Measurements with a Unicam Spectrophotometer

Photo-electric polarimeters are not yet availabl commercially, although several types have bee described in recent years[1]. Between about 4500 an 6500 A. there is no particular advantage in usin such instruments, since in this region visual spectropolarimeters are very accurate and convenient; bu for longer and shorter wave-lengths, photo-electri methods are less tedious than the older photographi ones. We are interested in the red and near infra-re for the extension of studies on the Cotton effect fo blue nitroso compounds[2], and we set out to adapt Unicam spectrophotometer for measuring rotator dispersion by adding two Glazebrook prisms and graduated circle. The arrangement has proved t be so satisfactory for our work that we feel justifie in making this preliminary communication.

In the Unicam instrument there is a passag (between the monochromator and the cell compartment) into which the polarizing prism can be fitted but the cell compartment is not long enough t house the other prism as well as the observation cell Accommodation for the analyser is therefore provided in a separate unit which is constructed so a to make the apparatus completely light-tight. Th prism is mounted in a rotatable tube between th central aperture of the graduated circle and a simila hole cut in a rectangular plate held to the circle b three pillars. Rotation of the prism is controlle by an arm which carries a vernier reading to 0·02 When the analyser unit is inserted in the instrument the rectangular plate forms a new back for the ce compartment, and the graduated circle is fixed i front of the photocell box.

The polarizer and analyser are adjusted visuall so that when they are crossed the scale reads approximately 0°. The actual zero is found by the 'metho of symmetrical angles'[3] in the following way (1) place cell containing solvent in light beam (2) turn transmission scale to 100 per cent; (3) se wave-length scale to desired value; (4) set analyse to a stop fixed at − 40° (the most convenient 'half shadow angle'); (5) adjust slit-width to give balance (6) rotate analyser clockwise through about 80° to position θ_2 to restore balance, then the zero i $\frac{1}{2}(\theta_2 - 40)$.

Readings of rotation are made in a similar way (1′) place cell with solution in light-beam; (2′) adjus transmission scale. If the solution is transparent the scale is left at 100 per cent; but if absorption i present it may be necessary to select a smaller valu to prevent the slit-width from becoming too larg

Operations (3′), (4′), (5′) and (6′) are then carried out as for (3), (4), (5) and (6). If in (6′) the analyser scale reads θ, the desired rotation α is given by

$$\alpha = \tfrac{1}{2}(\theta - 40) - \tfrac{1}{2}(\theta_0 - 40) = \tfrac{1}{2}(\theta - \theta_0).$$

The accompanying table contains values of rotation α and specific rotation [α] for various wave-lengths λ, obtained with a benzene solution of caryophyllene nitrosite (concentration 1·5280 gm. per 100 ml.) in a 1-cm. cell.

λ	α	[α]	ε
5000	+ 1·47*	+ 962*	0·30
5500	+ 1·98 *	+ 1293	1·38
5800	+ 2·40 *	+ 1571	2 53
6000	+ 2·67	+ 1748	6·17
6250	+ 2·74	+ 1794	10·50
6500	+ 2·42	+ 1584	15·40
6750	+ 0·94	+ 615	21·21
6800	+ 0·41	+ 268	21·99
6900	− 0·61	− 400	21·05
7000	− 1·96	− 1283	18·46
7250	− 3·05	− 1996	10·14
7350	− 3·07	− 2009	6·80
7500	− 2·82	− 1846	3·25
7750	− 1·84	− 1204	0·77
8000	− 1·30	− 851	—
8500	− 0·76	− 498	—
9000	− 0·49	− 303	—

* Visual readings.

It is seen that the specific rotation (column 3) passes through positive and negative maxima at about 6250 A. and 7350 A., respectively. Previous visual measurements had revealed only the positive maximum. Molecular extinction coefficients ε (also found with the Unicam spectrophotometer) are included in the table (column 4). Maximum absorption occurs near 6800 A. where [α] ≃ 0.

The analyser unit described above was constructed in our workshop under the direction of Mr. Robert McCulloch. One of us (J. V.) is indebted to the Department of Scientific and Industrial Research for a maintenance allowance.

STOTHARD MITCHELL
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Chemistry Department,
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June 1.

See Weissberger, "Physical Methods of Organic Chemistry", 2, 967 (New York, 1946).

Mitchell, *J. Chem. Soc.*, 3258 (1928) and subsequent papers.

Kenyon and Dickes, *Nature*, 117, 304 (1926).

Modification of Crystal Habit of Inorganic Salts with Dyes

THE publication of H. E. Buckley's "Crystal Growth"[1], with its chapters on modified crystals, is likely to stimulate interest in this field of research; he time is therefore opportune for this indication to be given of a conception of modification of crystal habit with dyes which, so far as it is at present capable of being tested, appears to explain many of the contradictions and inconsistencies previously confronting workers in this field.

Recent evidence points to the growth at finite ates of crystal faces being due to the spreading of layers from continuously renewed nuclei on the faces[2]. It is now suggested, from study of some forty cases of strong crystal-habit modifications of anhydrous norganic salts, including nitrates, sulphates and perchlorates in particular, that the incorporation, emporary or permanent, of dye molecules in one or more of the edge-faces of these layers is the usual means by which the growth of a crystal face is retarded by the presence of a dye in the solution[3,4]. Alternatively, the propagation of the nucleus could be affected in a similar manner[5].

The edge-planes of these spreading layers may conceivably be vicinal faces of high indices, or the ordinary low-order planes of high reticular density normally bounding the crystal, or something in between, according to their stage of growth. Consideration of many individual instances of very strong crystal-habit modifications suggests that in most cases the dye is incorporated into the edges of such spreading layers by virtue of there being suitable coincidence between the dye's polar groups and ionic sites in a particular edge-plane of the layer, so that the dye molecule can be incorporated in the edge-plane by virtue of its polar groups replacing the appropriate ions. The edge-plane involved will depend to some extent on the orientation of the polar substituent groups of the dye molecule; alternative edge-planes may thus be involved in bringing about crystal-habit modification on one particular face. The concept is virtually of a 'two-dimensional solid solution formation' at the growing edge of a layer. It is evident that a planar dye molecule will lie entirely in one crystal plane, and where the dye molecule preferentially fits or can only fit in one plane, then favourable conditions for the exhibition of pleochroism by the completed crystal exist, if all the dye molecules are not dislodged in the growth process.

In order that a dye may have strong crystal-habit modifying properties for a given salt, it should have the following properties. (1) Its solubility in the saturated saline solution should be high; this implies that an adequate number of solubilizing polar groups should be present. (2) The charge centres of the polar groups should coincide accurately with sites for similarly charged ions in a crystal plane; the greater the number of polar groups fitting into the lattice, the stronger the adhesion of the dye. (3) Any such polar group should not occasion disturbance of the lattice about the ionic site in question; any exclusion of adjacent ions will result in a diminution of the Coulomb forces responsible for the adhesion of the dye molecule. Hence arises the importance of a suitably close coincidence between the oxygen triangles of sulphonate groups and oxyacid ions.

Since presumably a certain amount of misfit may be tolerated in some cases at least, this conception of habit modification is quite consistent with the large number of dyes found by Buckley to have habit-modifying properties in various degrees. Further, it is evident that a certain selectivity will be exercised by the crystal structure, and not all dyes will fit; and that the effective dyes will depend on the crystal structure to be modified. Differing types of habit modification of one substance will depend on the different planes on which the dye molecules can fit.

Since commercial dyes are often complex, and erroneously described in the Colour Index, only strong habit modifications obtained with specially prepared pure dyes of known simple constitution have been considered. It has been possible to demonstrate by graphical methods that the requisite accurate coincidences between polar groups and ionic sites are, in fact, possible on planes indicated by the pleochroism of the dyed crystals as being the seat of the dye molecules, in such cases as the habit modification of ammonium nitrate IV with naphthol red *S*, acid magenta and 1 : 4 diamino anthraquinone 2-sodium sulphonate, for example. In certain cases, where the plane including the dye molecules is multiplied in the crystal by symmetry operations, and as a result the dye molecules are not parallel (for example, in the trigonal and hexagonal systems when modification is on the basal plane), pleochroism of dye inclusions in the modified crystals cannot be expected. Where it has not been possible to obtain crystals with pleochroic adsorbed dye inclusions, the necessary coincidences between the polar groups of dyes and ionic sites of suitable planes to account for the observed habit modifications may be similarly demonstrated. It is perhaps noteworthy that a small minority only of the habit modifications examined appear to be capable of explanation by fitting the dye molecule directly into the habit-modified face (for example, potassium nitrate with acid magenta). In these cases the habit modification is apparently not so strong as that found when the same dye fits on to a plane perpendicular to a habit-modified face of another salt; close comparisons are not justifiable, however, when solubility differences exist.

Some attempts are being made to predict the structures of crystal-habit modifiers according to this theory. In a certain number of cases success has been achieved; but a difficulty has arisen, that it is impossible to predict the solubility of the dye, which depends just as markedly on the orientation of the polar substituent groups as does its crystal-habit modifying powers[6]. A full account of this work will be reported elsewhere.

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May 31.

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Contamination of Evaporated Films by the Supporting Material of the Source

IN studies of the properties of films produced by vacuum evaporation, it is important to know whether appreciable contamination by the material of the boat or filament occurs under the normal evaporation conditions. The mass of a film is usually very small, and some properties of films are very sensitive to minute amounts of contamination. A test of high sensitivity is therefore required. The radioactive tracer method possesses this necessary sensitivity when there is a suitable isotope of the material of the boat.

The mechanical properties of tantalum and its high melting point make it a suitable material for evaporation sources. It has an active isotope, tantalum-182, with a half-life of 117 days. Moreover, since the whole of natural tantalum consists of the 181 isotope, from which the active isotope is produced by neutron irradiation, a high specific activity is easily obtained. Experiments have been made with an active tantalum boat as evaporation source, the evaporated materials being tested for active tantalum in the usual way. Silver and germanium have been examined, the evaporation being carried out at several temperatures. One count per minute above background corresponds to $2 \cdot 3 \times 10^{-10}$ gm. tantalum in the deposit. The masses of silver and germanium deposited on the test target were of the order 10^{-4} gm., so that contamination to the extent of a few parts per million was detectable.

The results with germanium showed that the tantalum content of the film ranged from 11 p.p.m. for an evaporation temperature of 1,120° C. to 26 p.p.m. at 1,800° C. For silver, the figures recorded were from 20 p.p.m. at 1,100° C. to 113 p.p.m. at 1,670° C.

The mechanism by which the tantalum is transported is not clear, since the two obvious processes, namely, direct evaporation and solution by the molten metal, would be much more temperature-dependent. From the practical point of view, however, it is seen that provided the temperature of the source is kept below about 1,200° C., the contamination does not exceed 10–20 parts per million. As an indication of possible contamination when films are evaporated very rapidly, it should be stated that on one occasion the boat temperature was raised to above 2,000° C. and that the resulting film contained 1 part in 7 of tantalum.

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Measurements of the Normal Stress Effect in Solutions of Poly*iso*butylene

Weissenberg[1-3], Garner and Nissan[4], and Garner Nissan and Wood[5] have described a number of ex periments which indicate that, in high-polymer solutions, steady-state laminar flow cannot be maintained by the action of shearing forces alone, even at low velocity gradients for which centrifugal effects ca be neglected. The effects observed in these experi ments have been interpreted by Rivlin[6,7] phenomeno logically as due to the fact that the relations connect ing the stress and strain velocity components for th steady-state laminar flow of such a solution involv a second physical parameter defining the flow pro perties of the fluid, in addition to the viscosity.

This parameter has been termed the 'normal stres coefficient', and effects which arise from its non vanishing have been called 'normal stress effects' From the phenomenological point of view, both th viscosity and the normal stress coefficient can depen on the state of flow through the flow invariants and if the flow is inhomogeneous, can vary from poin to point of the fluid.

It has further been shown[8] that values of the norma stress coefficient sufficient to give rise to effects c the observed order of magnitude could probabl occur in high-polymer solutions of a few per cen concentration as a result of the orientation of th dissolved molecules in the flowing solution.

The normal stress effect for solutions of polyiso butylene in *ortho*-dichlorobenzene has now been in vestigated using an experimental arrangement similar in principle, to one described by Weissenberg, an by Garner, Nissan and Wood. The solution is contained between two coaxial cylindrical cups as shown schematically in Fig. 1. The outer cu can be rotated at a variety of speeds and th distance between the disks forming the bases of th cups can be varied. The pressure which must b applied at these disks in order to maintain the solu tion in a steady state of laminar flow between them is measured automatically by a number of vertic tubes entering the base of the inner cup at variou

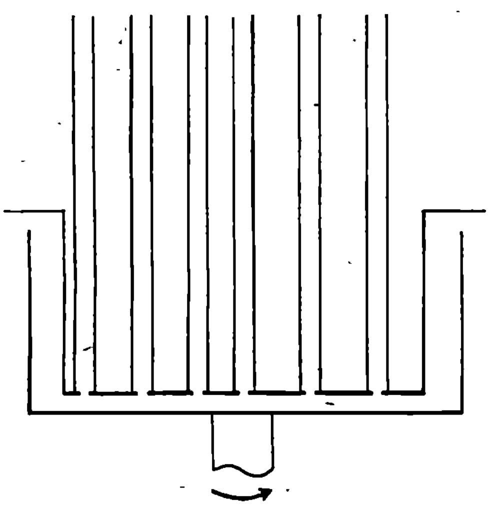

Fig. 1. Schematic diagram of apparatus

radial distances from the axis of rotation. The iquid is drawn up some way into the tubes, for ease of observation of its meniscus, by reducing the pressure n them, and the outer cup is rotated at constant speed. The change in level in each of the vertical tubes is then measured and is proportional to the normal surface traction applied to the plane surface of the fluid at the points of entry of the tubes.

Typical results, obtained with a 6 per cent solution of poly*iso*butylene (viscosity average molecular weight about 2 × 10^6) in *ortho*-dichlorobenzene, are shown n Fig. 2, in which the height of rise h of the solution n the tubes is plotted against their distance r from the axis of rotation for two different spacings of the disks d, that is, for two mean values of the velocity gradient. It is seen that the relations are substantially linear, small departures from linearity being obtained at low values of r for the higher value of d, and at high values of r for the lower values of d. The former departure from linearity increases and the latter decreases with decrease of the concentration of the solution and decrease of molecular weight of the polyisobutylene. It appears that for sufficiently low velocity gradients, concentration or molecular weight, substantial linearity between h and r^2 could be obtained.

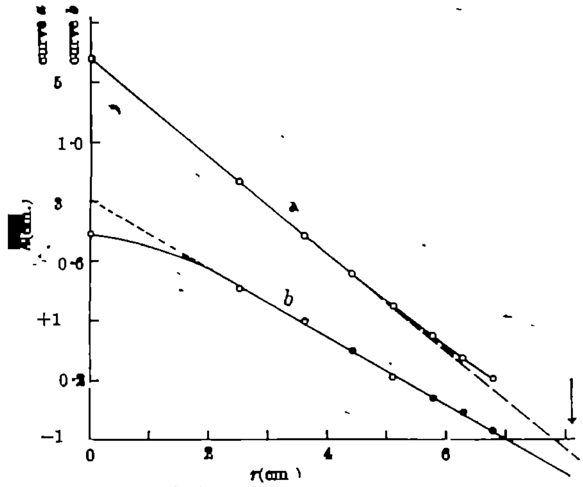

Fig. 2. Normal stress distribution over base of inner cup. h = height of rise of solution in tubes. r = distance of tube from axis of rotation. Curve a, disk separation, 0·12 cm.; speed of rotation, 40·9 r.p.m.; curve b, disk separation, 1·08 cm.; speed of rotation, 40·9 r.p.m. Arrow on right indicates edge of inner cup

According to the phenomenological theory advanced by Rivlin[6], h is related to r by the formula

$$\rho h = -\tfrac{1}{2}\Psi\frac{\Omega^2}{d^2}r^2 - \tfrac{1}{2}\frac{\Omega^2}{d^2}\int_a^r r\Psi dr, \qquad (1)$$

where ρ is the density of the solution, Ω is the speed of rotation in rad./sec., a is the radius of the cylinder and Ψ is the normal stress coefficient, which depends, in general, on a flow invariant $K_2 = -\tfrac{1}{2}\Omega^2r^2/d^2$. This result applies to the ideal case of laminar flow of a cylindrical body of fluid between plane disks, in which the curved surface of the fluid remains free. In the experimental arrangement used, the curved surface of the fluid is not free and therefore the absolute value of h, as distinct from its variation with r, will depend on the conditions prevailing at the edge of the disks.

Neglecting the small departures from a linear relationship between r and h found experimentally, we see that Ψ must be proportional to $(-K_2)^{-1/2}$ over most of the range of velocity gradients covered by the experiments, so that

$$\rho(h - h_0) = \alpha\frac{\Omega}{d}(a - 2r), \qquad (2)$$

where h_0 is a constant depending on the state of flow at the edge of the disks and α is given by $\Psi = \alpha(-K_2)^{-1/2}$. Mooney[9] has reported that results similar to (2) have been obtained by DeWitt with solutions of 'Vistanex' (poly*iso*butylene) in tetralin.

The particular relation between Ψ and K_2 leading to equation (2) is indicated by the linear relationship between r and h. It is seen that it implies a linear relationship between h and Ω/d. This has been verified experimentally.

Experiments carried out over the concentration-range 2·5–7·8 per cent showed that α is roughly proportional to the fourth power of the concentration. It has also been found that α decreases with increase of temperature. For example, for a 6 per cent solution, α decreased approximately linearly to about half its original value as the temperature was increased from 10° to 37° C.

A detailed account of the results obtained, together with the experimental precautions which were found necessary to ensure reproducibility and significance for the results, will be published later. A more critical discussion of their relationship to the various theories which have been advanced will then be given.

The work described in this communication forms part of a programme of fundamental research undertaken by the Board of the British Rubber Producers' Research Association and was carried out in the Davy Faraday Laboratory of the Royal Institution.

H. W. GREENSMITH
R. S. RIVLIN

Davy Faraday Laboratory,
Royal Institution,
London, W.1. June 5.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 15

UNIVERSITY OF LONDON (at the Institute of Neurology, National Hospital, Queen Square, London, W.C.1), at 5 p.m.—Dr. Donald Hunter: "Poisoning by Fluorine Compounds" (Guest Lecture).*

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Sir Philip Manson-Bahr: "Patrick Manson, the Father of Tropical Medicine (his Pioneer Work and its Influence on Modern Advances)" (Manson Lecture).*

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Council Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. W. Kneale: "Observables and Unobservables".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Mr. H. Hayhurst: "Infestation in Stored Products" (Presidential Address).*

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. K. C. Pounds: "Keeping Electricity Safe".

Tuesday, October 16

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Dr. E. W. Russell: "Soil Structure".*

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. F. H. Garner: "Combustion Processes in Engines" (Melchett Lecture).*

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Sir Jack Drummond, F.R.S.: "The Scientific Basis of Medicine, 3, Practical Aspects of Modern Nutritional Theories".* (Further Lectures on October 18, 23, 25 and 30, November 2, 5, 7, 14, 16, 20, 23, 27 and 29, December 4, 6 and 11.)

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "The 'j' Operator Method of Calculation—When and How should it be Introduced?" (to be opened by Mr. A. W. Gillies).

TEXTILE INSTITUTE, SCOTTISH SECTION (joint meeting with the SCOTTISH SECTION of the INSTITUTION OF THE RUBBER INDUSTRY, at 25 Charlotte Square, Edinburgh), at 7.30 p.m.—Mr. G. Appleyard: "Textile Development in the Rubber Industry".

TEXTILE INSTITUTE, SCOTTISH SECTION (joint meeting with the INSTITUTION OF THE RUBBER INDUSTRY AND PLASTICS INSTITUTE, at the Royal Technical College, Glasgow), at 7.30 p.m.—Mr A. M. Dobson: "Glass Textiles as Reinforcement in the Rubber and Plastics Industries".

Wednesday, October 17

INSTITUTE OF METALS (at Park Lane Hotel, Piccadilly, London, W.1), at 10 a.m.—General Discussion on "Metal Economics".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—William Smith Lecture.

UNIVERSITY OF LONDON (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Prof. G. Friedmann: "Technological Change and Human Relations".* (Further Lecture on October 19.)

MANCHESTER STATISTICAL SOCIETY (at the Reform Club, King Street, Manchester), at 5.30 p.m.—Mr. J. Stafford. "Census of Production".

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the FOOD AND MICROBIOLOGY GROUPS with the LONDON AND SOUTH-EASTERN COUNTIES SECTION of the ROYAL INSTITUTE OF CHEMISTRY, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. J. R. Vickery. "Bacterial Wastage in Eggs and its Control".

Thursday, October 18

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. M. K. Wells: "Exploring the Roots of Extinct Volcanoes".*

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Sir Jack Drummond, F.R.S.. "The Scientific Basis of Medicine, 4, Practical Aspects of Modern Nutritional Theories".* (Further Lectures on October 23, 25 and 30, November 2, 5, 7, 14, 16, 20, 23, 27 and 29, December 4, 6 and 11.)

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Dr. A. R. Lee and Mr. H. J. Dickinson: "The Durability of Tar and Tarmacadam".

CHEMICAL SOCIETY (joint meeting with the LOCAL SECTIONS of the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, at The University, Manchester), at 6.30 p.m.—Prof. A. R. Ubbelohde, F.R.S.: "Some Problems in the Oxidation of Hydrocarbons".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, MICROCHEMISTRY GROUP (joint meeting with the LIVERPOOL AND NORTH-WESTERN SECTION of the ROYAL INSTITUTE OF CHEMISTRY, in the Chemistry Lecture Theatre, The University, Brownlow Street, Liverpool), at 7 p.m.—Discussion on "Chemical Microscopy".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1, at 7.30 p.m.—Prof. C. A. Coulson, F.R.S.: "The Contributions c Wave Mechanics to Chemistry" (Tilden Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manso House, 26 Portland Place, London, W.1), at 7.30 p.m.—Sir Ne Hamilton Fairley, F.R.S.: "Schistosomiasis and some of its Problems' (Presidential Address.)

Friday, October 19

ROYAL SANITARY INSTITUTE (in the Council Chamber, Town Hal Stockport), at 10 a.m.—Papers on "The Prevention and Control c Infectious Diseases".

BRITISH MYCOLOGICAL SOCIETY (in the Main Chemistry Lectur Theatre, Imperial College of Science and Technology, Imperial Institut Road, London, S.W.7), at 10.30 a.m.—Discussion on "Epidemiolog of Air-borne Fungus Diseases".

TEXTILE INSTITUTE, LANCASHIRE SECTION (at 16 St. Mary's Parson age, Manchester), at 1 p.m.—Sir Robert R. Hyde: "Changes an Developments in Industrial Relations".

BIOCHEMICAL SOCIETY (at the London Hospital Medical College London, E.1), at 2 p.m.—Scientific Papers.

ROYAL INSTITUTE OF PHILOSOPHY (at University Hall, 14 Gordo Square, London, W.C.1), at 5.15 p.m.—Prof. H. Dingle: "Science". (Further Lecture on October 26.)

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, S James's Park, London, S.W.1), at 5.30 p.m.—Mr. A. C. Hartley Presidential Address.

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL STUDY GROU (at the Albert Hall, Peter Street, Manchester), at 6.45 p.m.—M P. J. Stanley: "Some Aspects of Production Statistics in the Aircra Industry".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS PHYSICAL METHODS GROUP (joint meeting with the TEES-SIDE LOCA SECTION of the ROYAL INSTITUTE OF CHEMISTRY, at the William New ton School, Norton, Stockton-on-Tees), at 7 p.m.—Papers on "Physica Methods in the Pigment Industry".

Saturday, October 20

BOTANICAL SOCIETY OF THE BRITISH ISLES (at the Natural Histor Museum, Cromwell Road, London, S.W.7), at 2.30 p.m.—Exhibitio Meeting.

BRITISH PSYCHOLOGICAL SOCIETY (in the Eugenics Theatre, Un versity College, Gower Street, London, W.C.1), at 2.30 p.m.—Pro T. M. Newcomb: "Some Research on the Concept of Referen Groups".

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANC (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m —Sir Harold Hartley, F.R.S.. "Chemical Engineering and th Future".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Roa Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. W. E. Swinton "100 Years of English Vertebrate Palæontology".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on o before the dates mentioned:

ASSISTANT LECTURERS FOR BIOLOGY AND CHEMISTRY—The Cle to the Governors, Essex Institute of Agriculture, Writtle, Chelmsfo (October 20).

GENERAL ASSISTANT ENGINEER (Mathematician), and a THIR ASSISTANT ENGINEER (Mathematician), in the research branch the Chief Engineer's Department in London—The Director of Esta lishments, British Electricity Authority, British Electricity Hou Great Portland Street, London, W.1, quoting Ref. No. AE/2 (October 20).

RESEARCH ASSISTANT to work on problems of applied econom forming part of the research programme of the Department Economics—The Registrar, University College, Hull (October 20).

SCIENTIFIC OFFICER (with a University degree in botany or ag cultural botany, with a sound knowledge of the principles of genet and practical plant breeding) IN THE PLANT BREEDING DIVISI of the Ministry of Agriculture—The Director of Establishmen Ministry of Finance, Stormont, Belfast (October 22).

STATISTICIAN (with thorough knowledge of statistical metho preferably in relation to social research) IN THE SOCIOLOGICAL RESEAR UNIT—The Secretary, London School of Economics and Politi Science, Houghton Street, Aldwych, London, W.C.2 (October 22).

RESEARCH FELLOW IN ECONOMICS OR ECONOMIC HISTORY at t East African Institute of Social Research, Makerere College (Univers College of East Africa)—The Secretary, Inter-University Council f Higher Education in the Colonies, 1 Gordon Square, London, W.C (October 25).

DEMONSTRATOR IN THE DEPARTMENT OF AIRCRAFT PROPULSION The Registrar, College of Aeronautics, Cranfield, Bletchley, Buc endorsed 'Demonstrator, Aircraft Propulsion' (October 27).

CHAIR OF ORGANIC CHEMISTRY at the University of Sydney—T Secretary, Association of Universities of the British Commonweal 5 Gordon Square, London, W.C.1 (November 12).

LECTURER (with a University degree or diploma, either in engine ing or in agriculture) IN AGRICULTURAL ENGINEERING at Canterbu Agricultural College (University of New Zealand)—The Secreta Association of Universities of the British Commonwealth, 5 Gord Square, London, W.C.1 (November 12).

AGRONOMIST IN THE DEPARTMENT OF AGRICULTURE, Gold Coast The Director of Recruitment (Colonial Service), Colonial Offi Sanctuary Buildings, Great Smith Street, London, S.W.1, quoti Ref. No. 27059/249.

NATURE

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CONTROL OF BROADCASTING IN BRITAIN

ALTHOUGH the dissolution of Parliament has made the Government's recent Memorandum* on the Report of the Broadcasting Committee of 1949 of somewhat academic interest, whatever government takes office will be required to deal with the broadcasting question as a matter of urgency. The present charter and licence of the British Broadcasting Corporation expire on December 31, 1951, and final decisions on future broadcasting policy cannot be postponed when next Parliament meets. It is apparent both from the Beveridge Committee's report and also from the debates in the House of Lords and in the House of Commons that division of opinion does not run on party lines. Nevertheless, it is vitally important that the significance of the real issues involved should not be lost to sight in the dust of political controversy, and that the decisions should be taken in the light of the fullest possible informed public discussion.

The criticism already expressed of the Report indicates that the debate on the monopoly issue is only just beginning, and that the Beveridge Committee was possibly too timid in considering alternatives to the present system. Because of the urgency of the question and the general trend of discussion, no government is now likely to feel able to do other than extend the present charter on much the same basis, as is proposed in the present Memorandum. In view of the discussion now proceeding on the monopoly issue, as well as the possible technical developments in television and the introduction of very-high-frequency broadcasting, the Memorandum was manifestly right in proposing to renew the charter for a limited period only. The fifteen years suggested seem a reasonable compromise, provided that due regard is had to the fact that certain of the changes recommended by the Beveridge Committee are likely to weaken the administration of the Corporation and, while avoiding abuse of monopoly, make the Corporation inefficient or at least less effective. Moreover, technical developments may offer more promising means of breaking the monopoly or minimizing its inherent dangers.

There are two particular points to be kept in mind. First, during the next fifteen years the danger of ossification in the Corporation is likely to increase. With the passage of time, various areas of B.B.C. activity will lose their novelty and the scope for new ideas will become progressively smaller while the influence of tradition increases. The development of the Home and Overseas Services and now of television cannot indefinitely supply the stimulus they have done during the past two decades. The recommendations of the Beveridge Committee on the administrative side may well accentuate this senescence. This risk requires fuller consideration than is given in the Memorandum.

The second point is that stressed by Prof. John Coatman in an article in the *Journal of Public*

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* Broadcasting: Memorandum on the Report of the Broadcasting Committee, 1949. (Cmd. 8291.) Pp. 12. (London: H.M. Stationery Office, 1951.) 6d. net.

Administration (29, 160–172; 1951). Prof. Coatman points out that the British Broadcasting Corporation differs from most other public corporations in that its general policy cannot be clearly distinguished from the day-to-day activities which bring it into touch with the public and are the main occasion of criticism. The content of the programmes provokes the bulk of public criticism, and a structure of central responsibility which excludes or ignores such criticism of day-to-day policy is to that extent unreal and unadapted to the situation. To limit public discussion in Parliament in this respect is not in keeping with the nature of the public service which the Corporation provides and, in fact, sells.

Prof. Coatman seeks his solution in an administrative structure on the lines of that of a university. The prototype of the organization Prof. Coatman visualizes is the university with its senate and its council or court. Corresponding with the senate, he suggests, should be a body of high-ranking officials in the B.B.C. charged collectively with similar duties and responsibilities in regard to their work. Major projects such as the inauguration of the Third and Light Programmes, the creation of the board of management and like important matters would be fully discussed by this body, and the governors would be guided by its advice. It would supervise the programme output in respect of quality, technical competence, subject-matter and distribution of time, see to the proper co-ordination of the central and regional programmes, and at the same time eliminate one of the main weaknesses of the existing system, namely, excessive concentration of executive authority at the centre.

The board of governors would correspond with the university council or court, and its relations with the body proposed would be similar to those of the council or court with a university senate. Prof. Coatman suggests further that the board of governors might include a member of the 'senate'. The proposal would ultimately, he suggests, revolutionize the relations between Parliament and the B.B.C., would lighten the responsibility of the Government in respect of broadcasting and would make the B.B.C. a far more democratic and efficient instrument.

There are two conditions, however, which must be served if those purposes are to be achieved, especially if one stresses any analogy between the constitutional position of the B.B.C. and that of the universities in Britain. The first of these is that emphasized by Prof. Coatman himself. Really effective decentralization is essential. Besides broadcasting commissions for Scotland, Wales and Northern Ireland, there would be one or more for England, with functional devolution of television and overseas broadcasting. Really viable units of control would thus be obtained, the activities of which would be co-ordinated in the federal board of governors. Besides this, Prof. Coatman would make either the Lord President of the Council or the Lord Privy Seal responsible for acting for the Government in relation both to Parliament and the B.B.C., apart from matters which, under the Telecommunications Act, fall within the competence of the Postmaster-General. Parliament itself might also appoint an all-party broadcasting committee which would be responsible for keeping in touch with the broad policies and day-to-day activities of the Commissions and the federal B.B.C. board to see that the conditions of the charter are not violated and that the public interests in broadcasting are duly served.

The second condition is that any analogy between the constitutional position of the B.B.C. and that of a university must not be pressed too far. It is purely an administrative matter. The B.B.C. is not and could not be in any sense a university, despite the talk about the Third Programme being 'a university of the air'. Education is only one of the functions of broadcasting. Concern over the maintenance of standards or the elimination of administrative difficulties must not lead us to overlook the fact that the Corporation ultimately must provide what the listener requires. Safeguards against the lowering of standards must not be carried to the point of dictation.

There would appear to be room for much more constructive and fundamental thought on this question of the implications of monopoly and on the maintenance of standards than the recent Memorandum indicates. The first point, about viable units of control, has, however, not been included in the Memorandum. While attaching great importance to the maximum devolution to all areas in programme policy, and recognizing the need for the English regions as well as Scotland, Wales and Northern Ireland to have full opportunities of making their distinctive rich and diversified contribution to the pattern of British life and culture, the administrative implications are apparently not realized. The proposals of the Broadcasting Committee to appoint to the board of governors 'national' representatives, and that there should be 'national' bodies—for which the name 'Broadcasting Councils' is proposed—the primary function of which would be to control the general policy and content of their home programmes, are accepted. In regard to finance and capital development, such Councils would have advisory functions only; but they would be responsible for the appointment of staff wholly employed in connexion with their Home Services.

This is not federation, nor is it decentralization in the sense urged by Prof. Coatman. The idea of 'representation' on the board of governors is in itself objectionable; but the more serious aspect of the proposal in the Memorandum is that such 'national' representatives on the board of governors should themselves each be chairman, not of a commission of five, as suggested by the Beveridge Committee, but of an unpaid broadcasting council drawn mainly from nominees of the county councils and major urban local authorities. The Beveridge Committee did not propose any change in the English Regional Advisory Councils except to increase their independence and knowledge, and thus to strengthen existing programme autonomy of the regional controller; but the Committee recognized that it would be for the proposed national commissions to decide whether or not to appoint such advisory councils in their areas.

The immediate effect of the proposals of the Memorandum would clearly be, first, to destroy the authority of the regional controller and, secondly, to subject the regional programmes to political and sectional pressure. The bodies proposed could not but have a strong local-government and probably party-political trend, and local sectional interests would continually press on the regional controller. Quite rightly the governors of the British Broadcasting Corporation have pointed out that the proposal would for the first time introduce into British broadcasting a system of control into which a political element would be entering. Not only would this be a break with a principle which has been one of the strongest features of the B.B.C., but also it introduces a dual allegiance which itself is liable to endanger standards.

It would be fair to suggest that the Memorandum gives insufficient thought to what is implied by regionalism and to the distinction between separation and the federation advocated by Prof. Coatman. The governors' comment on the proposals indicates that there is real danger that the adoption of such proposals would lead to the fragmentation of British broadcasting and the disappearance of all national programmes. Fortunately, the Memorandum's proposals here, and particularly the selection of broadcasting councils from local authorities, found so little support in Parliament that it was intimated that final decisions would not be taken until Parliament had expressed its views; this should make it easy to drop the whole proposal for regional devolution.

It is to be hoped that the administrative aspect of the proposals will also receive further attention than was apparent in these two debates. While the potential clash of loyalties which might be involved for the B.B.C. staff in devolution was duly noted by several speakers, few apart from Capt. L. P. S. Orr and Mr. A. Wedgwood Benn indicated any appreciation of what was implied financially or administratively. Capt. Orr, quoting from the Beveridge Report that no region could afford by itself to provide a programme service in any way comparable with what is now being achieved by the combined effort of all, rejected devolution accordingly as meaningless without fiscal autonomy. Those who suggested separate corporations for Wales or Scotland did not attempt to meet the difficulty of the limited number of wavelengths available, which was put quite frankly by Mr. Gordon-Walker in opening the debate on July 19.

The problem of decentralization and of the excessive size of the present Corporation was most constructively handled by Mr. Wedgwood Benn, whose suggestion for four boards of management or corporations, responsible for overseas broadcasting, for television, for the Home Service and for the regions, went far towards meeting the need for viable units of control. This was the most constructive suggestion for dealing with this question advanced in either debate, but it is apparent that much more thought is still required in these matters of regionalization and administration before we can secure the steady progress towards greater decentralization, devolution and diversity put forward in the Beveridg Report. Moreover, whatever the immediate decisio as to the terms of the new charter, it is importan that the utmost care should be taken to ensure tha adequate encouragement is given to the developmen of new scientific methods and processes which migh greatly facilitate devolution and decentralization i future.

Mr. C. I. Orr-Ewing directed attention to th possibilities in this direction which the use of very high-frequency broadcasting may offer. Such possibilities are a matter of finance also, and this is on reason for deploring the Memorandum's proposal t raid the B.B.C. licence fund. It is proposed, with n reason except the ingenious argument that "i present circumstances the B.B.C. should make som contribution to the general revenue", that th Government should take 15 per cent of the net licenc revenue for the first three years of the new charte and that the position should be reconsidered at th end of that time.

This proposal also has brought a strong prote from the governors of the B.B.C., who point out tha since January 1, 1947, the B.B.C. has already contributed from its revenues £4,666,330 to meet incom tax, and that in the next ten years the prop development of the broadcasting service would ta the Corporation's resources so fully that, if remissio of income tax was not obtained, even though 100 p cent of the net licence income was retained, the Co poration would eventually face a deficit of £6,800,00 The Corporation will accordingly, if only 85 per ce of the licence fee is retained, be forced to borro money which the listener will have, in effect, alread contributed. The proposal was heavily attacked i both debates, alike from its effect on technica developments and from the point of view of i essential dishonesty, the implications of which hav already been noted in these columns.

There can now be no doubt as to the misgivin with which the proposals of the Memorandum a regarded on all sides, independent of party lines. no satisfactory scheme of devolution can be devise immediately, it is imperative that the utmost ca should be taken to strengthen the regional advisor councils and to promote means of bringing effectiv criticism to bear upon the hierarchy. Metho adopted for that purpose or to strengthen the positio of the governors and make them more effectiv watchdogs for democracy must not impair th administrative soundness of the organization, o encourage the danger of senescence to which it ma well be increasingly exposed. Further, there mus be the fullest possible resources available for th exploration of the new technical developments an their implications. It is to be hoped that whe official proposals are again forthcoming, they wi take fuller account of these matters, that the rai on the licence revenue will be dropped, as well a the threat of introducing political influence into th regional councils; and that whether the charter i renewed for fifteen years or a shorter period, ther will be ample opportunity for ensuring that not onl are new technical developments explored but als the means of averting the dangers inherent in a monopoly. Only by careful attention to such matters can we hope that British broadcasting will continue to uphold its high standards and tradition, and to reconcile its function of selling a public service with the maintenance of an unrivalled reputation for integrity and political impartiality.

SUPERCONDUCTIVE ELECTRODYNAMICS

Superfluids

Vol. 1: Macroscopic Theory of Superconductivity. By Fritz London. (Structure of Matter Series.) Pp. viii+161. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 40s. net.

ALMOST twenty years ago Dr. H. London—then a young research student at the University of Breslau—realized when dealing with the problem of a perfect conductor in an alternating magnetic field that Maxwell's equation $J = \sigma E$ becomes inadequate when $\sigma \rightarrow \infty$, since it makes no provision for the inertia of the electrons. Instead he proposed $\dot{J} = (1/\Lambda)E$, where Λ is a new constant which he called "internal specific self-inductance". He thus showed that a magnetic field will enter a superconductor and that the depth of penetration is determined by Λ. In the same year (1933), Becker, Heller and Sauter published a paper in which by considering the problem of a rotating superconductive sphere they arrived independently at the same result.

In 1934, H. London joined his brother, F. London, in Oxford, but in the meantime an important development had taken place—Meissner had discovered the expulsion of a magnetic field from the superconductor. A confused situation had arisen leading to vain attempts at relating the new phenomenon of zero induction with the known fact of zero resistance by means of ordinary electrodynamics. In 1935, F. and H. London provided this link by proposing the new equation, curl $\Lambda \dot{J} = -(1/c)H$, which in conjunction with the equation of H. London and Becker has since won general recognition as the fundamental law of superconductive electro-dynamics. In a number of papers F. and H. London have further extended the new electrodynamics, treating various aspects of the subject and providing great stimulus to experimental research. F. London, in particular, has elucidated the quantum-mechanical significance of the theory.

His new book is the first comprehensive summary of the work to be written in English. In 1937 he had written a rather shorter monograph in French[1], and another on the same subject, by M. von Laue, has more recently been published in German[2]. After introductory chapters on the magnetic phenomena and thermodynamics, the equations are introduced and applied to a number of problems. Then their significance is discussed in relation with the assumption of non-viscous flow. The determination of the penetration depth by measurements of the susceptibility and by microwave absorption is described. The next section, dealing with the intermediate state and domain structure, is followed by a discussion of the surface energy between the superconductive and the normal phase and of the transition of thin wires and films. The final section sets out a programme for the molecular theory of superconductivity, and contains the interesting conclusion that in the superconductor it is the momentum vector rather than the current which exhibits long-range order. It is this concept of momentum condensation on which the similarity with liquid helium II, stressed in the introduction, is based.

This clear and rigorous account of a difficult but fascinating subject will be greatly welcomed by all working on superconductivity. One could only wish that the author had been as careful when making historical statements as he has been with regard to the subject-matter. To say that Tisza's two-fluid model of liquid helium (1938) "was not taken seriously enough to be given an experimental test" which had to wait for Kapitza's work in 1941 is quite unjustified, since, in fact, such a test—which yielded a positive result—had been made in Oxford in 1939. The way in which the pioneer work of Becker and co-workers is introduced also does not do full justice to the achievement which it constituted at the time. The analogy between liquid helium and superconductivity has been suggested by others as well, and mention of their work would have detracted nothing from the author's own fundamental contribution. These are, however, very minor blemishes which do not affect the subject-matter of the book. It can certainly be recommended to any research student embarking on the theoretical or experimental study of low-temperature phenomena.

K. MENDELSSOHN

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[1] London, F., "Une conception nouvelle de la supra-conductibilité" (Paris: Herman et Cie., 1937.)

[2] Von Laue, M., "Theorie der Supraleitung" (Berlin and Göttingen Springer, 1949.)

IMPACT OF SCIENCE ON FARMING

The New Farming

By Dr. D. H. Robinson. New edition. Pp. 234+16 plates. (London: Faber and Faber, Ltd., 1951.) 16s. net.

THE line between pure and applied science is getting more indistinct, and much of the new knowledge now being used to good effect on the farm is neither simple nor elementary from the scientific point of view. For example, the scouring of cattle on the so-called 'teart' pastures might easily have been ascribed to copper deficiency, and it must be confessed that there was an element of luck in the discovery that it is, in fact, caused by an excess of molybdenum. The solution of the problem presented by the warble fly, or the disentangling of the many sheep diseases, has required much purely scientific work of a very high order. Consequently, a smattering of the elements of a few sciences is no longer sufficient for the agriculturist; he is faced with the task of keeping up with new advances in a number of fields of scientific endeavour.

Dr. D. H. Robinson has set out to simplify this task, and in a little more than two hundred pages he exemplifies the benefits that farming has received from new knowledge. The tale is not, of course, complete. The wider matters of economics and farm management are outside the scope of the book, and in each chapter the method is to pick out the more prominent cases where science has been successful by way of illustration, rather than to cover the subject completely. The examples are skilfully chosen, however, and together they give a good picture of the impact of science on modern farming, stressing the large contribution that has already been made and indicating the exciting quests which still remain.

It is doubtful if the book would provide a very digestible meal for the non-technical reader; it is very concentrated, and there is no room for explanation of all the terms used. To the agriculturist and to the farmer (in common parlance these two words are not synonymous) it offers a real feast. The chapters on the soil and on crops are sound and satisfying (except for a misprint in regard to the production of sugar in Great Britain), while that on grassland is absorbingly interesting; pests and diseases of crops and livestock, the breeding and feeding of farm animals, herbicides and ensilage are ably discussed. The reviewer started reading the book with some scepticism, doubting whether in such a small compass enough could be included to be useful with sufficient description to make it intelligible. But there is no denying that the aim has been achieved and the reader's interest is held, though that of one reader flagged somewhat over the work of the engineers.

This is not a text-book, although it contains much information. It brings the reader up to date on many questions, impresses on him the importance of science in agriculture and stimulates him to ask for more. It is certainly very easy to read because the English is simple and clear, with a nice economy in words.

THE NEW FOREMANSHIP

The Foreman

A Study of Supervision in British Industry. Undertaken by the National Institute of Industrial Psychology and sponsored by the Human Factors Panel of the Committee on Industrial Productivity. Pp. 158. (London and New York: Staples Press, Ltd., 1951.) 12*s*. 6*d*. net.

As Sir George Schuster says in the foreword, this book deserves notice for three main reasons. First, it is a study of a subject the importance of which is recognized by all who are concerned with the pressing need to increase Britain's industrial productivity. Secondly, the method of investigation —the collection of facts before the elaboration of theories or opinions—is one which is relatively unknown in those sectors of Britain's industrial life which determine the behaviour of men and women. The third merit of the book is that it is one of the projects sponsored by the Human Factors Panel of the Government Committee on Industrial Productivity. It is, in fact, the first comprehensive report to be published on any of these projects, and its contents and presentation augur well for those on joint consultation and other aspects of human relations in industry which are yet to come.

The contents of the book are partly based upon information collected by six investigators over a period of two years. During this time 107 factories were visited, and individual studies of 752 supervisors and their jobs were completed; the report relates to information collected from 87 of the factories and all the individual supervisors. During these investigations a questionnaire covering various aspects of foremanship was sent to some 4,700 establishments employing more than 250 persons, of which 751 returned completed forms. The investigators also devised and carried out trial selection procedures and training courses as well as collaborating with others who were responsible for similar courses. Visits were made to a number of supervisory training courses within firms, in technical colleges and training institutions in Britain and other European countries. In addition, the activities of various foremen's associations, discussion groups and related organizations were observed, while the investigators also made an extensive study of the British and foreign bibliography on foremanship.

It may thus be fairly claimed that the survey has been comprehensive and thorough. But the investigators have not been misled into thinking that their observations have been complete or made into typical cross-sections of British industry. It proved impossible, for example, to arrange for a random sample of firms to be studied, and many of the factories visited were probably above average in several aspects of management policy and practice. Similarly, the foremen seen in each firm probably included too high a proportion of the more able men. For these reasons the investigators readily admit that, almost certainly, the study presents too favourable a picture of existing practice in British industry.

Yet the conclusions will not be without value if they do no more than stimulate discussion on an important subject. They confirm the common belief among thoughtful managers that foremanship to-day requires different skills from those needed in the past; the power of being able to 'sack' has given way to the need for positive leadership based on knowledge, ability and personal qualities. The modern foreman is closely concerned with questions of human relations and administration as well as with his technical and production responsibilities. He must be selected for his capacity to gain the respect, confidence and co-operation of his operatives, colleagues and managers, and he must be trained so that these potentialities will be fulfilled.

Apart from the statistical analyses, much of this book is devoted to the views of the investigators on the status of the supervisor and ways in which he should be selected and trained. Their occupational analysis of supervisory work (on pp. 32–34) is one of the most valuable features of the book, although their prescriptions for selection and training may need revision as further diagnoses are made. In this connexion one of the most practical suggestions put forward by the investigators is the need for a residential centre for supervisory training. For small and medium-sized firms, particularly, such a centre would be of incalculable worth, and it is to be hoped that the sponsors of this investigation will make the necessary approach to industrial and educational organizations and the government departments concerned; a junior version of the administrative staff college is overdue.

The presentation of this survey leaves little to be desired. It is always concise and usually clear; occasionally there is evidence of the efforts of several writers not all of whom have the same gifts for writing or clear thinking. The summaries at the end of each chapter are brief and to the point; the 'review and summary' at the end of the book has been shrewdly prepared so that readers may not forget that the evidence collected and the views put forward by the investigators represent one of the most valuable statements yet prepared on the means of promoting good human relations in British industry.

T. H. Hawkins

ARCHÆOLOGICAL DATING OF THE CLIMATIC CHANGE IN NORTH EUROPE ABOUT A.D. 1300*

By Dr. AXEL STEENSBERG

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It is a general feature of the agrarian history of northern Europe during the Middle Ages that large-scale colonization of land came to an end late in the thirteenth century, and that in the next two centuries it was followed by the abandonment of hundreds of villages in nearly all parts of north European countries. This phenomenon seems to be connected with a climatic change, and in order to examine the problem briefly it is convenient to separate the sources roughly into two groups: on one hand, the literary records and, on the other, what may be called the scientific evidence.

Among the literary sources one may first mention the hundreds or thousands of notes about the weather of whole years, of seasons or of single days which medieval annalists have included in their historical records. This information has never been studied properly in the full light of modern textual criticism, or with regard to the misconceptions upon which some of them were based. For medieval Denmark, including the lost provinces of Skåne and Holstein, such notes about weather were collected by a doctor of medicine, F. V. Mansa, nearly a hundred years ago[1]. Such data have also been published in the *Scriptores Minores* and *Annales Danici*. For Germany, similar information has been collected by Fritz Curshmann for the period up to 1317[2] and by R. Hennig up to 1800[3]. For Iceland the material has been collected by Dr. S. Thorarinsson, of Reykjavík, and others.

I do not think myself that it is possible to draw any exact scientific conclusions from such imprecise material. The difficulty is, of course, that the records are subjective, and what we find in the annals is almost entirely confined to relative statements. Some few of the official Danish documents do, however, give some information of scientific value which is particularly relevant to this problem. In 1334 they record for the first time that a farm has been left desolate. During the next three or four hundred years this became a general phenomenon in Denmark. The Danish Place-Name Society has recorded the names of hundreds of villages abandoned during the late Middle Ages. They nearly all seem to be names of the type with the termination *-thorp*. In Denmark most of the villages with names terminating in *-thorp* were founded in the early Middle Ages, that is to say, from the tenth to the twelfth century. In one small district of Jutland there are to-day eighteen villages with this name-ending; the Place-Name Society knows of sixteen other *-thorp* villages in this district which were abandoned in the late Middle Ages, and, of course, there may have existed others the names of which have been forgotten.

For Zealand the archivist Svend Aakjær has just published in the *Danish Historical Review* tables which show the decrease in the area of cultivated land from about the middle of the thirteenth until the late fourteenth century. Broadly speaking, the parish tithes of seventy-nine parishes in Zealand declined by about 70 per cent. This retraction of the cultivated land in the late Middle Ages is also well known in England. In 1943 the German scholar W. Abel published his "Die Wüstungen des ausgehenden Mittelalters"[4]. Prof. J. Schreiner, of Norway, has shown that the retraction was a general phenomenon throughout northern Europe[5], whereas we know from other sources that the agriculture of Italy was flourishing in the fifteenth century. Everywhere in northern Europe the retraction was connected with a fall in the prices of corn and with a falling population. Prof. Schreiner has shown clearly that corn prices fell from about 1300, whereas it was not until 1348 that the pestilence known as the Black Death first broke out. The English records of the output of corn from year to year, which are preserved for some abbeys and manors throughout the Middle Ages, do not show any decline of output starting anywhere around 1300, but this may be due to the fact that all the land to which the English records relate had been tilled and cultivated intensively from Saxon times or even longer. Such well-tilled land with a big content of humus is not very sensitive to an increase in the wetness of the climate. A change from less to more rainfall would first hit marginal lands recently brought into cultivation, which commonly lack humus in their raw clay and sands and which are therefore the first to be affected by climatic changes.

All this, however, only shows that there is nothing inconsistent between an unchanged record of corn output and a climatic deterioration. It does not prove that such a change occurred; and, indeed, the historical sources clearly cannot themselves provide any such proof.

Recently Dr. S. Thorarinsson, in his work "Tefrokronologiska Studier", has tried to date the layers of ash from the volcanoes of Iceland, and seems to have been completely successful[6]. It has been possible to fix the layers of the big eruption of Hekla to the year 1300. It seems clear that in Iceland a climatic change at about this time brought corn-growing to a gradual end. Pollen analysis has shown that corn-growing started in Iceland when settlers occupied the country in the Viking period; in particular, they grew barley and also some oats. Corn-growing had not quite stopped in the year 1300 when Hekla had its great eruption, the ashes of which can be discerned in the bog strata. It cannot be argued that corn-growing stopped merely because importation became easier as a result of trading with the Hanseatic League in the late Middle Ages, for, until modern times, Iceland never had better intercourse with foreign countries than during the tenth century, when corn-growing reached its maximum. Dr. Thorarinsson has also shown that the glaciers of Iceland advanced from the late Middle Ages until they reached a maximum about the year 1700. Since 1850 they have been retreating again, and it is now again possible to grow some corn in the country.

Franz Firbas and others have investigated the history of the vegetation in the Alps of Central Europe. In his "Untersuchungen über die Entstehung der heutigen Waldstufen in den Sudeten" (1949) he mentions that woods with abundant beech trees covered the Riesengebirge right up to the ridges of the mountains at least until the beginning of the fourteenth century[7]. From the fourteenth to the seventeenth centuries the upper tree-line lay 100–200 m. lower than either before or after. In the western Alps also, the glaciers advanced from about 1300 onwards, but they retreated again during the fifteenth century; a new advance began about 1600. When, however, Brooks in his "Climate through the Ages" correlates these changes with the climatic history of Iceland, he is probably making a mistake. Thorarinsson mentions that in Iceland there was also a glacial advance in the sixteenth century and beyond, lasting until the mid-seventeenth century or even into the mid-eighteenth century.

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* Substance of a paper read on August 14 at Edinburgh before Section H (Anthropology and Archæology) of the British Association.

Before going on to discuss recent Danish investigations, mention must be made of the underground water which seems to have caused great difficulties in the silver mines of Central Europe in the years after 1300. The production of silver fell throughout Europe and caused a great shortage in England as well as in other countries. Of the Goslar mines in Germany, it is stated that in 1360 the water in the mines had been increasing for more than fifty years and that all attempts to improve the conditions had been in vain. Just after 1400 it is recorded that a new but unsuccessful attempt was made to resume production at the Rammelsberg mines. In Freiberg an attempt was made in 1365 to introduce a hoisting apparatus for getting rid of water, and a further unsuccessful attempt was made in 1379. In Bohemia the same problems arose in 1315 at Iglau, and the mines of Dutchbrod were abandoned as early as 1321. At Kuttenberg the use of mechanical drainage was started in the second half of the fourteenth century; but it was not until the Fugger merchants made extensive investments in the mines and in mining equipment in the late fifteenth century that silver production of Central Europe overcame the difficulty of excessive water[8]. These difficulties with water in the mines, starting as they do soon after 1300, provide a practical demonstration of the climatic change implied by the advance of the glaciers.

The best proofs of the reality of the change, however, will, I think, be found in the bogs and in the desolated villages of northern Europe. The Swedish pollen-analysis expert, Erik Granlund, published in 1931 his first observations on the so-called recurrence-surface No. 1 (the *RY* I), which he dated roughly to about A.D. 1200[9]. These recurrence surfaces represent renewals of the growth of sphagnum in the bogs concerned, and like the well-known *Grenshorisont* (designated *RY* III in Granlund's terminology) probably represent a relative increase of atmospheric wetness compared with the period which the surface terminates.

In 1943 Valdemar Mikkelsen, of Copenhagen, demonstrated the existence of such recurrence surfaces in five Jutland bogs, and in his work on Præstø Fiord in 1949 he advanced the thesis that the climatic change at *RY* I is characterized by the rise of the beech curve in the pollen diagrams and by the occurrence of *Centaurea cyanus*, the cornflower[9]. Cornflowers had not been identified in Denmark since the Late Glacial Period apart from one or two dubious finds from the Iron Ages. But from *RY* I Mikkelsen has now counted nearly forty grains. This is an exceptionally large number because the pollen grains of *cyanus* are spread only by the aid of bees and other insects, not by the wind, as in the case of a great many other pollen grains.

Dr. Hagbart Jonassen has also recorded the existence of the *RY* I[10]. In some diagrams of Jutland bogs which have been published in his work "Recent Pollen Sedimentation and Jutland Heath Diagrams" (1950), in each case the beech curve is rising just at *RY* I, but he has not noticed *Centaurea cyanus* because the sections which he has investigated lie in uncultivated areas in the Jutish heaths. Prof. Knud Jessen, in his work on the Late Quaternary deposits and flora history of Ireland published in 1949, states that there are similar recurrence surfaces in that country. So far, however, it has not been possible to assign exact dates to these surfaces. Even Granlund's date of about 1200 for *RY* I is very vague and problematical.

Dr. Mikkelsen and I think that we can now date *RY* I more exactly. I happened to carry out an excavation in an abandoned village named Bolle, in Vendsyssel, the northern promontory of Jutland. This village was not one which had been abandoned in the Middle Ages but had survived until 1650, when it was abandoned in order to create a manor. The most interesting archæological discovery was the dam of a water-mill dated at the turn of the last century B.C. and the first A.D. I was excavating this site with interruptions during 1939–48. During the last season Dr. Mikkelsen and I carried out large-scale investigations into the stratigraphy and pollen distribution of the site.

The mill-pond was not, of course, made in a sphagnum bog, and it was therefore impossible to find the *RY* I itself. We did, however, find the fluctuations of the beech curve which we knew from so many other localities both in Jutland and on Zealand, and moreover the *Centaurea cyanus* started just where the beech curve was rising for the last time.

It was, however, the dating of this phenomenon which we wanted to know. Fortunately, during one of the first years of my excavation at Bolle, I happened to find a hearth on which iron ore had been reduced to iron, and among the layers of charcoal and slag I found some potsherds which could be dated with certainty to not earlier than 1250 and not later than 1325–50. I had been cautious enough only to destroy one-half of this hearth, and I remembered that it had been stratified with peat both above and beneath it; we therefore dug a section from the hearth out into the middle of the bog and took pollen samples from both ends. Dr. Mikkelsen was not able to let me have the pollen spectra and his commentaries at the time of writing this article; but he is just finishing his report, and this will appear within a year in publications of the National Museum. It will show that the bog at Bolle was dry from about the Viking period or the very early Middle Ages just up to the time of the dated finds, which can now be assigned to about A.D. 1300. It is exactly at this level that the *Centaurea cyanus* starts and the beech curve rises.

One naturally seeks for an explanation of these two characteristics. The increase of beech pollen need not indicate that the beech forest has actually been recovering because the climate has become wetter. Dr. Johannes Iversen has suggested that the increase may be no more than a relative one, expressing the fact that other tree species, the pollen of which were formerly represented in the bog, had by this time disappeared.

The phenomenon of the appearance of the cornflower is connected in some way with the cultivation of ordinary wheat. Nowadays the cornflower flourishes chiefly in wheat fields which have suffered much from winter frost. As yet, we do not know much about the kinds of wheat grown in Denmark during the Middle Ages. Mr. Hans Helbæk has studied grain impressions on potsherds and carbonized cereals in England, Ireland, Holland and Denmark, and he is now working on the rich Swedish material from Vallhagar in Gotland. In his book on grain impressions from English potsherds, published by the Royal Danish Society of Science in 1944, he and Prof. Jessen state that most of what popularly is called wheat from earlier periods in England is in reality naked or hulled barley, emmer (that is, *Triticum dicoccum*) or small spelt (*Triticum monococcum*)[11].

Ten years ago, when I was excavating some farm-sites in the village of Hejninge, near Slagelse in Zealand, I happened to find a heap of carbonized grain on a floor which could be dated by coins to between A.D. 1300 and 1500. Last year, when I was excavating the medieval levels of some farm-houses in Store Valby, also near Slagelse, I happened to find in a post hole some carbonized barley with a small piece of rye bread. This post hole had been covered by a fireplace layer within which was a coin, by means of which the grain and the bread could be dated to not later than about 1400, and potsherds in the floor to which the post hole belonged indicated a date for the finds of not much earlier than 1300.

This find led me to investigate every spot of black earth containing any sort of carbonized material which could be dated by means of potsherds or coins. I took Mr. Helbæk down to the site, and immediately he discovered single grains and seeds in other black spots. After this I took all this material back to the laboratory. Mr. Helbæk made a washing device to make it easy to divide the grains and seeds from the earth and dust, and he has made a number of interesting new finds which he expects to publish. Mr. Helbæk and I hope that it will soon be possible to reconstruct a generalized sequence of plants and seeds for the Middle Ages as it has already been possible to do for the prehistoric times. It will remain, however, very important that sites of villages which have been abandoned in the late Middle Ages should be excavated so that information on the mixture of corn and wild seeds in such places may be obtained. I am at present surveying the fields of such a village in Zealand, and I shall try to find the site by means of analysis of the phosphoric acid content. I am sure that the knowledge gained from such investigations, together with advances in the other fields of inquiry which I have mentioned, will yield much more exact information than has been available hitherto about the true character of the climatic change which we can be certain took place round about A.D. 1300.

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[1] *Bidrag til Folkeernæringens og Sundhedsplejens Historie i Danmark* (Copenhagen, 1878).

[2] "Hungersnöte im Mittelalter", *Leipziger Studien aus dem Gebiet der Geschichte*, 6, 1 (1900).

[3] Katalog bemerkenswerter Witterungsereignisse, *Abh. der Kgl. Preuss. Meteorol. Inst.*, 2, 4 (1904).

[4] "Quellen und Forschungen zur Agrargeschichte", 1 (Jena, 1943).

[5] "Pest og prisfall i senmiddelalderen", *Norske videnskaps-akademi i Oslo*, 2, Hist.-filos. klasse 1948, No. 1.

[6] Copenhagen, 1944. Also *Geografiska Annaler* (Stockholm, 1944).

[7] *Planta*, 36 (1949).

[8] Granlund, Sveriges geolog. undersöknings Årsbok 1931; De svenska högmossarnas geologi, Årsbok, 26 (Stockholm, 1932).

[9] *Res. Botanicæ Danicæ*, 13, No. 5 (1949).

[10] *Res. Botanicæ Danicæ*, 13, No. 7 (1950).

[11] *Kgl. danske vidensk. selskab, Biol. skrif.*, 3, 2 (Copenhagen, 1944).

THE EAST AFRICAN AGRICULTURE AND FORESTRY RESEARCH ORGANIZATION

By Dr B. A. KEEN, F.R.S.
Director

THE headquarters and laboratories of the East African Agriculture and Forestry Research Organization at Kikuyu, Kenya, formally opened by the Right Hon. James Griffiths, Secretary of State for the Colonies, during his recent visit to East Africa, were built with money provided from the research allocation of the funds made available by the Colonial Development and Welfare Acts. Although neither the initiation nor the stimulation of research into Colonial problems are new ideas in British Colonial policy—the work of the Imperial Institute and of the short-lived Empire Marketing Board affords evidence of this—the idea of regional research organizations serving a group of contiguous Colonies is a relatively new conception. The British Colonies lend themselves to this idea, forming such obvious groups as Malaya, West, East, and Central Africa, and the West Indies. The Colonies within a group have many common problems, and it is obviously more efficient and more economical of men and money to conduct on a regional basis the researches required.

The machinery for regional research into agricultural problems of both arable and animal husbandry has so far been most fully developed in East Africa. Although still short of staff, and handicapped by swiftly rising costs, the East African Agriculture and Forestry Research Organization is now functioning in its new headquarters and laboratories at Muguga near Nairobi. A sister organization, the East African Veterinary Research Organization, will share some of these new facilities, and is also in process of developing others for research into animal diseases on an adjoining site. The initial development of the Agriculture and Forestry Research Organization was greatly helped because it absorbed the staff of the East African Agricultural Research Institute established in 1927 at Amani in Tanganyika Territory, and certain new appointments could be housed there pending the completion of the new centre at Muguga.

The Colonial Development and Welfare scheme setting up the Agriculture and Forestry Research Organization was approved in February 1948. It was based on the conclusions of two East African conferences, held in 1946 and 1947, and on the recommendations of the director of the Organization, who had been appointed earlier in 1947, so that he could go into the matter on the spot. Two subsidiary schemes, one for the study of fertilizer responses in East Africa, and the other for the study of the serious 'sudden-death' and 'die-back' diseases of cloves in Zanzibar, were also set up earlier on grounds of urgency; the scientific staff for these was drawn from Amani, and the Agriculture and Forestry Research Organization scheme was designed to re-absorb them on the expiry of the subsidiary schemes.

Amani was quite unsuitable for development because of its isolation and very steep slopes; nevertheless, the decision to build near Nairobi, because of its central position and accessibility, would have been a costly one, but for the generous action of the Kenya Government in presenting an admirable site of 1,600 acres in the Muguga Forest Reserve, close to Nairobi and accessible in all weathers.

The Colonial Development and Welfare scheme for the Organization is based on a research staff of forty-five at the end of 1957; the intention was to reach thirty-five by the end of 1952, plus the appropriate administrative and scientific-assistant posts. Steeply rising costs have imposed changes in the original scheme. Thus, although the capital expenditure has been increased over the original amount, it cannot provide all the house and hostel accommodation needed, even for the scientific and administrative staff envisaged at the end of 1952. The buildings for administration, and for various common services that are discussed later, will serve adequately for the full original scheme; the laboratory accommodation is, however, insufficient for this, even allowing for some overcrowding. Rising costs have also affected the recurrent part of the scheme, and it will be very difficult to sustain even the establishment of thirty-five research officers; this number has been agreed on as the minimum required for a properly balanced research programme.

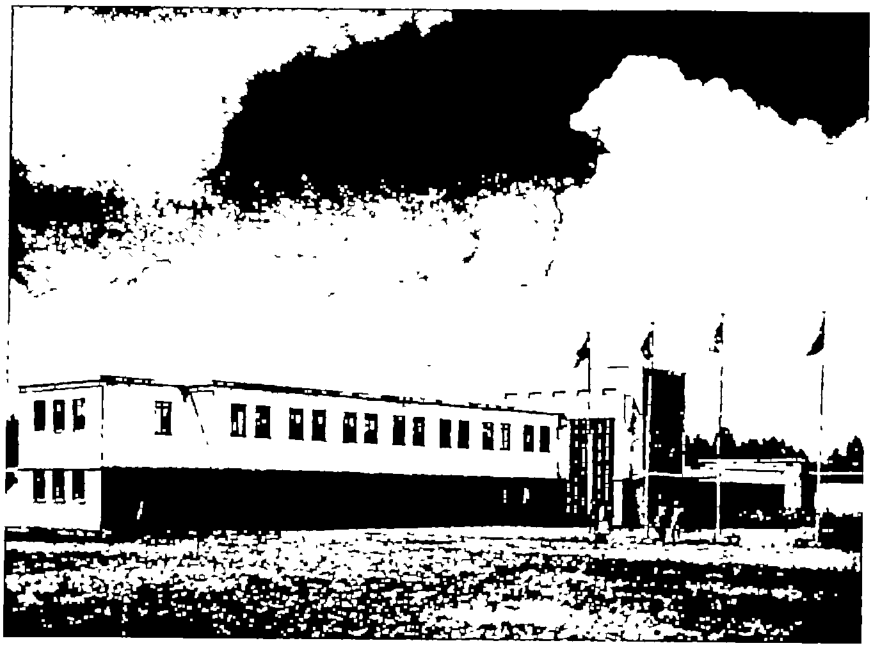

Photo: East African Railways and Harbours, P.O. Box 79, Nairobi

Headquarters building of the East African Agriculture and Forestry Research Organization

The capital grant was £296,000, and was wholly provided by the British Government. One-half of the recurrent costs is also provided from home, and the remaining half is shared in equal proportions by Kenya, Tanganyika and Uganda; Zanzibar also provides a small contribution. The budget for 1951 was about £80,000, so the share of any one territory was less than £14,000.

More than 54 per cent of the capital grant of £296,000 had to be spent on housing and site development items, such as access roads, boreholes, sewage and drainage; in Britain, the great bulk of the cost of these items would not have been incurred. The direct capital expenditure on the Research Organization was as follows:

Laboratories	£34,800
Library	13,000
Administration and offices	21,100
Site works for above	4,700
Workshops and stores	5,200
Equipment	42,800
Animal husbandry (under construction)	14,800
	£134,900

A considerable part of this capital expenditure has been incurred not for the Agriculture and Forestry Research Organization, but for the East African Veterinary Research Organization, in accordance with the declared policy of effecting the closest integration of these two research organizations in all matters of common interest. Thus, there is a joint Division of Animal Husbandry; the library, workshop and services will be common; the General Analysis and the Statistical Sections, although staffed by the Agriculture and Forestry Research Organization, will serve both organizations; one-quarter of the laboratories are for the use of the Veterinary Research Organization; and the administrative offices of both organizations are under the same roof. The administration block also includes, besides offices, the following items: Bureau for Epizootic Diseases; Forestry Bureau; librarian's room, book-binding and library service room, and stack room; rooms for the head of the joint Animal Husbandry Division; the Statistical Section of the Agriculture and Forestry Research Organization; and, finally, a large conference room and ante-room. The laboratories are in three single-story blocks, and there is ample space on the axial line of each block for the orderly placing of auxiliary buildings such as pot-culture and green-houses. Each block consists of six laboratories, 15 ft. × 20 ft., on one side of the corridor; on the other side there are six ancillary laboratories, each 15 ft. × 12 ft., a number of which are subdivided into rooms 7½ ft. × 12 ft., which is a convenient size for balance, washing-up, photographic rooms, etc. The possibility of future re-arrangement was borne in mind, and the laboratory blocks were so designed that none of the transverse walls is weight-bearing. Bench design follows modern practice, with bench legs and laboratory fittings in steel and of unit-design. Substantial economies over the cost of imported bench tops were made by constructing them locally from Mvule (*Chlorophora excelsa*) obtained from the Amani plantations, and by making floor-blocks from the waste pieces. The windows are of plate-glass louvres which provide adjustable ventilation and avoid the casting of inconvenient shadows from window-bars. As the station is nearly on the equator the axial line of the laboratories runs east to west, and further shielding from direct sunlight at varying seasons and times of day is provided by horizontal hoods projecting beyond the windows, and vertical fins between them.

The library has a 6,000-ft. run of shelves, with a maximum shelf height of 7 ft., so that no book is beyond arm's reach. Four study-cubicles have also been provided for the use of those writing reports or theses.

The research programme of the East African Agriculture and Forestry Research Organization, although at present incomplete because of staff shortages, is being worked out in close consultation with the territorial departments and the Colonial Office, so that the regional and Colonial Empire aspects, respectively, are kept under review.

The building-up of the regional programme offers some problems in co-ordination. The specialist officers of agriculture and veterinary services in the territorial departments, and in the 'commodity stations' such as those for coffee and sisal, are already following certain lines of investigation. In addition, there are the research centres of the Empire Cotton Growing Corporation at Namulonge in Uganda, the Overseas Food Corporation in Tanganyika and the recently established Tea Research Institute at Kericho in Kenya.

It is obviously to the general interest that each of these organizations should, when drawing up its own programme, be fully aware of what the others have in mind, and that there should be every opportunity for discussions, especially between those engaged on similar lines of work in different centres. It is, or should be, equally obvious that, in the laudable attempt to secure 'co-ordination of effort and prevention of overlapping'—to use a heavily over-worked phrase—there is much danger of elaborating the administrative organization at the expense of flexibility and freedom of the scientific work. This tendency is likely to arise in regions such as East Africa, where each Colony has its own departments of agriculture, veterinary services and forestry, and where the regional research organizations come under the East Africa High Commission; it may lead, for example, to a particular scientific committee being three or four times larger than necessary or, alternatively, to the formation of three committees where one would serve, plus yet a fourth committee to 'co-ordinate' the other three.

For these reasons every effort is being made in East Africa to develop horizontal contacts (direct communication on scientific matters between opposite numbers) instead of the usual vertical system employed for administration purposes. The arrangements outlined below are tentative and will, no doubt, be improved with experience. The East Africa High Commission has created an Advisory Council for Agriculture, Animal Industry and Forestry, composed of government, technical and unofficial representatives from each Colony, with the directors of the Agriculture and Forestry and Veterinary Research Organizations, and the other non-government research centres already mentioned. This provides a forum for the general discussion of agricultural problems both scientific and practical. The Council is forming an increasing number of specialist committees on specific scientific problems, such as plant breeding, soil survey, insecticides. Their membership consists of a small number of the appropriate research and specialist officers from the research organizations and centres, and from the territories. They review the existing work in their subject and make suggestions for co-ordinating and extending it. They have scientific functions only, with no executive or administrative powers. These latter, and their financial implications, are exercised by the directors of the two Research Organizations and the directors of the territorial departments of agriculture, etc.; here, co-ordination is obviously necessary, and it is achieved by sub-committees consisting of the three directors of agriculture (or veterinary services, or forestry) with the director of the Agriculture and Forestry Research Organization or the Veterinary Research Organization as chairman. For matters such as animal husbandry, the agriculture and veterinary sub-committees meet together. Because these sub-committees have administrative and financial responsibilities they are not responsible to the Advisory Council but to another body, the Research Organization's Committee. This Committee can be regarded as an embryonic governing body for the Agriculture and Forestry Research Organization and the Veterinary Research Organization. It has a small membership: the Members for Agriculture of Kenya and Tanganyika, with a government official from Uganda, which does not have the Member system; one non-official from each territory who is a member of the Central Legislative Assembly of the East Africa High Commission; the directors of the two Research Organizations, and one High Commission officer, with the Administrator—the chief executive officer of the High Commission—as chairman.

It is hoped that, by these means, there will be quick and effective decisions on the scientific aspects of programmes of work, and on the executive and financial aspects as well.

There is one generalization that has guided the developments just described. This is the recognition of the fact that, in general, the sequence between discovery and introduction to practice falls into three phases: first, basic or fundamental research that discloses a new fact or a general principle; second, technological investigations, consisting of a series of systematic experiments to see how the new knowledge is affected by the range of variation within the regional environment; third, the introduction of the results of the second phase into practice. The regional research organizations are, normally, responsible for the first phase, and the territorial departments for the third phase. But both are equally concerned in the second phase, and it is here that effective and economical team-work is achieved between the Research Organizations and the territorial departments.

UNSTABLE PLANETARY CONFIGURATIONS

By Dr. W. H. RAMSEY

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THE present article describes a new type of planetary instability which arises in connexion with the theory of the internal structure of the earth which I have developed[1]. I attribute the sharp core discontinuity at about half-way to the centre of the earth, at which the density almost doubles[2], to a phase transition under pressure. This is in contrast to the older view that the core is iron which has separated under gravity from the less dense silicates of the surrounding mantle. In the new theory, the enormous pressure of 1·4 million atmospheres at the boundary of the core is presumed to have partially destroyed the molecular structure of olivine, the principal constituent of the mantle. The olivine in the mantle has the familiar ionic structure; in the core it is in a dense metallic state. In an ordinary polymorphic transition, in which the molecules are merely rearranged into a different crystal structure, the density changes by only a few per cent. But in a transition to a metallic phase, in which the molecules themselves are partially destroyed, the increase in density will be of the order of 100 per cent.

The transition of a non-metal to a metallic phase is not a common occurrence in the laboratory. Usually a pressure of the order of a million atmospheres is necessary to make a non-metal metallic, and the highest pressure so far attained is only 100,000 atmospheres. But both metallic and non-metallic modifications of a few elements exist under laboratory conditions; examples are white and grey tin, metallic and yellow arsenic, black and yellow phosphorus. The metallic modification is always considerably denser; metallic arsenic is more than 2·5 times as dense as the yellow allotrope. The new interpretation of the core in terms of a phase transition is compatible with all seismic evidence of the earth's internal structure, and it accounts for some features not previously explained.

The new theory receives considerable support from the observed mean densities of the terrestrial planets. Jeffreys[2] has shown that, on the iron core hypothesis, the terrestrial planets have different chemical compositions; the smaller planets have relatively smaller cores, and so smaller proportions of iron. This is difficult, if not impossible, to reconcile with the planets having a common origin. The difficulty is removed by the new interpretation of the core. The new theory, together with the assumptions current in geophysics, implies that the variation in density within the earth is due mainly to the influence of pressure and not to changes in chemical composition. It is true that the crust contains a number of chemically distinct layers, but they account for only one per cent of the total mass. The pressure – density relationship for the material of the earth, which can be derived from seismic data[3], has been used to compute the mean densities of smaller planets of similar composition. It is found that all the terrestrial planets have the same chemical composition[1]. The smaller planets have smaller cores because of their smaller central pressures; and in the smallest planets, Mars and Mercury, the pressures are too low to support a core.

In the course of these calculations on the terrestrial planets, it was found that the smallest planetary cores are unstable and so would not occur in Nature. This feature is a direct consequence of the main assumption underlying the calculations, namely, that the jump in density at the boundary of the core is controlled by pressure. This phenomenon, which has recently been examined in some detail by Lighthill[4] and myself[5], may have played a significant part in the evolution of the solar system. To illustrate the effect, I have made calculations[5] on planets composed of a material which has a constant density ρ_0 at all pressures below a critical pressure p_c, and a constant density $\lambda\rho_0$, which is greater than ρ_0, at all higher pressures; in other words, both phases of the material are assumed to be incompressible. The central pressure always specifies the planetary configuration unambiguously; that is, the central pressure determines uniquely the mass and radius of the planet and the radius of its core. The radius of the core is necessarily an increasing function of the central pressure. But, for very small cores, the mass and radius of the planet are decreasing functions of the central pressure if the density jump at the boundary of the core exceeds 50 per cent (that is, if $\lambda > \frac{3}{2}$). The relationship between the mass M of the planet and the central pressure is illustrated in Fig. 1; the behaviour of the total radius is qualitatively similar. The mass M is a continually increasing function of the central pressure if the parameter λ does not exceed $\frac{3}{2}$; any planet of given mass has therefore only one possible equilibrium configuration. But if λ exceeds $\frac{3}{2}$, a mass M in a certain critical range

$$M_1 < M < M_0 \qquad (1)$$

is compatible with three different planetary configurations, denoted by A, B and C in the diagram. Configuration A has no core, and B has a smaller core than C. In general, the three configurations have different total radii and different degrees of stability.

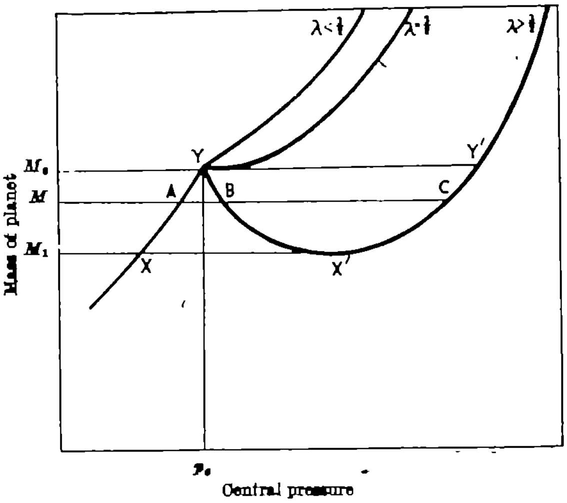

Fig. 1. Behaviour of the mass M of a planet as a function of the central pressure

Lighthill[4] has extended these considerations to the general case of planets composed of a material the density of which is a continuous function of the pressure up to a critical pressure p_c, and at the critical pressure the density is assumed to jump discontinuously from ρ_0 to $\lambda\rho_0$. Lighthill has shown that the derivative (dM/dP) of the mass of the planet with respect to the central pressure P changes discontinuously by a factor

$$(3 - 2\lambda)/\lambda^2 \qquad (2)$$

when the central pressure is equal to the critical pressure p_c. The derivative with respect to P of any other bulk characteristic, such as the radius of the planet, changes by the same factor. This factor is positive if λ does not exceed $\frac{3}{2}$, and so the mass M is a continually increasing function of the central pressure as shown in Fig. 1. But the factor (2) is negative if λ exceeds $\frac{3}{2}$, so that (dM/dP) changes sign. As the mass M cannot decrease with P indefinitely, the behaviour must be qualitatively as shown in Fig. 1. The earlier considerations therefore apply also in the general case of a compressible material. Using Bullen's[3] estimate of the density distribution within the earth, it is found by numerical integration that the planet with its centre at the critical pressure has the following mass and radius:

$$M_0 = 0{\cdot}80\, M_E, \qquad R_0 = 6{,}300 \text{ km.}, \qquad (3)$$

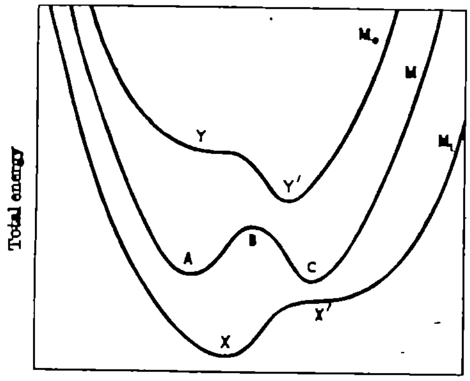

Fig. 2. Energy of a planet as a function of its total radius

M_E being the mass of the earth. The mass range $(M_0 - M_1)$, in which a planet has three possible equilibrium configurations, is only about 0·02 M_E. The total radii of different configurations of the same planet may differ by more than 100 km.

Fig. 2 shows schematically the energy of a planet as a function of its total radius; the letters A, B, etc., refer to the same equilibrium configurations as in Fig. 1. The middle curve refers to a general mass in the interval (1). Configurations A and C with minimum energies are stable; A has no core, and C has a large core. All configurations with small cores are of type B and are unstable; a small disturbance will cause a transition to either A or C. It is estimated that for stability the core of a terrestrial planet must be at least 1,000 km. in radius. For this reason the phenomenon is referred to as "the instability of small planetary cores". The top and bottom curves in Fig. 2 refer to the masses M_0 and M_1, which are special cases. For these masses a maximum and a minimum in the energy diagram coalesce to give a point of inflexion, and there is only one stable configuration for each mass. For mass M_0 the stable configuration is Y', which has a core; for mass M_1 the stable configuration is X, which has no core. The total energy of the stable configuration C with a core may be greater than or less than that of configuration A without a core, depending on the mass of the planet. The difference in energy between the two stable configurations is greatest near the ends of the critical mass range (1), that is, for masses near M_0 and M_1. The energy difference is estimated to be 10^{36}–10^{37} ergs—sufficient to remove from the surface of the planet a mass between 0·001 M_E and 0·01 M_E. Earthquakes release about 10^{25} ergs per year, and an atomic bomb about 10^{21} ergs. Thus if a planet were to undergo a transition from one configuration to another, the energy released would be enormous by ordinary standards. The transition would take minutes, or at most hours, and the energy released in this brief period would exceed that released by earthquakes during the whole of geological time. The energy liberated is always partly in the form of vibrations of the planet as a whole, but in some transitions a large fraction of the energy goes into blast waves. These blast waves, the pressure amplitude of which will be hundreds of thousands of atmospheres, will travel through the planet to the outer surface. The material on the surface will be shattered by the sudden impact of such large pressures, and fragments may fly off the planet into space. The mass of material removed may be of the order of 0·001 M_E. It is tentatively suggested that this mechanism may have been responsible for meteorites, and possibly also for the asteroids.

A planetary transition of the type envisaged will occur if the planet's mass M crosses the critical range (M_0, M_1) in either direction. The planet's mass could have changed gradually due to the aggregation of material or to the loss of light elements, depending on the mode of formation of the solar system. Alternatively, a planet could cross the critical range because of changes in the critical masses M_0 and M_1, which are functions of the internal temperature of the planet; a reasonable change in temperature could alter the critical masses by 10 per cent, and the mass of Venus is only 2 per cent greater than M_0. A planet must acquire a core if it crosses the critical mass range (1) in one direction, and it must lose its core if it crosses in the opposite direction. The core must be large at formation or disappearance since small cores are unstable; the planet must therefore undergo a transition of the type described. Venus and the earth may have undergone such transitions. The idea of an 'exploded planet' is an old one, but this mechanism makes an 'explosion' plausible for the first time. The irregular shapes and rough surfaces of the asteroids suggest that they have originated in this way. Meteorites also seem to be fragments of an 'exploded planet'. Local chemical separations, such as are apparent in stony meteorites and are necessary to account for iron meteorites, could only have occurred in a planet. In my opinion, the material of the earth below the crustal layers probably consists of ultrabasic rock with pockets of iron, such as would correspond to a representative mixture of all meteorites. Brown and Patterson[6] have recently advanced strong chemical evidence that meteorites were formed at high pressures, such as would occur in the central regions of a small planet or in the outer layers of Venus or the earth.

The present theory differs in one important respect from the old concept of an 'exploded planet'; the material removed is representative of the surface layers and not necessarily of the whole planet. Meteorites are not, of course, of the same chemical composition as surface rocks; but the transition envisaged would occur before the interior became quiescent, and so before the formation of a crust. As regards radioactivity, meteorites may be abnormal if they have originated from the surface layers of a planet; the earth's radioactivity is largely concentrated in the outer 50 km. There is circumstantial evidence that the radioactive content of meteorites is an order of magnitude greater than that of the earth as a whole.

Bullen[7] has suggested that the phenomenon under discussion may have a bearing on the origin of the moon. He reconsiders the old theory in which the moon is supposed to have been torn from the earth by a resonance tidal action of the sun. This theory has been in disrepute since Jeffreys[8] pointed out that internal damping would prevent the necessary build-up of amplitude. Bullen proposes that the function of the tidal resonance is primarily to induce a planetary transition of the type C to A in Figs. 1 and 2. He assumes that the primitive earth-moon body, due to its higher central pressure, contained within the central core another and denser core. This additional core disappeared when the moon was formed, and its disappearance released the energy necessary to separate the moon from the earth. It is highly desirable that this idea be examined quantitatively.

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[4] Lighthill, M. J., *Mon. Not. Roy. Astro. Soc.*, 110, 339 (1951).

[5] Ramsey, W. H., *Mon. Not. Roy. Astro. Soc.*, 110, 325 (1951).

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OBITUARIES

Academician S. I. Vavilov

THE death of S. I. Vavilov at the age of sixty, which occurred on January 25 of this year, was a heavy loss to science in the Soviet Union, for he was not only a great man of science but, even more, one of the founders of science in his country.

Vavilov entered the University of Moscow in 1909 and worked under F. N. Lebedev, whose researches on the physics of light absorption were to furnish the theme of Vavilov's scientific career. His first paper, on "The Effect of Heat on the Fading of Dyestuffs", was written before he left the University in 1914 with other members of the staff and students as a protest against police persecution in the University. After a period of war service, in which he worked on radio physics, Vavilov found himself one of the small band of trained physicists, not more than forty in number, with the immense task of building up physical teaching, research and application in the new Soviet Republic. He managed to combine this with the furtherance of his own research in the field of physical optics. The chief contribution was embodied in some hundred papers on fluorescence and phosphorescence of dyestuff molecules. He elucidated, by a combination of experimental and theoretical study, the laws governing the quantum yield of fluorescence, the maintenance of excited states, particularly at low temperatures, and the explanation of impurity quenching, and self-quenching of fluorescence. This work, which linked with that of Frank and Pringsheim, he summed up in a paper in 1945[1] and in a semi-popular book, "The Microstructure of Light"[2]. His study of fluorescence led him into the field of the physiology of vision, especially in the quantum effects that can actually be observed at very low light intensities. He was also, in his latter years, largely responsible for the study of the 'shock wave' radiation from electrons moving faster than the speed of light in the medium through which they pass.

Vavilov's scientific work was always closely linked with that of the organization of research. Before 1917, Russia had imported practically all optical apparatus from abroad, largely from Germany. It was then decided to build up a State Optical Institute in Leningrad, where research and development were to lead into full-scale production. Vavilov played a major part in the building up of the Institute and, in particular, in establishing the production of fluorescent lighting.

These activities by no means used up all his intellectual capacity. Indeed, it was from them that he acquired an intimate knowledge and practical experience of the relation of science to social needs. He showed this first in his studies on the history of science; British readers will remember his contribution to the Newton tercentenary, where he threw new light on Newton's atomism and its intimate connexion with optics and chemistry[3]. He had also thought profoundly on the philosophy of physical science[4], particularly of the factors that led to the twentieth-century revolution in physics, which he attributed in the first place to Maxwell's use of mathematical hypotheses. On the practical side, his wide understanding qualified him first to contribute to and ultimately, as president of the Academy, in 1945 to co-ordinate and direct the work of Soviet scientists in the solution of the great practical problems involved in transforming the economy of the country. He was a deputy both to the Russian and Union Supreme Soviets, and his advice was taken in all problems involving science[5,6]. In the international field, despite all difficulties, he was always a firm supporter of the need for the co-operation of scientific workers of all countries in building a peaceful world.

Vavilov as a man had a quiet dignity. He did not impose himself on others but commanded respect by the rationality of his judgments and the integrity of his character. His death in harness was probably due to overwork; but he had already contributed more than his share to his country. He will be counted with Lomonosov as one of the great builders of science in the U.S.S.R.

J. D. BERNAL

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[3] Vavilov, S. I., "Newton and the Atomic Theory", in "Newton Tercentenary Celebrations", 43 (Cambridge, 1947).

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[5] "Soviet Science in the New Five Year Plan" (based on a lecture by S. I. Vavilov), *Anglo-Soviet Journal*, 8, No. 2, 5 (winter, 1947).

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Dr. K. C. Bailey

DR. KENNETH CLAUDE BAILEY was born in 1896 and educated at St. Andrew's College, Dublin. He entered the University of Dublin in 1913, where he immediately earned fame by taking, when still only a junior freshman, first place in the examination for classical scholarships, an honour which is usually obtained only by men of senior freshman or junior sophister standing. The First World War, in which he served from 1915 until 1919, interrupted his academic career, and when he returned to Trinity College after demobilization he continued his classical course and also commenced to study experimental science. In 1921 he obtained brilliant degrees in both these subjects, and afterwards worked for about a year in the University of Toulouse under Prof. Sabatier, where he obtained a doctorate in science. A few years after his return to Trinity College as lecturer in chemistry he was elected in 1926 to a fellowship, which he continued to hold until his death.

He married in 1923 Miss Dorothy Lavelle, who is also a science graduate of the University of Dublin, where their only child, Miss Pauline Bailey, is now studying medicine.

In the space available it is quite impossible to give any adequate picture of Dr. Bailey's multitudinous activities since 1926. It may be said that his principal public interests were mainly threefold, embracing chemistry, classics, and the administration of the affairs of Trinity College, Dublin. In all three he did notable and memorable work.

His reputation as a chemist will probably rest on his work on the inhibition of chemical reactions, on which he contributed a long series of papers to the scientific publications of the Chemical Society, the Royal Irish Academy, the Royal Dublin Society, and others. In 1937 he published his book, "The Retardation of Chemical Reactions", which appears to be the first general treatment of this subject that had appeared in any language. It represents the experimental and literary research of more than a decade. Its thoroughness can be judged from the fact that the bibliography alone contains some 1,600 references to original papers. He intended to publish a second edition, and had done most of the preliminary spade-work, but unfortunately his other occupations postponed the fulfilment of this intention, and owing to this occurrence chemical science is undoubtedly the poorer. During the Second World War he assisted the Irish Emergency Research Bureau in its attempt to alleviate the local shortage of certain essential materials. Among other problems, he worked out the details of the production of potassium chlorate, needed for the match industry, from sodium chloride and kelp. This process was eventually developed on a fairly large scale towards the end of the War.

On the classical side, Bailey published two books, the titles being "The Elder Pliny's Chapters on Chemical Subjects", and "Etymological Dictionary of Chemistry and Mineralogy", in the latter of which his wife, Dr. Dorothy Bailey, collaborated. He was also greatly interested in the development and history of chemistry, and wrote several articles on these subjects for various journals.

It might be thought that with his teaching duties as lecturer, and later as professor of physical chemistry, and the quantity of original work he produced, Bailey would have found little time for administrative duties. This, however, is far from true. He held the onerous and rather thankless post of Junior Dean of Trinity College for a period of eleven years, a term of office which has only once been exceeded in length during the history of the College. He was a member of the Board of the College for twenty years, first as a representative of the Junior Fellows, and since 1942 as registrar. During this period he was instrumental in introducing several excellent reforms. It is perhaps a pity, from the scientific point of view, that his duties as registrar very largely curtailed his original chemical research work after 1942, although he continued to lecture in the Chemical School until his retirement, due to ill-health, in October 1950. He did, however, find time to write an interesting and very readable volume entitled "The History of Trinity College Dublin from 1892 to 1945" during his later years.

Of Bailey's personal characteristics one finds it hard to write. He was always the most pleasant and courteous of colleagues, always ready to help in any problem proposed to him. As might be expected from a man of his calibre, he held very definite views on many subjects; but he was never dictatorial in expressing them, and always willing to listen to contrary opinions.

Trinity College, Dublin, may long and truly mourn

> "A man so various, that he seem'd to be
> Not one but all mankind's epitome".

J. H. J. Poole

NEWS and VIEWS

Zoology at University College, London : Prof. D. M. S. Watson, F.R.S.

The new term has begun at University College, London, without the official attendance of this distinguished zoologist. It was in 1912 that Mr. David Watson joined the College staff after a brilliant student career at the University of Manchester. Already he was the author of papers to which reference is still made. From that date until 1921 he was lecturer in vertebrate palæontology. He was absent, it is true, during part of the First World War as a lieutenant in the R.N.V.R.; but even there his palæontology was not forgotten, and he was largely responsible for the design of a pterodactyl type of aircraft that later was to take the air. In 1921 he succeeded Prof. J. P. Hill in the Jodrell chair of zoology and comparative anatomy at University College. There he has created not only a school of zoology, but also has attracted numbers of graduate students in zoology and palæontology who have themselves gone to chairs of zoology or geology. Some years before the Second World War he had the task of remodelling commercial premises to his departmental purposes in the Malet Place buildings of the College.

During these arduous and fruitful years Prof. Watson has also made opportunities for world-wide travel and for collecting expeditions in which he has visited Canada, the United States, South Africa, the Soviet Union, Scandinavia and Ceylon, and he has visited every site of importance to vertebrate palæontology in Great Britain. His many contributions to the study of fossil fishes, on the origin and development of the amphibians, and on many groups of fossil reptiles are too well known to need comment here. These, with his ease and clarity as a lecturer, have made him welcome in many assemblies and conferences. Among his many honours is the Darwin Medal of the Royal Society. Since the War he has been a trustee of the British Museum. Prof. Watson was sixty-five on June 18 and the event was celebrated in his department with a tea-party, when he was presented with an album of photographs and signatures of many of his friends, pupils and admirers from all over the world. His last term of office was clouded by an illness. Happily he has recovered his full vigour and will continue his researches in the familiar surroundings of University College. His friends and colleagues will wish him many happy years of work, and pleasure in his library and his collection of Oriental art. Prof. Watson has been succeeded by Prof. P. B. S. Medawar, Mason professor of zoology in the University of Birmingham (see *Nature*, 160, 14; 1947).

Television in the North of England

The scheme of the British Broadcasting Corporation for establishing television on a nation-wide basis moved another step forward on October 12, when the North of England station at Holme Moss was opened for public service by Lord Simon of Wythenshawe, chairman of the governors of the

Corporation. In order to cover the greatest possible area in the central and southern portions of the North of England, the site of the Holme Moss station was chosen in a very high and isolated region some sixteen miles east-north-east of Manchester. The altitude of the site is 1,700 ft.; and this, with the mast, which is similar to that of the station at Sutton Coldfield, Birmingham, results in the height of the aerial being some 2,450 ft. above sea-level. The carrier frequencies of the vision and sound transmitters are 51·75 and 48·25 Mc./s., and the corresponding powers are 45 and 12 kW., respectively. The resulting range for good and reliable reception is expected to be between fifty and seventy miles, depending upon local conditions and the nature of the intervening terrain. It has already been reported that the opening programme was received clearly in North Wales at a distance of about eighty miles.

Due to the exposed position, special precautions have been taken in the design of the buildings and the mast to ensure that they will stand up to the severe blizzards and gales which will almost certainly be experienced during most winters. The task of maintaining and operating the station will not be easy or pleasant; and arrangements have been made for the staff to live on the station when access becomes difficult or impossible owing to snow and ice. The Holme Moss transmitter is connected to the Birmingham and London television stations by a special coaxial cable installed by the General Post Office. This cable transmits programmes in either direction as required; and it provided a very satisfactory means of viewing, in the London area, the inaugural ceremony of the new station in the Manchester Town Hall, and a programme from the Theatre Royal, Leeds, on the following evening.

Thousandth Issue of *The Practitioner*

First published in 1868, *The Practitioner* has celebrated its thousandth issue (vol. 167, October 1951), providing, in addition to its usual features, thirteen valuable articles on advances in various aspects of medicine and surgery. All these articles are written by distinguished specialists in the fields they cover. There is also an article by Sir Henry Dale entitled "The Changing Face of Medicine, 1868–1951", another by Sir Henry Bashford on "The Social Background of Medicine" and a third by Dr. W. N. Pickles entitled "Trends of General Practice: a Hundred Years in a Yorkshire Dale". The whole issue thus constitutes an epitome of the immense advances that have been made in the past hundred years or so, and it worthily enshrines the very great benefits that medicine has conferred upon us during this period. In these benefits the animals, especially the domesticated animals, have shared, and one of the inspiring trends, not specifically noticed in these pages, is the increasing co-operation between the medical and veterinary professions. It is impossible to select from so many excellent articles any that are more valuable than the others. The layman will find a great deal that will interest and encourage him in the three papers already mentioned; Dr. Pickles, in his sketch of three generations of practitioners, re-creates for us that great and tireless 'guide, philosopher and friend', the general practitioner of an age that many readers will know only in literature. *The Practitioner* has proved, with this issue, that it is as vigorous and progressive as it has ever been, and it would not be easy to find, for any scientific journal, contributors more skilled in the art of explaining, pleasantly and effectively, the intricate matters that are the busy medical practitioner's everyday concern.

Institute of Metal Finishing

The Council of the Electrodepositors' Technical Society announces that application for official incorporation has now been granted; also permission has been given for the adoption of a new title embracing metal finishing generally (excluding only vitreous enamelling). This is in accordance with the general policy of the Society to extend its field beyond electrodeposition processes to include metal finishing generally, with which the bulk of its members are vitally concerned. The new title by which the Society will henceforth be known is 'The Institute of Metal Finishing incorporating Electrodepositors' Technical Society Limited'. The original aims and objects of the Society, namely, to promote the study of, and disseminate information on, electrodeposition and cognate processes as widely as possible, are in no way affected by these changes. The sphere of interest has now been significantly widened and the Council is of the opinion that this will bring with it corresponding benefit to the membership. The executive officers and Council of the Electrodepositors' Technical Society have become the officers of the new Institute. The present executive officers are: *President*, Mr. H. Silman; *Honorary Secretary*, Dr. S. Wernick; and *Honorary Treasurer*, Mr. F. L. James. The headquarters of the Institute are at the Northampton Polytechnic, St. John Street, London, E.C.1; all communications should be addressed to the Honorary Secretary at 27 Islington High Street, London, N.1.

Agricultural Research Council: Potato Genetics Station

The Commonwealth Potato Collection, Huntingdon Road, Cambridge, which was formerly a responsibility of the Commonwealth Agricultural Bureaux, has recently been transferred by agreement to the control of the Agricultural Research Council and will in future be known as the Potato Genetics Station. In 1939 the Commonwealth Agricultural Bureaux organized an expedition to Mexico and South America to collect varieties of wild and cultivated potatoes in their native home; and the collection based on the samples brought back has been housed since 1945 in a building erected, through the generous financial assistance of the Nuffield Foundation, on a site provided free of cost by the University of Cambridge. In the past ten years, description and classification of the collection have been completed, and the reactions of the material to certain virus diseases, eelworm, late blight, wart, frost and other factors have been studied. Some work on the chemical content of tubers has been carried out, but much remains to be done. This comprehensive collection would seem to offer valuable material for comparative biochemical studies in a vegetatively propagated crop plant. Students in several Commonwealth countries co-operated in this first phase of the work, and material has been widely distributed for the use of potato breeders at home and overseas.

The change in administrative responsibility marks the beginning of a second phase of development, in which the collection will be used mainly for genetic research. The programme includes studies of resistance to various diseases, with a view to the synthesis of lines for the potato breeder, and investigation of the general problems of genetical history and differentiation in the tuberous species of *Solanum*. The valuable research material that has been assembled will thus continue to be used to the ultimate advantage of the potato industry. The Potato Genetics Station is under the direction of Dr. K. S. Dodds.

Acustica: A New International Journal

The first two numbers have recently appeared of *Acustica* (Zurich: Hirzel-Verlag, 1951; 36 Swiss francs a year), a new international journal sponsored by the Acoustics Group of the Physical Society of London. There have been previous attempts to start national acoustical journals in both France and Germany, but neither of these survived the Second World War. In recent years hopes have been expressed for a revival of these and for the setting-up of a journal in English on the eastern side of the Atlantic, sponsored by the respective groups of scientific workers and technicians interested in acoustics. Eventually it was decided to combine these efforts and to found a journal which should publish articles received in English, French or German of any origin but particularly those coming from European countries and from countries associated therewith, such as the British Commonwealth. Dr. C. W. Kosten, of Delft, was appointed editor-in-chief, and Dr. E. G. Richardson, of King's College, Newcastle upon Tyne, is the editor for papers submitted in the English language. *Acustica* will appear six times a year and will publish from time to time additional one-language supplements under subvention by one or other of the national groups. (One such supplement, in German, has already appeared.) For the main journal, up to the present more papers have been received in English than in any other language, but those printed in the first two issues include some in all three languages. Between them they cover the subjects of building acoustics, subjective sound, musical acoustics, ultrasonics, loud-speakers and the history of sound. It is indeed the aim of the editors that fundamental, and not only technological, aspects of sound shall be well represented in the journal.

Study of the Arthropod Mandible

It is generally accepted that the mandibles of an arthropod have evolved from a pair of limbs in a primitive ancestral form, though precisely which part or parts of the limb is involved is still a subject of discussion. The typical, primitive arthropod limb consisted of a basal coxopodite or coxa and a distal segmented telopodite. The coxa was articulated dorsally on the tergum and ventrally on the sternum, and the limb was moved antero-posteriorly probably by a pair of dorsal muscles originating from the tergum and a pair of ventral muscles originating from the sternum or an endophragmal projection therefrom. These muscles may be termed the dorsal promotor and remotor and the ventral promotor and remotor, respectively. A change in the position of the points of articulation or in the places of origin of the muscles or both would, of course, bring about a change in the direction of movement of the limb. Starting with these quite reasonable assumptions, R. E. Snodgrass has carried out a most interesting series of "Comparative Studies on the Jaws of Mandibulate Arthropods" (Smithsonian Misc. Coll., 116, No. 1; pp. 85. Washington, D.C.: Smithsonian Institution, 1950). He points out that in many Entomostraca, some Malacostraca and the Machilidae, the mandible most clearly resembles this idealized coxa in structure and musculature, bearing in mind that there is no sternum as its place is occupied by the mouth. The work traces the various modifications and specializations that are to be found in all groups of mandibulate arthropods. The text is illustrated with twenty-five text-figures and the majority of these have seven or eight individual diagrams.

Annual Conference of Aslib

In what circumstances are mechanized aids quicker or slower than human beings in selecting information from a wealth of coded material? Can the flow of work in a library be usefully compared with that in a process plant when planning layout? Would the use of intelligence and aptitude tests help in choosing a better information officer? These are typical of the questions raised at the twenty-sixth annual conference of Aslib held during October 5–8 at Ashorne Hill, the conference centre of the Iron and Steel Corporation near Leamington Spa, and attended by nearly two hundred and fifty delegates. The theme of the conference was 'design for efficiency'. The particular fields in which problems of increasing efficiency were studied were: international bibliography; optimum use of staff and training the user; and the future development of Aslib. The formation of subject groups within the framework of Aslib in the fields of aeronautics, food and agriculture, textiles and economics stimulated lively discussion. Some constructive co-operative plans for rationalization in the purchase, listing and loan of periodicals, for exchange of staff, and for translation have already been initiated. In the sessions on choosing, training and directing staff, and on training and directing the (unchosen) user, scientific and statistical methods of assessing the problems attracted the interest of delegates. It was noticeable that attempts to measure the capabilities of persons and the efficiency of processes are increasing. Unesco's efforts to stimulate the development of bibliographical services in under-developed areas and to tidy up the existing services elsewhere were described in a paper submitted by the head of the Libraries Division of Unesco. Added interest was provided in this session by contributions both from members of the Organization for European Economic Co-operation (O.E.E.C.) mission at present touring Europe to study technical information services, and also from delegates recently returned from the Conference of the Fédération Internationale de Documentation in Rome. The Conference not only provided the usual stimulus of contacts between specialists, but also raised problems that may be profitably pursued by smaller groups in the future.

University of Birmingham

The following appointments have recently been made in the University of Birmingham: P. J. Palmer, formerly of the Boulton Paul Aircraft Co., to be lecturer in civil engineering; J. H. O. Varley, to be lecturer in metallurgy. The following resignations from the University have been announced: Dr. E. S. Twyman, lecturer in botany, on appointment as professor of botany in Rhodes University, Grahamstown; W. S. Norman, lecturer in chemical engineering, on appointment as lecturer in chemical engineering in University College, London; Dr. A. J. Wilson, lecturer in mechanical engineering, on appointment to the Metals Division of Imperial Chemical Industries, Ltd.; Dr. Mary Gregg, lecturer in botany, on appointment as lecturer in botany in University

College, Dublin; Dr. Vera Norris, senior statistical officer in the Department of Medical Statistics, on appointment as medical statistician at the Maudsley Hospital, University of London.

Postgraduate Agricultural Scholarship Awards

THE Ministry of Agriculture and Fisheries has awarded postgraduate research and training scholarships in the following subjects, tenable in the first instance at the university or institute shown for periods up to three years from September 1, or later. *Agricultural Economics:* E. A. Attwood, School of Agriculture, Cambridge; and K. C. Abercrombie, P. N. Barker, S. A. Bradburn, A. A. Marsh, J. D. Sykes and Miss F. R. Walker, Agricultural Economics Research Institute, Oxford. *Agricultural Engineering:* P. R. Attwood, D. P. Blight, D. J. B. Calverley, A. J. Crowther, J. L. Manson, W. T. B. Marchant, J. J. Thomas and M. A. Keech, King's College, Newcastle upon Tyne. *Husbandry:* A. J. Abbott, W. H. Broster, S. C. Meadowcroft, P. Radford, K. W. G. Shillam and Miss J. P. Tibbitts, University of Reading; D. Archer and R. J. Colley, University of Leeds; B. F. Bland, A. W. Court, F. K. Deeble, B. C. Knight and R. P. Voelcker, School of Agriculture, Cambridge; Miss D. E. Fisher, University of Nottingham; J. Sherwell and B. R. Watkin, Wye College, University of London; and J. G. Watkin Jones, Rowett Research Institute, Aberdeen. *Agricultural Statistics:* Miss A. W. Boyes, University of Oxford; and F. R. Latham, University of Manchester.

Commonwealth Fund Fellowships for Study in the United States

THE Commonwealth Fund of New York (41 East 57th Street, New York 22) is again offering a number of Commonwealth Fund fellowships to British subjects for study and travel in the United States. The fellowships provide for all expenses of travel, study and living, with some adjustment for married men with families. The fellowships, which are open to British men or women who are not normally resident in or near the Americas and who have not previously worked or studied for more than a few months in the United States, are offered annually in six categories as follows. *Ordinary:* twenty fellowships to graduates of a university in the United Kingdom of Great Britain and Northern Ireland. Candidates must be available in London for interview in March 1952; age, 23–35; tenure, 12–21 months; applications by December 15. *Home Civil Service:* five fellowships to permanent members in the higher ranks of the Civil Service in Great Britain, three for the administrative grades and two for the scientific and professional grades. Age, less than 40; tenure, 6–12 months; applications by December 31 to the Treasury. *Dominion Civil Service:* five fellowships to Civil servants in the Governments of Australia, New Zealand and South Africa. Age, less than 40; tenure, 12–21 months; applications by February 1. *Colonial Civil Service:* two fellowships to Civil servants in the Governments of the British Colonies, Protectorates, and Trust Territories. Age, less than 40; tenure, 12–21 months; applications by December 31 to the Colonial Office, London. *Journalism:* three fellowships to journalists practising in the United Kingdom and engaged on the opinion-making or broadly editorial side of their profession. Age, 23–35; tenure, 9–15 months; applications by January 1, 1952. *American Studies:* four fellowships will be available to faculty members appointed to or holding posts in American studies in universities in the United Kingdom, candidates to be nominated by their universities; tenure, 4–12 months; these fellowships are not limited by previous study in the United States. Application forms and further details of these fellowships can be obtained through British universities or through government departments, or from the Warden, Harkness House, 35 Portman Square, London, W.1.

Announcements

H.R.H. the Duke of Edinburgh has been elected an honorary member of the British Institution of Radio Engineers.

THE Franklin Medal, the highest honour given by the Franklin Institute, Philadelphia, has been awarded to Sir James Chadwick, master of Gonville and Caius College, Cambridge, for his work in nuclear physics.

PROF. P. TH. OOSTERHOFF, Sterrewacht, Leyden, has been appointed assistant general secretary of the International Astronomical Union. Prof. Bengt Strömgren remains general secretary of the Union.

THE Committee of the Privy Council for Agricultural Research and Nature Conservation has reappointed Sir Alan Drury, Director of the Lister Institute, to the Agricultural Research Council for a further term, and has also appointed Prof. S. J. Watson, professor of agriculture and rural economy in the University of Edinburgh, to fill the vacancy caused by the retirement from the Council, on completion of his term of office, of Prof. T. J. Mackie.

THE following appointments have been announced from the University of London: Dr. Ruth Bowden, to the University chair of anatomy tenable at the Royal Free Hospital School of Medicine; Dr. R. J. Harrison, to be head of the Department of Anatomy at the London Hospital Medical College, with the title of reader in anatomy in the University in respect of this post.

THE Société Française de Métallurgie will be holding a series of autumn sessions during October 22–27 at the Centre Marcelin Berthelot, Maison de la Chimie, 28^{bis} rue St. Dominique, Paris 7^{e}. On each day papers will be read on a number of metallurgical topics. Further details can be obtained from the Society at 5 Cité Pigalle, Paris 9^{e}.

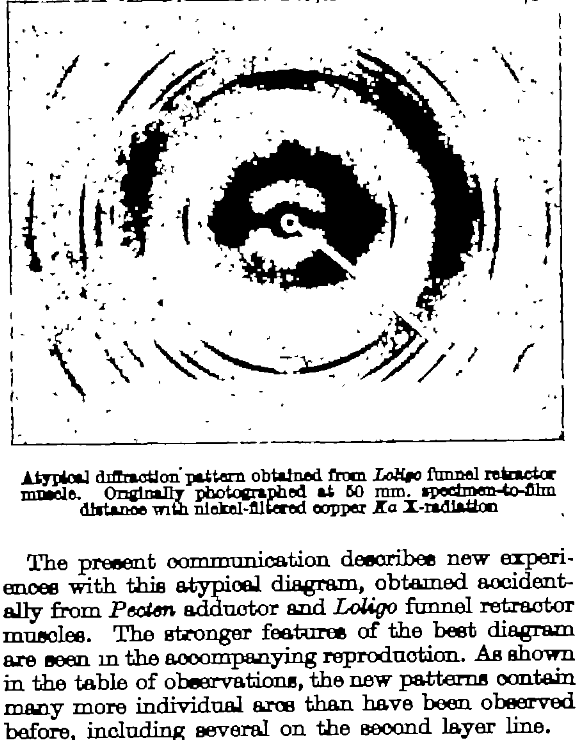
THE British Standards Institution has recently published "Methods for the Analysis of Soaps" (B.S. 1715: 1951. Pp. 42; London: British Standards Institution, 1951; 5*s*. net). This document gives both the British Standard methods and also the methods of the International Commission for the study of fats. Full details of the analytical methods and of any special apparatus required are outlined.

THREE textile research fellowships have been created by the Commonwealth Scientific and Industrial Research Organization to enable research men trained in physics, chemistry or engineering to obtain special experience in textile science in the United Kingdom. The fellowships are being financed from money made available by the Associated Woollen and Worsted Textile Manufacturers of Australia. Fellows will be appointed for twelve months. They will receive a salary of £A1,000 per annum, plus travelling expenses. Further details can be obtained from the Secretary, C.S.I.R.O., 314 Albert Street, East Melbourne.

THE 'LOTMAR-PICKEN' X-RAY DIFFRACTION DIAGRAM OF MUSCLE

By Prof. RICHARD S. BEAR and Dr. CECILY M. M. CANNAN
Department of Biology, Massachusetts Institute of Technology, Cambridge, Mass.

MUSCLE specimens normally yield the α-type of X-ray diffraction at wide angles[1]; but on rare occasions another pattern is obtained exhibiting characteristics of an oriented, highly crystalline substance[2,3]. Assuming this to be a protein derived from a fibrous component of muscle, Lotmar and Picken[3] developed a detailed structure which has been widely discussed. Because of lack of reproducibility, confirmation of their conclusions has not been readily possible, and the suggestion that the Lotmar-Picken substance is protein has already been questioned[4]. Nevertheless, Pauling and Corey[5] have also recently used the Lotmar-Picken data to consider the structure of fibrous proteins.



Atypical diffraction pattern obtained from *Loligo* funnel retractor muscle. Originally photographed at 50 mm. specimen-to-film distance with nickel-filtered copper *Kα* X-radiation

The present communication describes new experiences with this atypical diagram, obtained accidentally from *Pecten* adductor and *Loligo* funnel retractor muscles. The stronger features of the best diagram are seen in the accompanying reproduction. As shown in the table of observations, the new patterns contain many more individual arcs than have been observed before, including several on the second layer line.

The Lotmar-Picken diagram has now been observed in examples of the major types of muscle: smooth and striated, vertebrate and invertebrate. So far as we are aware, the pattern has never been derived from tissues other than muscle. In every case the orientation effects are closely related to those of the fibrous elements of the muscle.

The conditions required for development of the Lotmar-Picken crystals are still not evident. The present examples were air-dried under tension sufficient to maintain approximately resting length and had been stored for a few days (*Pecten*) to two months (*Loligo*, at 4° C.) before X-ray examination. A companion *Loligo* specimen, taken from the other side of the same squid funnel and treated similarly, except for stretching 30 per cent, exhibited the usual α-diagram. Attempts to test the function of tissue autolysis in the Lotmar-Picken effect, suspected in the *Pecten* case, failed to show any connexion.

Possibly the Lotmar-Picken crystals are developed at the expense of the fibrous structures of the muscles. Under comparable conditions of examination, samples yielding the Lotmar-Picken pattern show the α-diagram and associated small-angle diffractions (type II of Bear[6], similar to those of actin films[1]) somewhat less intensely than is normal.

There is little doubt that the present patterns have the same origin as those of previous investigators. Although several minor differences in the line positions and intensities may be noted in the table of observations, serious difficulties arise only with respect to the following positions: (*a*) on the equator near $\frac{\sin\theta}{\lambda} = 0·052$, and (*b*) near the meridian at the first layer line. Both these areas are ones to which the normal α-type diffraction, plus a certain amount of diffuse scatter, contribute a confusing background. As the reproduction shows, however, the present pattern offers particularly good opportunity for distinguishing the Lotmar-Picken reflexions from others.

DIFFRACTION POSITIONS ON ATYPICAL MUSCLE DIAGRAMS

Figures are $\frac{\sin\theta}{\lambda}$ values. Letters indicate intensities as follows: S = strong, M = moderate, W = weak, VW = very weak.

Herzog and Jancke (ref. 2)	Lotmar and Picken (ref. 3)	Bear and Cannan
Equatorial:		
0·060 S	0·064 S	(0·062) W
0·077 M	0·076 S	0·076 S
0·086 M	0·084 VW	0·085 W
	0·106 S	0·106 S
0·127 W	0·126 W	0·125 W
	0·134 M	0·133 M
	0·143 M	0·143 S
	0·170 W	0·172 M
		0·180 VW
	0·182 W	0·183 W
	0·202 W	
	0·230 M	
First layer line:		
0·094 M		0·094 M†
		(0·099) W
0·103 M	0·104 S	0·103 W
0·107 M		
	0·117 M	0·117 M
	0·126 M	0·124 S
0·144 W	0·138 M	0·139 M
0·161 W		0·174 M
	0·184 W	0·185 W
		0·196 VW
	0·199 W	0·200 W
	0·204 W	0·204 VW
		0·208 W
Second layer line:		
Bear and Cannan	Bear and Cannan	Bear and Cannan
0·180 M†	0·209 W	0·239 VW
0·194 VW	0·213 VW	0·254 VW
0·200 VW	0·233 W	

Figures enclosed in parentheses are for background reflexions of the normal muscle α-diagram. True diatropic reflexions, corresponding to b_0 = 5·29 A., are indicated by †. The equatorial region at 0·200 and beyond was not covered by present films.

While showing good radial sharpness, all spots are arced sufficiently to make decision as to certain indices and unit-cell dimensions difficult. The fibre-axis translation (b_0) is the only cell element clearly distinguishable. All non-meridional arcs of the first layer line, as well as diatropic reflexions on the first and second layer lines, indicate a value for b_0 of 5·3 A., as compared with the 5·65 A. suggested by Lotmar and Picken.

One may also ascertain that interferences comparable in sharpness and intensity with the others are not present at the position of the diffuse equatorial spot corresponding to the 'side-chain' spacing of the α-diagram. Diffraction in this region played a prominent part in the considerations of Lotmar and Picken and of Pauling and Corey. Our results throw considerable doubt on the correctness of the previously suggested unit cell, and also deny the validity of any structural conclusions which require, on the atypical muscle diagram, strong equatorial diffraction corresponding to spacings of about 10 A.

Crystalline proteins should show large cells the dimensions of which are functions of the large lengths and/or breadths of the molecules. Although the abnormal *Loligo* specimen yielded a single, partially oriented (equatorial) diffraction, corresponding to a spacing of about 50 A., this is independent of the Lotmar–Picken diagram, since on occasion similar diffraction has been observed in muscles failing to show the distinctive Lotmar–Picken phenomenon. The oriented rings observed in such cases are like those yielded by phospholipids[7], which are common tissue contaminants.

There remains the possibility, if protein is involved, that the wide-angle diffractions represent intramolecular diffraction from individual protein particles. This is excluded by the radial sharpness and the spotted character of the observed diffractions, which could not be produced by particles of size less than that reported for intra-myofibrillar filaments (breadths c. 100 A.)[8]. Several of the interplanar spacings observed for the Lotmar–Picken substance are as small as 2 A. or less, a magnitude which, though not impossible for a protein, is smaller than is usually encountered.

Additional indication as to the nature of the Lotmar–Picken substance was found in experiments employing solvents to disperse this material. The abnormal *Loligo* specimen was divided and one portion subjected to distilled water, another to benzene, for two days. After drying, neither specimen yielded the Lotmar–Picken diffractions, exhibiting only the normal α-diagram. Dispersion by water is rather inconclusive; but the solubility in benzene may narrow the possibilities. The water had weakened the intensity of the 50-A. ring mentioned above; but benzene removed it entirely. The more bulky sample of *Pecten* muscle was extracted with benzene, and upon concentration of the extract by evaporation of solvent the residue yielded a small-angle ring (43 A.) but no evidence of Lotmar–Picken diffraction.

Probably the Lotmar–Picken substance, while related in origin to the fibrous elements of muscle, is not a protein. It is more likely to be a small organic molecular species which usually remains hidden by complex formation or solid solution within or near the fibrous components. On occasions, the circumstances of which are unknown, this material may be released to form separate crystalline phases, much as the lipid components of the nerve myelin sheath separate from the protein upon drying[9]. While this view denies that the Lotmar–Picken diagram is of any direct significance for the problem of protein structure, the diagram may still retain considerable interest for conceptions of muscle structure.

[July 25.

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MOVEMENT OF PROTEINS ON FILTER PAPER

THE separation of proteins by chromatography has been described by several workers[1,2]. Recently, Franklin and Quastel[3,4] reported the separation of proteins on filter paper. They developed two-way chromatograms with a variety of solvents (sugars, amino-acids and sodium salts of weak dibasic or hydroxy acids). The importance of their work, and its possible value in clinical research, rendered it desirable to examine the movement of proteins on filter paper under the influence of different eluting solutions, and to follow the effect of the conditions employed on the appearance of the resulting chromatograms.

The factors concerned in the ultimate separation of a two-dimensional chromatogram are: (1) extension of the mixture from a single spot to form either an elongated band or a series of discrete spots along the origin of flow of the second dimension; and (2) separation of the components of this band to give the final pattern.

After certain preliminary experiments, it appeared doubtful whether either of these two conditions was fully met in the system under consideration, and further experiments were designed to study the

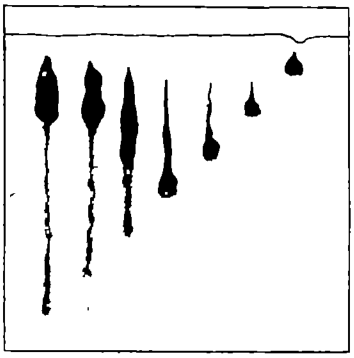

Fig. 1

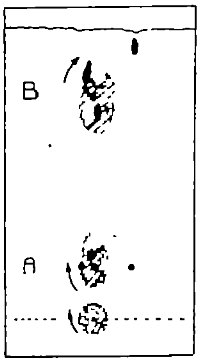

Fig. 2

Fig. 1. Diagram demonstrating the changing shape of protein spots at various intervals after the commencement of a chromatogram. The black area indicates the protein mass as demonstrated by ultra-violet fluorescence or iodine, the shaded area that which also stains blue with benzidine, showing that this indicator in part dissociates from the protein during the run

Fig. 2. Diagram demonstrating non-linear flow of solvent in neighbourhood of protein mass. When protein had reached *A*, spots of bromphenol blue were added at positions indicated. The relative movement of the component parts of the spot is shown by the positions of the bromphenol blue spots at *B*

mode of transport of mixtures of proteins such as occur in serum.

Following the conditions of Franklin and Quastel's experiment[4], serum and hæmin were mixed and 0·02 ml. dried on paper in a current of cold air. The chromatogram was developed by upward irrigation with 0·1 *M* glucose, lævulose, sodium glutamate, adipate malate or maleate solutions. To determine the shape of the protein mass after varying periods of time, spots were applied at increasing distances from the lower edge of the paper. When the solvent front had reached the uppermost spot and had flowed a distance of approximately 10 cm., the chromatogram was dried in a stream of cold air, and treated with benzidine (Fig. 1). There was a marked lag in the elution of the spot, leaving an indentation in the advancing front. Only after the solvent front had moved two or three centimetres ahead of the spot did elution commence. In further experiments small quantities of bromphenol blue were added to the chromatogram on either side of the mid-line of flow of the protein (Fig. 2). Material from the sides of the spots was eluted first and occasionally caused the production of "two separate fractions inside the finger" as observed by Franklin and Quastel[4]. Thereafter, owing to the inward flow of the solvent across the front of the spot, the tails fused and material from the rear was continuously carried to the front of the moving protein mass.

It was therefore apparent that the relative positions of the components of a mixture are dependent on certain factors not necessarily functions of its complexity. The protein is first segregated radially through the spot during drying, followed by peripheral elution. Secondly, infiltration and elution of the central portion which afterwards overtakes the material initially eluted causes the relative final positions of the fractions eluted from the centre and periphery of the original spot to depend on the distance the solvent front has travelled. It will be noticed that towards the end of a run of 20 cm., the protein is located as an oval spot only about twice the length of the original. Paper electrophoresis[5,6] of various portions of spots run under such conditions showed that at no stage in the process was there a linear distribution of the various components, albumin and globulin bands appearing in the final electrophoresis patterns of all areas of the spot. If by adequate manipulation of the conditions an elongated spot does result from the first run, this is again securely bound to the paper during drying, so that the developing solution is held back by the dried spot but eventually bursts through after its freely moving front has by-passed the spot by about 15 mm. The elongated protein trace is thus disrupted into a number of fractions. As many as eighteen have been observed immediately after the spot has been wetted out, if bromphenol blue is added to the protein initially. As the solvent front progresses, the faster-moving portions at either side flow inwards across the front of the protein, compressing the effective length of the complex of small spots, causing them to coalesce. Thus, the number of separate spots appearing on the final chromatogram depends on: (*a*) the length of the first run, since this affects the length of the spot; and (*b*) the length of the second run, since fewer spots are observed when this run is protracted.

It is also possible to show that the fractionation produced during the second run is not dependent on the existence of separate protein species in discrete positions on the paper. Spots of serum of varying length but containing the same volume were placed on the starting line, and developed with an appropriate solvent. The results showed great similarity to those obtained after a two-dimensional run.

Certain poly-hydroxy emulsifying agents were shown by Franklin and Quastel[4] to have the effect of increasing the number of fractions into which serum could apparently be divided. Since little or no separation may occur in the first direction, any increase in fractionation must be looked for in the second. This effect is apparently due to the greater degree of wetting-out occurring in those systems containing both protein and surface-active agent. Experiments with 'Span 20', sodium alginate and 'Tween 85' showed that the separation into small fractions could take place before the solvent front had passed the protein. There was therefore no tendency for the solvents to flow inwards and recombine the fractions; hence the greater number of fractions observed at the end of a run. For a similar reason the protein stayed with the front and did not lag behind.

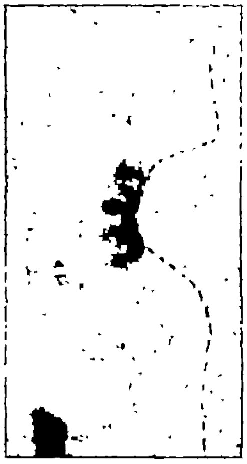

Fig. 3. Photograph of chromatogram obtained with 'Tween 80' and hæmin in the absence of any proteins. Solvent in both directions, *M*/100-fructose. Similar results are obtained with other combinations of solvents

There is therefore no reason for believing that the separate spots observed by Franklin and Quastel should be considered as individual chemical entities. Indeed, chromatograms of a mixture of the emulsifying agents 'Tween 80' or 'Tween 81' and hæmin without any protein produce an essentially similar pattern of spots (Fig. 3). Therefore, the inclusion of this type of compound may well increase the number of spots solely on its own account.

The conclusion to be drawn from this survey is as follows: during flow on a sheet of filter paper, the resistance of protein to transport in aqueous solution, coupled with the ease with which the solvent may by-pass the protein, will always tend to minimize the effectiveness of any possible separation of similar protein species.

The separation of proteins of quite dissimilar nature by this method, however, is, of course, perfectly practicable, as has been shown by Gross, Leblond, Franklin and Quastel[7]; but the patterns observed in complex mixtures such as serum are so dependent on the conditions of the experiment as to be pure artefacts. Given adequate control, there is no doubt a good degree of reproducibility; but owing to differing interactions between various components of different mixtures, the patterns observed can have no direct correlation with the complexities of the mixture.

Since this work was completed, Swingle and Tiselius[8] have also expressed the opinion that the patterns observed under these conditions are artefacts dependent on the general properties of proteins in contact with paper; but owing to the fact that our observations may be of interest in further work on protein separation, we have felt it desirable that they should be placed on record.

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F. Wewalka

Department of Medicine,
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A TECHNIQUE for the two-dimensional chromatography of blood plasmas or protein mixtures on filter paper has been described by Franklin and Quastel[1] which differs in certain important respects from the well-known methods adopted in amino-acid paper chromatography. It was found that the additions of small quantities of surface-active agents such as the 'Tweens' or 'Spans' seemed to facilitate the separation of plasma constituents and extend the protein 'pattern'. The technique adopted at present is to add 'Tween 85' or 'Tween 81' to the plasma and use hæmin as the protein marker. A mixture of an alcoholic solution of benzidine and hydrogen peroxide, made acid with acetic acid, is used for detecting the hæmin. Solutions of sucrose and of sodium potassium tartrate have been selected, after many experiments, as the most suitable developing solvents in the first and second dimensions respectively. The former solution appears to facilitate movement of certain protein hæmin complexes, as well as uncombined hæmin, in the first dimension; the latter solution allows movement of certain protein complexes in the second dimension while preventing movement of uncombined hæmin. There must not be overloading of the paper with protein; usually 0·02 ml. plasma is applied. The technique has been used in the study of blood plasma changes that occur consistently after heparin administration and after single high-fat meals[2] and in investigations of multiple sclerosis[3]. It has also been used profitably in an investigation of the combination between thyroxine and plasma constituents[4], in a study of the breakdown of casein by rennin and of the separation of rennin from crude rennet preparations[5], and in the demonstration of non-specific agglutinins for Brucella in bovine sera[11].

Drs. Hall and Wewalka point out that the upward flow of the plasma proteins from the original spot on the paper consists of a gradual elution by the ascending solvent and conclude "that the relative positions of the components of a mixture are dependent on certain factors not necessarily functions of its complexity". They also state, without giving the experimental evidence, that at no stage in the process is there a linear distribution of the various components, albumin and globulin bands appearing in the final electrophoresis patterns of all the areas of the spot (no surface-active agents were used). Thus, they intimate that no separation of protein constituents of the plasma takes place in the first-dimensional run. This conclusion leads them to imply that the fractionations seen in the second dimension are due simply to the mechanical or physical factors operating in this technique, and do not reflect any separations of a chemical nature. It is further claimed that the action of surface-active agents is only to prevent the coalescence of fractions which is observed in the second-dimensional run when no surface-active agent is present.

If these observations and conclusions are correct, it follows that the protein patterns of various plasmas should offer no great dissimilarities, since the patterns are allegedly not dependent on the chemical complexity of the plasmas but on the physical factors operating in the runs in the two dimensions.

Much experience has shown that the protein patterns obtained using our technique with normal plasmas are very similar to each other and may be reproduced with considerable regularity. On the other hand, the patterns obtained with many pathological plasmas differ very greatly from those given by the normal. These may also be duplicated with regularity in the same patient, so long as the clinical condition of the patient does not alter. There is now ample evidence which, it is hoped, will be published shortly, to show that the abnormal patterns observed in certain diseases revert to normal when the disease is successfully treated. Photographs of typical paper chromatograms of (*a*) normal plasma, (*b*) plasma of a patient suffering from cancer of the

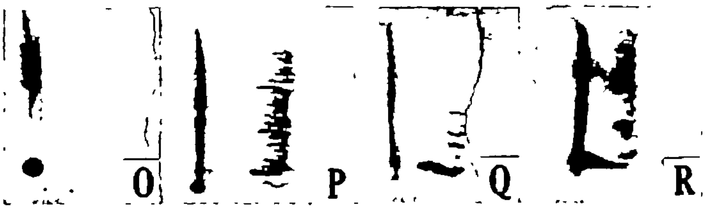

Fig. 1. *K*, Hæmin control (0·02 ml. of 0·3 per cent hæmin in 0·5 ml. of distilled water plus 0·02 ml. of 'Tween 81'); *L*, normal plasma (0·02 ml. of 0·3 per cent hæmin and 0·02 ml. of 'Tween 81' added per 0·5 ml. of plasma); *M*, plasma of a patient with cancer of the stomach (0·02 ml. of 0·3 per cent hæmin and 0·02 ml. of 'Tween 81' added per 0·5 ml. of plasma); *N*, plasma of a patient with lupus erythematosus (0·02 ml. of 0·3 per cent hæmin and 0·02 ml. of 'Tween 81' added per 0·5 ml. of plasma); *O*, same as *K* but with 0·01 ml. of 'Tween 85' instead of 'Tween 81' added per 0·5 ml. of plasma; *P*, same as *L* but with 0·01 ml. of 'Tween 85' instead of 'Tween 81' added per 0·5 ml. of plasma; *Q*, same as *M* but with 0·01 ml. of 'Tween 85' instead of 'Tween 81' added per 0·5 ml. of plasma; *R*, same as *N* but with 0·01 ml. of 'Tween 85' instead of 'Tween 81' added per 0·5 ml. of plasma

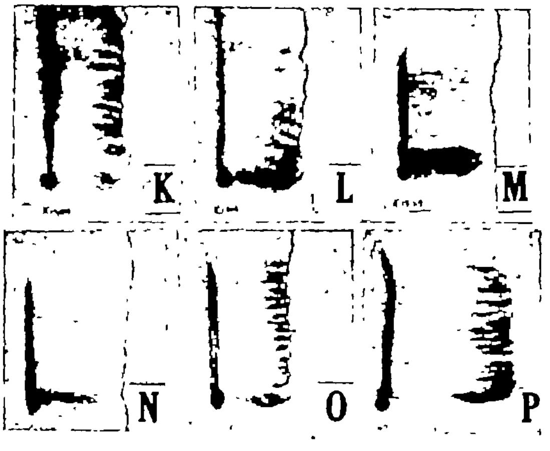

Fig. 2. *K*, Cohn fraction V (95 per cent albumin and 4 per cent α-globulin), 0·02 ml. of 0·3 per cent hæmin and 0·02 ml. of 'Tween 81' added to 0·5 ml. of a 6·5 per cent solution; *L*, Cohn fraction IV-4 (16 per cent albumin, 46 per cent α-globulin and 38 per cent β-globulin); experimental conditions as in *K*; *M*, Cohn fraction II (3 per cent β-globulin and 97 per cent γ-globulin); experimental conditions as in *K*; *N*, Cohn fraction I (7 per cent albumin, 8 per cent α-globulin, 15 per cent β-globulin, 9 per cent γ-globulin and 61 per cent fibrinogen); experimental conditions as in *K*; *O*, reconstituted plasma (3 per cent Cohn fraction V, 1·3 per cent Cohn fraction IV-4, 0·5 per cent Cohn fraction II, and 0·6 per cent Cohn fraction I in 0·85 per cent saline); experimental conditions as in *K*; *P*, normal human plasma; experimental conditions as in *K*

stomach, (c) plasma of a patient suffering from lupus erythematosus are shown in Fig. 1 (see also ref. 6, where further results are presented). These facts, pointing to extensive differences between the patterns of normal and pathological plasmas, make it obvious that the nature of the two-dimensional pattern must be a function of the chemical composition of the plasma.

That the physical factors operating in this form of paper chromatography help to determine the final pattern need scarcely be said, and this, it seems to us, is inevitable. But this fact does not justify the conclusion that the pattern does not reflect the chemical composition of the plasma or protein mixture. Moreover, no statement has been made in our publications that the fractions seen in the paper chromatograms of plasmas represent separate protein species.

Definite separations of proteins are practicable by this technique. For example, cytochrome *c* may be separated from serum albumin in a mixture of these substances[illegible]. The former moves but little in the first dimension and is easily taken into the second dimension, whereas the latter moves freely in the first dimension, to the head of the advancing front, and also moves easily in the second dimension. It can be shown (see Fig. 2) that widely different patterns occur with purified preparations of serum albumin, α- and β-globulins, γ-globulin and fibrinogen using our technique. Papastamatis and Wilkinson[7] have also recently demonstrated the different rates of movement of insulin, fibrinogen, γ-globulin and serum albumin, on filter paper using salt solutions as developing solvents.

The paper chromatogram of a mixture of serum albumin, serum globulins and fibrinogen in the proportions in which they are present in plasma gives a pattern very similar to that obtained with a normal plasma (see Fig. 2). This is a further indication that the chromatogram of a protein mixture is dependent on the chemical composition of its constituents.

Hæmin alone, in the absence of added proteins, under our experimental conditions gives but little movement in the second dimension, and this is negligible compared with the movement of the protein–hæmin complexes (see Fig. 1). Drs. Hall and Wewalka point out that movement of hæmin, in the absence of added proteins and in the presence of 'Tweens', does take place in the second dimension; but they use a fructose solution as developing agent in *both* dimensions. Naturally, in such circumstances, a movement in the second dimension will take place; but this is quite irrelevant since they do not use our developing solvent, which suppresses the movement in the second dimension.

Furthermore, Drs. Hall and Wewalka assert that the action of the surface-active agents is due to a 'wetting-out' phenomenon whereby the fractions obtained in the first direction are not allowed to coalesce in the second. Thus, the appearance of greater fractionation is observed. But this assertion does not take into account the fact that, in the absence of the surface-active agent, serum albumin will ascend wholly to the head of the paper, there to be separated into a few fractions in the second dimension[illegible], whereas in the presence of suitable quantities of a 'Tween' the rate of movement of the protein is depressed and a considerably lengthened spot is obtained in the first dimension, giving rise to an increased number of fractions. With a serum globulin, the presence of the 'Tween' may suppress all movement in the first dimension (see Fig. 2).

Combinations of detergent and enzyme proteins have been described[illegible] and it is known from the work of Putnam and Neurath[illegible] that albumins combine with surface-active agents such as the detergents to form complexes of various mole ratios. It is therefore likely that the elongation of the protein spot in the first dimension may be partly due to the different rates of solution of the surface-active agent – protein complexes and partly due to the varying affinities of these complexes for the cellulose of the paper. The increase, therefore, in the number of fractions is probably largely due to the formation of these complexes. There can be little doubt that complex formation between globulins and surface-active agents, such as 'Tweens', also occurs and that these complexes move with great difficulty in the first dimension under our experimental conditions. Use of other surface-active agents may provide for more effective separations of albumins and globulins than we have been able to obtain so far.

Further experiments[illegible] have shown that the admixture of γ-globulin to human plasma brings about a marked alteration of the pattern, a heavy basal fraction appearing when 'Tween' is used. The heavy fractions at the bottom of the pattern seem to be typical of the chromatograms obtained in plasmas of

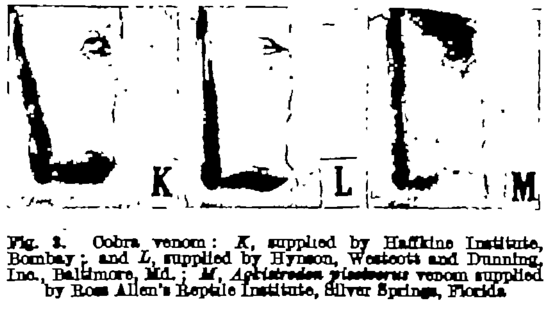

Fig. 3. Cobra venom: *K*, supplied by Haffkine Institute, Bombay; and *L*, supplied by Hynson, Westcott and Dunning, Inc., Baltimore, Md.; *M*, *Agkistrodon piscivorus* venom supplied by Ross Allen's Reptile Institute, Silver Springs, Florida

pathological cases where the globulin/albumin ratio has been increased. It has already been pointed out[1] that the chromatogram of the plasma of a horse immunized against diphtheria toxin (the plasma presumably having an increased globulin content) differs from that of normal horse plasma by the possession of extra fractions at the bottom.

The fact that protein mixtures of different chemical composition yield different patterns is also illustrated by the photographs given in Fig. 3. These show chromatograms of two different samples of cobra venom and of a sample of *Agkistrodon piscivorus* venom, the same quantity (0·8 mgm.) being taken, and no surface-active agents being present. It will be observed that the chromatograms of the two cobra venoms are very similar to each other but differ from that of the other venom.

It is difficult to reconcile two statements in Drs. Hall and Wewalka's communication, namely, "The separation of proteins of quite dissimilar nature by this method, however, is, of course, perfectly practicable", and "the patterns observed in complex mixtures such as serum are so dependent on the conditions of the experiment as to be pure artefacts". We readily agree that all patterns are dependent on the conditions of the experiment; but since separations of proteins admittedly do occur by this technique, the patterns cannot be regarded as solely dependent on the physical conditions and therefore as pure artefacts.

With reference to the suggestion of Swingle and Tiselius[10] that the chromatograms may be "artefacts", we are informed by Dr. Swingle[12] that the evidence referred to in their paper was rather circumstantial and did not seem to justify publication without additional experiments.

Further investigation, especially of a quantitative nature, is needed to decide the chemical nature of the fractions obtained in the second dimension, and such work is now in progress. But ignorance of this fact, at present, need not deter further development of the technique, which is obviously in an exploratory stage. It is possible that it will provide an inexpensive means of clinical aid both in diagnosis and in following treatment.

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July 17.

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ANNUAL EXHIBITION OF THE ROYAL PHOTOGRAPHIC SOCIETY, 1951

THE ninety-sixth annual exhibition of the Royal Photographic Society was opened in London on September 13 for one month and will also be shown at the City Art Gallery, Aberdeen, during November 3–24. The exhibition is divided into five groups: pictorial, record, Nature, medical and scientific photography, with a total of 908 exhibits.

The scientific entries constitute the smallest individual group; but medical and surgical entries are well represented. There is a collection of some nine full-sized radiographs in this latter section, one of which is very effectively shown as a two-colour radiograph by D. Stevenson Clark and entitled "Bas relief colour radiograph of right pneumothorax". This was prepared from the original radiograph by contact-printing a positive to give a magenta image and registering this with a solarized negative coloured cyan. One of the other monochrome radiographs, by R. M. Leman, was given a distinct relief effect presumably by the use of a slightly out of register negative mask, which resulted in a noteworthy emphasis of the arteries shown in this particular exhibit. Among the medical prints is one from Manchester Royal Infirmary, in which the arteries of a heart are well revealed by a radiograph made after injection of lead phosphate. Included in the several examples of ophthalmic photography are two, one by P. N. Cardew and the other by Miss A. E. Milne, in which an annular electronic flash tube was used to illuminate the eye. The reflexion of the tube itself by the outer surface of the cornea indicates whether any imperfections exist on this surface, these being revealed by distortion in the shape of the annulus. Two exhibits by D. M. Kermack showing stages in the dissection of a marine worm provide an illustration of how revealing and orderly a careful example of this type of work can be. A series of photomicrographs by G. C. Lenney on cell division in a mouse tumour must have caught the eye of any who have visited the Festival of Britain Science Exhibition, where a large section is devoted to cell division: in these photographs both normal double-cell division and abnormal multi-cellular division showing stickiness of the chromosomes are well shown.

The most interesting exhibits in the science section are those submitted by the National Physical Laboratory. In one of these there is an example of the use of the Linnick interference microscope, in which the relief effect shown on the surface of a photographic negative of a three-bar resolution test object is examined. Horizontally, the magnification is × 2,100; but by virtue of the optical interference shadows an effective vertical magnification of × 166,000 is achieved. The actual relief effect in the gelatin of the image under examination is seen to be almost one micron. The Laboratory also shows some examples of the *Schlieren* patterns produced by high-velocity air flow. Thus the air flow in the neighbourhood of a supersonic jet is shown, as are the pneumatic disturbances produced around an aerofoil at high subsonic and also supersonic speeds. The shock wave produced in the former case and the 'bow wave' in the latter are clearly indicated. By using the properties of polarized light, the degree of air compression in these waves can be assessed by measurement of the interference colours, as is shown in a pair of colour transparencies. Brown–Firth Research Laboratories present what must have been a very difficult subject to photograph satisfactorily, namely, the surface of molten chromium–molybdenum steel at 1,600° C. in a Siemens open-hearth furnace. Several ordinary aerophotographs are shown; but there is no doubt that the stereo-viewing of this type of exhibit as shown by Hunting Aerosurveys, Ltd., is much more impressive, particularly to those unfamiliar with the viewing of this type of photograph. The exaggerated relief effect emphasizes even slight contours, and ordinary two-dimensional photographs of this type of subject seem all the flatter by comparison.

The photographic recording of a collection of examples of mechanical engineering submitted by H. C. Lane also illustrates the value of the stereoscopic record compared with that of the ordinary paper print, although it must be remembered that, in a series of this type, the stereophotographs, being transparencies, are likely to excel the prints in quality by virtue of their extended optical density-range quite apart from the three-dimensional effect. Among the more interesting record photographs must be mentioned those of Lost John's Cave, Leck Fell, Lancs, by J. Benjamin, who, with the aid of an illustrated plan, follows up several regions of this cave, which contains 4,000 yards of passages, by a series of photographs. In the record section, a Royal Photographic Society Medal has been awarded to J. H. Steer for his photograph of a "Tablet", and perhaps the "Chair Back" of Miss J. W. Robinson and the "Royal Festival Hall" by Miss Margaret Harker should also be mentioned among many fine examples.

The largest part of the section on Nature is devoted to pictures of birds, of which the owl seems to be the most popular. Special mention is due to W. E. Higham for a fine series of pictures entitled "Golden Eagle".

UNIVERSITY OF OXFORD

NEW DEPARTMENT OF BOTANY

THE new building of the Department of Botany in the University of Oxford was formally opened on October 8 by Lord Rothschild, chairman of the Agricultural Research Council.

The first professor of botany in the University was appointed by Charles II in 1669. The early teaching of the subject was associated with the Botanic Garden which had been founded in 1621, and buildings for the study of botany were erected during the seventeenth century just outside the Garden wall. Extensions were made to contain the library and herbarium of William Sherard as a condition of his endowment of the chair of botany; but these buildings were removed at the end of the eighteenth century and an orangery was used for housing the library and herbarium. This orangery was incorporated in the professor's house, built by Daubeny in 1836. Daubeny also built a lecture room which was joined to another orangery, altered to hold the Fielding Herbarium, presented to the University in 1851. These two orangeries within the Garden wall were the starting-points of the two separate buildings which, until now, have accommodated the Department of Botany. Further additions were made up to 1933 by new construction and by the lease of the adjacent laboratories of Magdalen College.

The history of the Department meant that its buildings were separated from the other scientific Departments of the University and were unsuitable for the modern study of botany. Soon after Prof. T. G. B. Osborn was appointed to the Sherardian chair in 1937, the University therefore decided to transfer the Department to a new building in the Museum area, although this meant separating it from the Botanic Garden. Sir Hubert Worthington was appointed as architect and the major plans were begun in 1939; but building was held up by the War.

The new building is situated on the south side of the University Parks, behind the Observatory and between the Departments of Pathology and Physical Chemistry. It is united to the new Imperial Forestry Institute by a lecture theatre. The building has a steel frame, reinforced concrete floors and exterior walls of Bladon and Clipsham stone. There are four floors with a total area of nearly 40,000 sq. ft. and the flat roof is available for experimental work.

The teaching of the Department is carried out in three laboratories for advanced study and one for elementary study. The elementary laboratory is designed for a class of 102 in a room that can be comfortably controlled by the demonstrator. There is a small lecture room as well as the large theatre shared with the Department of Forestry. Research is accommodated in large laboratories for plant physiology and mycology and others for ecology and cytogenetics. In addition to private laboratories for the staff, there is also a number of research rooms for one or two workers and rooms for special apparatus. All the main laboratories have their own ancillary rooms for preparing and storing material and apparatus. In one of the northern wings the Fielding Herbarium, the Druce Herbarium (which was formerly kept in its founder's house in north Oxford) and the Forest Botany Herbarium (which used to be kept in the old Imperial Forestry Institute) are collected into two large rooms. Another room contains a small museum and the ancient herbaria. The main store rooms in the basement are served by ramps from street-level and by a lift to all floors and the roof. The departmental library of some fifteen thousand volumes is housed mainly in two stack rooms, except for the collection of taxonomic works which is kept with the herbaria. The reading room contains the Sherard Library and other valuable old books in glass-fronted cases, and is attractively furnished in unstained oak. The furniture and fittings throughout the building have been designed for flexibility and economy in the use of space. Wall benches are supported on cantilevers wherever possible and cupboards and drawers are in interchangeable units. The main services are carried in flues; as well as gas, water and A.C. lighting and power lines, there are 100-volt and 6-volt D.C. circuits in most research rooms; compressed air and fresh air are piped to some benches.

A garden courtyard has been laid out between the new building and the Imperial Forestry Institute and there is a small plot on the north side and a greenhouse on the roof available for growing plants for experimental purposes. The Department will, of course, continue to depend upon the Botanic Garden for much of its material.

RESEARCH AND DEVELOPMENT IN BRITISH COLONIAL TERRITORIES

THE survey "The Colonial Territories (1950–51)"*, as in previous years, provides much of the background against which the value of the work of the Colonial Research Council and like bodies is best appreciated; the present report includes a chapter on research and surveys which summarizes progress reported more fully in "Colonial Research, 1950–51". Meanwhile, the establishment during the year of a Scientific Council for Africa South of the Sahara, which held its first meeting in Nairobi in November, is noted, and also the holding in June of a review conference to survey the work of the Commonwealth Agricultural Bureaux Organization. Progress in starting the work of the various Colonial fishery stations and institutes continues to be hampered by the shortage of qualified staff, and special stress is laid on the opening of the Sugar Technology Laboratory at the Imperial College of Tropical Agriculture. The Colonial Products Advisory Bureau completed ninety-five laboratory investigations and dealt with 672 inquiries. The year saw the formal opening on January 31 of the West African Institute for Trypanosomiasis Research, with laboratories and installations at Kadua and Vom in Northern Nigeria. Construction of a central Trypanosomiasis Research Institute in East Africa has been agreed upon by the East African Governments and the Secretary of State for the Colonies, and it is expected that the whole of the capital expenditure and about 50 per cent of the recurrent expenditure for the first five years will be met from the Colonial Development and Welfare vote.

Although details of the actual scientific work are reserved for the report on "Colonial Research", major developments are appropriately reviewed in the wider context of the present report. This review thus helps to correct some of the criticism which is directed against British Colonial policy; that is also true of other activities of direct interest to the scientific worker which are recorded in the chapter on "The Social Services". Educational developments are discussed elsewhere, but reference may appropriately be made here to the developments recorded in mass education, which show how the organization of government is being adjusted to fit in with the new conception of community development, notably in Kenya, Uganda and West Africa. Where the formation of community development departments or appointment of community development officers has led to village communities being encouraged to co-operate in numerous small projects to prevent flooding or desiccation of the land, reclaim land, construct buildings, eradicate hookworm or roundworm, much has been done to improve the welfare of the community. Steady progress is reported in the medical and health services, and as general standards of public health improve it is becoming easier to select for attention in a particular territory those diseases which have the greatest social and economic significance. On January 1, 1951, there were, however, still 160 vacancies for medical practitioners in Colonial territories, the need being particularly urgent in West Africa and Malaya. The development of health centres in urban and rural areas is gaining in popularity and proving effective. The mobile maritime dispensary service in Sarawak was augmented, and marked success was achieved by the mobile health unit serving twenty-five villages in a remote part of Cyprus. Medical field units, or epidemic control units, which deal with endemic diseases of all kinds in their areas, and also when necessary with epidemics of smallpox, cerebrospinal meningitis, relapsing fever and trypanosomiasis, have been evolved in West Africa from the former Sleeping Sickness Control Units, and their scope has recently been extended to include health surveys.

Arrangements were made during the year with the Pasteur Institute in Paris for freeze-dried B.C.G. vaccine to be supplied to all Colonial territories which require it, but much research is required before the value of universal B.C.G. vaccination can be finally assessed. On the whole, very satisfactory results have been obtained in the treatment of leprosy with sulphone preparations, particularly with diphenyl sulphone.

In the field of malaria, an international conference held in Uganda in November–December under the joint auspices of the World Health Organization and the Commission for Technical Co-operation in Africa made apparent the important contribution in research which could be made in British Colonial territories. At Ibaro in Nigeria the effect of residual spraying in a hyper-endemic area is being carefully studied; a campaign in British Honduras was intensified, when spraying of about 98 per cent of the dwelling houses in the Colony with an emulsion of DDT was completed, and the first phase of the Mauritius eradication scheme—spraying of houses with residual insecticide—was also completed during the year. Increased attention was given to the control of onchocerciasis in African territories—for example, by attacking the small biting fly (*Simulium*) which carries the disease—and it is hoped to eradicate the fly from that part of the Nile where work is in progress on the Uganda hydro-electric scheme by aerial spraying with DDT.

As regards subordinate staff, the main emphasis is still on the training of hospital assistants, male and female nurses, and health inspectors; but laboratory technicians and pharmacists are also being trained and the development of specialist services is accompanied by some specialization in training. Owing to staffing difficulties, Colonial territories could not take full advantage of the offer of the National Association for the Prevention of Tuberculosis, and only two of the six scholarships for training in tuberculosis work in Great Britain were awarded.

Organized efforts to improve nutrition are an essential part of the campaign for raising the level of health, and a feature of practical nutrition programmes is the increased use of food-yeast. Reference is also made in this report to the important part played by broadcasting in education and in assisting the understanding of public affairs, and to the invaluable work in these territories of the British Council. The dependence of social welfare and social services on economic development is made clear, and the report is as useful a contribution to the discussion of economic or political developments in these territories as it is to the consideration of the scientific or technical work which is reviewed more fully elsewhere.

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* Colonial Office. The Colonial Territories (1950–51). (Cmd. 8243.) Pp. ix+184. (London: H.M. Stationery Office, 1951.) 4s. 6d. net.

LETTERS TO THE EDITORS

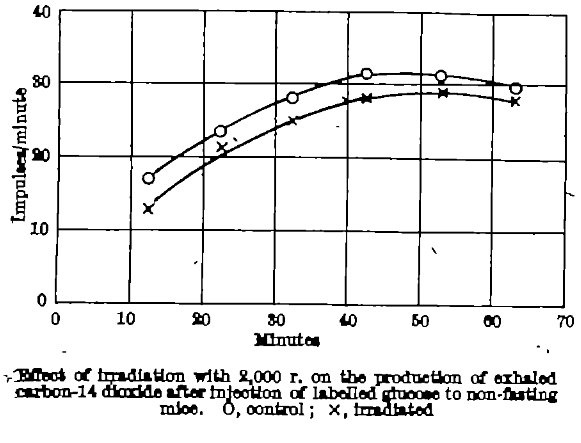
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Effect of Irradiation by X-Rays on the Exhalation of Carbon Dioxide by the Mouse

It has been shown previously that the rate of formation of deoxyribonucleic acid is depressed by a sublethal dose of X-rays. Both the incorporation of phosphorus-32 [1-4] and that of carbon-14 [6,7] was found to be reduced about 50 per cent. The rate of incorporation of carbon-14 into the purines of ribonucleic acid is reduced as well[7], though to a smaller extent than its incorporation into the purines of deoxyribonucleic acid. These blocking effects are presumably due to inactivation of enzymes involved in the synthesis of the deoxyribonucleic acid and ribonucleic acid compounds. One or a few days after irradiation, the incorporation of carbon-14 into purines of deoxyribonucleic acid has nearly returned to the rate for the non-irradiated controls. This suggests that a partial reactivation has occurred. The early metabolic changes produced by irradiation are not confined to interference with nucleic acid synthesis. We find that irradiation interferes with glucose metabolism as well.

Fully grown mice which had been fed *ad libitum* were placed in perforated metal boxes which prevented gross movement. In each experiment four such boxes were symmetrically placed in a metal cylinder containing carbon dioxide-free air and kept at 27°. Exhaled carbon dioxide was swept from the brass cylinder by carbon dioxide-free air at constant velocity and collected in a series of three wash-bottles containing barium hydroxide. At intervals of 10 min. the air stream was switched over to another aggregate of wash-bottles. The carbon dioxide was collected for one hour.

Glucose (60 γ having an activity of 0·03 μC.) labelled in all its carbon atoms was injected subcutaneously into each mouse immediately after irradiation. Collection of carbon dioxide started 8 min. after injection. The increase in weight of barium carbonate with increasing time shown in the graph has no significance, as it is a result of the fact that the content of exhaled carbon dioxide in the metal cylinder increases with time. We wished only to determine the ratio of carbon dioxide exhaled by irradiated and control mice, not the total amount exhaled.



Effect of irradiation with 2,000 r. on the production of exhaled carbon-14 dioxide after injection of labelled glucose to non-fasting mice. O, control; ×, irradiated

We found that the non-fasting irradiated mice exhale only some 80 per cent of the amount of carbon dioxide exhaled by control mice. This result does not necessarily prove an impaired catabolism of body glucose. Since only about one-half of the exhaled carbon dioxide originates from catabolism of glucose[8], the other half having its origin in catabolism of fatty acids and other body constituents, it may be that the catabolism of the last-mentioned compounds and not that of glucose is responsible for the reduced exhalation of carbon dioxide by the irradiated mouse. The fact, however, that if labelled glucose is administered the irradiated mice exhale a smaller amount of carbon-14 labelled carbon dioxide than the controls proves unambiguously that irradiation depresses the glucose catabolism of irradiated mice. The graph indicates that the depression is already apparent after the lapse of 8 min. and may possibly be still more pronounced at an earlier time.

It is of interest to note that Lourau and Lartigue observed that addition of glucose to the diet of the guinea pig increases its radiosensitivity[9], that irradiation with 500 r. produces hyperglycæmia in the irradiated animal[10] and, quite recently, that 12–15 days after irradiation glycogen formation in the liver is reduced 1–2 hr. after feeding glucose[11].

The reduced catabolism of glucose in the irradiated mouse is reflected in an increase of forty to one hundred per cent in the carbon-14 content of liver fats.

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The Philippine Trench and its Bottom Fauna

Very little is known about animal life in the greatest ocean depths; only two previous hauls seem to have been made below 6,000 metres. In 1899 the U.S. Fish Commission steamer *Albatross* obtained siliceous sponges in the Tonga Trench at 4,173 fm. or 7,632 metres[1]. A similar deep haul was not made until 1948 when the Swedish Deep Sea Expedition trawled holothurians, a fragment of a polychæte, an isopod and a few amphipods in the Porto Rico

Trench at depths between 7,625 and 7,900 metres[2]. I can now report that in July the Danish Deep Sea Expedition of 1950–52 in the research ship *Galathea* obtained living animals of several phyla from a depth of greater than 10,000 metres in the Philippine Trench, more than 2,000 metres below previous known occurrences.

The Philippine Trench is considered to be the deepest area of the oceans of the world. The area of the Trench at 10,000 metres or more was readily delimited with the supersonic echo sounder on board the *Galathea*. Although no real survey of the Trench was aimed at, the soundings necessary for the biological work indicate a continuous area between 9° 04′ N., 127° 05′ E., and 10° 41·3′ N., 126° 37′ E., that is, about a hundred nautical miles long, while the width probably never exceeded about two nautical miles. The greatest depth was found to be 10,540 metres, corrected according to Matthews[3]. This was recorded on July 23, 1951, at 12.50 hr. at 10° 23·8′ N., 126° 40·5′ E. The depth of 10,800 metres recorded by the German cruiser *Emden* was sought for in vain; our soundings were in general agreement, however, with those of the Dutch research ship *Willebrord Snellius* and the U.S.S. *Cape Johnson*, the last-named of which recorded a maximum depth of 10,497 metres[4]. The general direction of the bottom area was about 340°, thus pointing about 20° W. of north. The bottom itself is very even, consisting of a very fine clay with an admixture of sand, small stones, vegetable debris and chitinous remnants of terrestrial insects. A sample of 26 litres was taken with the 0·2-sq. m. Petersen grab from 10,395 metres, besides two cores 75 cm. long with the Kullenberg corer. The temperature at 10,123 metres was 2·56° C., while the minimum temperature of 1·59° C. was found at 3,500 metres.

A three-metre wide sledge trawl of the Agassiz type brought up in the first haul from 10,462 m. an abundance of clay with several stones. The first animal seen was a small white actinian attached to a stone; further search gave altogether some twenty-seven actinians, seventy-five holothurians (*Myriotrochus* sp.), five bivalves (*Portlandia* ?) and one amphipod. The Petersen grab contained one specimen of the same species of *Myriotrochus*. The total result obtained, including one haul with the sledge trawl from 10,417–10,484 m. and another from 10,026 m., was about forty actinians, five echiurid worms, eighty *Myriotrochus*, one elasipod holothurian, five bivalves (*Portlandia* ?), one of each of two species of amphipods and one well-preserved specimen and three fragments of two species of tanaids. This gives altogether nine species, to which undoubtedly more could have been added. But two typhoons passing north of the area made further operations impossible. The skilful manœuvring of the ship, commanded by Captain Sv. Greve, R.D.N., and the very special equipment for deep-sea trawling, were decisive for the positive results. Trawling in other trenches and deeps will be tried in the near future to add material for comparison.

Prof. Claude E. ZoBell, of the Scripps Institute, University of California, has secured live samples of bacteria from the bottom deposits and is keeping cultures on board under his special high-pressure technique.

The proof that a variety of animals have been adapted to life under a pressure of more than 1,000 atmospheres must lead to a renewed consideration of many problems in physiology and biochemistry. The living bacteria may yield valuable material for experiments to solve them.

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Composition and Structure of Yeast Cell Walls

IN a study of the structure of the cell wall of baker's yeast with the electron microscope, one of us (A. L. H.) obtained results which induced us to start microchemical work on the presence of chitin (P. A. R.) and to study X-ray diffraction of the cell walls (D. R. K.).

In baker's yeast the main cell-wall material, which remains after successive treatments with dilute alkali and acid, is a glucan[1–4] with links of the 1 : 3 and 1 : 2 β-type. Cellulose has not been found in the cell walls of yeast.

The presence of chitin in several species of yeast has been claimed on the grounds of both the isolation of glucosamin and the chitosan iodine test[5,6]. So far as the Endomycetaceæ is concerned, this has been corroborated by X-ray diffraction; but in other yeasts, including *Saccharomyces cerevisiæ*, no chitin could be detected with this method[7].

In purified cell-wall material from baker's yeast a small amount, ± 0·5 per cent, of nitrogen has been found[1,3,4], which has been interpreted as an impurity. However, the amount is sufficient to account for an admixture of chitin up to ± 7 per cent. In fact, I. Hoette[8] obtained chitosan sulphate crystals from many species of yeast, including *Saccharomyces cerevisiæ*. Although in several species the crystals could not be obtained, chitin was supposed to occur in all of them but in varying and sometimes non-demonstrable amounts.

As to our microchemical work, we could mainly confirm Hoette's conclusions, since chitosan sulphate crystals could be obtained from baker's yeast and from all yeasts tested, including some species which had given negative results in Hoette's experiments. So far, we have encountered only one possible exception. In addition, our results suggest that the amount of chitin in yeasts may increase with the age of the cultures.

On electron micrographs cell walls freed from cytoplasm and cell inclusions by grinding, washing and centrifugation generally appear smooth and without a clear structure. After boiling in dilute alkali, a network of thin fibrils is discernible locally, especially in scars from buds. They seem to be embedded in non-fibrillar material. After subsequent boiling in 2 per cent hydrochloric acid a very striking, coarse network of aggregates of rather short fibrils is shown.

These changes are reflected in the degree of crystallinity as deduced from X-ray diagrams. Native cell-wall material, obtained as mentioned above, generally produces three to four broad and partly weak diffuse rings.

After the alkali treatment the diffuse rings become stronger. In yeast species sufficiently rich in chitin, there appear in addition one or two sharper interferences corresponding to the strongest chitin lines. After the subsequent acid treatment, all interferences become more intense and the diffuse rings are partly resolved into several sharper lines.

With cold 30 per cent hydrochloric acid the chitin could be extracted selectively; this treatment caused the chitin lines to disappear, but left the pattern of other lines unchanged. It does not effect any visible change in the electron micrograph.

There is little doubt that we have obtained the submicroscopic picture and the X-ray powder diagram of the insoluble yeast glucan mentioned earlier. Apparently, in the native membrane the substance is mainly amorphous, or possibly forms part of an amorphous complex of cell-wall constituents linked by easily hydrolysable bonds.

Details of our investigation will be published elsewhere[9].

The work has been supported by the Netherlands Organization for Pure Research (Z.W.O.).

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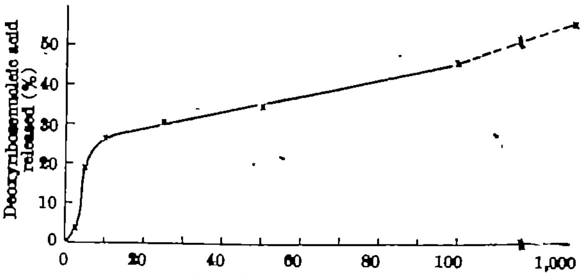
Effects of Ionizing Radiations upon Isolated Deoxyribosenucleoprotein Fibres

CHANGES in chemical and physical chemical characteristics of deoxyribosenucleoprotein and deoxyribosenucleic acid in solution following exposure to ionizing radiations have been described by several investigators[1-3]. Decreased viscosity and chemical decomposition have been reported.

Recently, we have carried out similar experiments using deoxyribosenucleoprotein in fibrous form and have found marked changes at relatively low radiation dosages.

Deoxyribosenucleoprotein was prepared from rabbit liver and calf thymus following the method of Petermann and Lamb[4]. Immediately prior to irradiation, the protein solution in 1 *M* sodium chloride was diluted with 6 volumes of distilled water at *p*H 6·8, producing the characteristic fibres; these, now suspended in 0·9 per cent sodium chloride solution, were subjected to ionizing radiation produced by a stream of electrons from an 800-kV. peak, resonance-transformer type cathode-ray machine. The control samples were prepared in identical fashion.

Following irradiation, the samples were centrifuged for 10 min. at 5,000 r.p.m. The clear supernatant fluid was assayed for nucleic acid by ultra-violet absorption at 2600 A. in a Beckman spectrophotometer, for deoxyribosenucleic acid by the Stumpf colorimetric test[5] and for protein by a quantitative biuret test[6].



Production of soluble deoxyribosenucleic acid by ionizing fibres of deoxyribosenucleic protein at *p*H 6·85

It was found that, following irradiation, variable amounts of nucleic acid had gone into solution (see graph). The biuret tests for proteins in the supernatants were negative.

No significant change in this effect was observed by varying the hydrogen ion concentration from *p*H 5 to *p*H 8. The addition of 0·005 *M* hydrogen peroxide to the deoxyribosenucleoprotein in *M* sodium chloride instead of the distilled water produced no change without irradiation; and subsequent exposure of this mixture to ionizing radiation was followed by changes identical with those without hydrogen peroxide.

In another experiment, deoxyribosenucleoprotein fibres were frozen at −20° C. during exposure. This procedure appeared to protect the fibres, since no deoxyribosenucleic acid was found in the supernatant fluid, indicating that the above-mentioned process takes place as the result of a chemical or 'indirect' reaction.

From these observations it appears that an important change occurs in the deoxyribosenucleoprotein fibres as a result of exposure to ionizing radiations. This decomposition may be related to the chromosome changes seen in cell nuclei following similar exposures.

Because of the radiomimetic action of the nitrogen mustards, we placed deoxyribosenucleoprotein fibres in varying concentrations (0·00064–0·0000064 *M*) of methyl *bis* (β-chloroethyl) amine hydrochloride, but found no evidence of decomposition even after allowing the fibres to remain in these solutions for 18 hr.

We are now carrying out experiments designed to study the effect of lowered oxygen tension, reducing agents and other chemical compounds upon the decomposition of the deoxyribosenucleoprotein fibres; we shall report detailed findings elsewhere.

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Nature of the Striated Muscle Fibre Membrane

At the present time, considerable confusion exists as to what should properly be called the sarcolemma, or true muscle fibre membrane. Long[1] defined the sarcolemma as a bipartite structure consisting of an inner layer, the true plasma membrane, and an outer layer composed of reticular fibrils. Meyer and Bernfeld[2] concluded that the sarcolemma is a collagenous-type protein. Jones and Barer[3] failed to find evidence of a collagenous or fibrillar structure.

Cytochemical tests have been carried out on the sarcolemma of isolated muscle fibres of the frog, *Rana pipiens*. In the process of teasing out fibres from various leg muscles, retraction clots were formed in the protoplasm. These clots shrank away from the sarcolemma, thus exposing large areas of the free membrane. The Withrow Morse[4] test for collagen was applied to fifty muscle fibre fragments as well as to entire muscle and bundles of fibres. The sarcolemma in the isolated fibre fragments invariably gave a negative response for collagen. In the whole muscles and bundles a positive reaction was obtained. In the second test for collagen (Chittenden[5]) muscles were boiled in a solution containing dilute sodium hydroxide and nitric acid. Numerous wrinkles, crevices, and folded edges appeared in the sarcolemma. The latter appeared to be festooned along the outer edges of the fibre. These festoon-like areas probably resulted from the swelling effect of the dilute acid. The third test, that of Barer[6], involved digestion of the fibre material in a 0·15 per cent solution of crystalline trypsin at *p*H 7·8. As a control, ligaments, tendons and other collagenous tissue were used. After digestion for four hours the sarcolemma had ruptured and gone into solution. The control tissues were unaffected by trypsin, even after eight hours in the enzyme solution. The xanthoproteic and ninhydrin reactions for protein were applied to the sarcolemma. A positive result was obtained in both tests. In the xanthoproteic reaction, the colour intensity of the sarcolemma decreased as the concentration of the nitric acid was lowered. Lipids were tested for by means of nile blue sulphate and sudan III dyes, with alcohol–ether extracted fibres serving as controls. Positive tests for lipid in the sarcolemma were indicated in both cases.

Bairata[7] regards the sarcolemma as a network of collagen fibres imbedded in a homogeneous colloidal matrix. He states that he has seen fine fibrils within the sarcolemma under polarized light and dark-ground illumination. This could not be substantiated here, nor could fibrils be seen using a phase-contrast microscope. What Bairata possibly considered a collagenous network in the membrane may in reality be the areolar connective tissue investing the individual fibre. Meyer and Bernfeld[2], using the dye methyl red, and Reed and Rudall[8], using the electron microscope, appear to have demonstrated the presence of collagen in the sarcolemma. The latter authors were able to demonstrate collagen fibrils; however, when the optical level of the true sarcolemma was reached, they found it to have a dotted, rather than a fibrillar, make-up. Barer[6] attempted to digest isolated portions of sarcolemma with the enzymes hyaluronidase and collagenase, but without any obvious effects. Jones and Barer[3] failed to find any evidence of a collagenous or fibrillar structure. They found, as did Reed and Rudall, numerous small dots present within the sarcolemma.

Typically, in the present investigation, a positive reaction for collagen in the sarcolemma was always obtained when whole muscle or bundles of fibres were used. When individual fibres, free of endomysium and other connective tissue, were tested, collagen was invariably absent. Furthermore, the sarcolemma always gave positive tests for protein. Unlike collagen, it proved digestible by trypsin. These facts, together with the positive reactions for the presence of lipids, suggest that the sarcolemma is a protein, possibly a lipoprotein. This type of chemical constitution is in agreement with that of the classical object of plasma membrane chemistry, the mammalian erythrocyte envelope.

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Transamination in the Human Tooth

In previous communications[1,2] it was shown that the presence of free aspartic and glutamic acids could be demonstrated in carious but not in sound dentine. With the view that a knowledge of the metabolic processes in the sound tooth might aid in an understanding of the caries process, it was decided to investigate whether the sound dental tissues exhibited any enzymatic activity towards aspartic and glutamic acids as substrates.

Using a paper chromatographic method[3], it has been demonstrated that a transaminase occurs in the human tooth in dentine and pulp tissue. This enzyme catalyses the reaction:

$$\text{L}(-)\ \text{aspartate} + \alpha\text{-ketoglutarate} \rightleftharpoons \text{L}(+)\ \text{glutamate} + \text{oxalacetate} \quad \ldots \quad (1)$$

Weaker activity was also demonstrated for the reaction:

$$\text{L}(+)\ \text{alanine} + \alpha\text{-ketoglutarate} \rightleftharpoons \text{L}(+)\ \text{glutamate} + \text{pyruvate} \quad \ldots \quad (2)$$

Owing to the very real technical difficulties involved in working with such small amounts of starting material, it has not been possible as yet to isolate relatively pure active preparations of the enzymes. However, anaerobic incubations using crude extracts and tissue suspensions have been made, and preliminary quantitative studies carried out successfully. The optimum *p*H for reaction 1 is 7·5 and Q_t values for pulp tissue are in the order of 10–12. Studies on the rate of glutamic acid formation, compared with the associated aspartic acid decrease, indicate a greater formation of the former than can be accounted for by loss of aspartic acid. This problem is at present under investigation.

Fuller accounts of this work will be published elsewhere.

Our thanks are due to Prof. E. Matthews, in whose Department the work is being carried out, for help and advice.

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Amino-acid Composition of Crotoxin

THE first snake-venom prepared in the pure crystalline form was crotoxin from *Crotalus terr. terr.* as described in 1938; at that time only its cystine and methionine contents were quantitatively determined[1]. This protein, with a molecular weight of 30,000[2], proved to be homogeneous[3] in the ultracentrifuge[3] as well as by electrophoresis[4].

We hydrolysed each time 10 mgm. recrystallized crotoxin in 10 ml. of 6 *N* hydrochloric acid (five times redistilled) for 18 hr. at 120° in closed glass tubes. After removal of the acid in the usual manner, the mixture of amino-acids was analysed by paper chromatography.

The two-dimensional chromatogram on Whatman paper No. 1 with *n*-butanol + acetic acid (40 vol. *n*-butanol, 10 vol. glacial acetic acid, 50 vol. water) in the first, and phenol saturated with water at room temperature in the second, dimension is shown in the accompanying figure.

The following amino-acids could be identified:

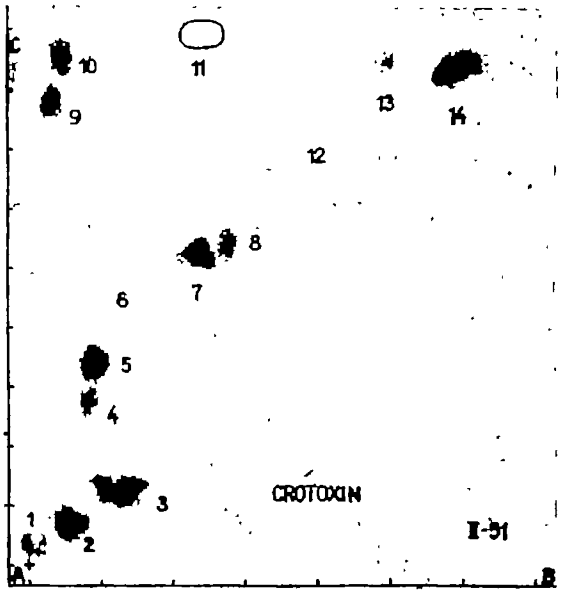
(1) Cystine
(2) Aspartic acid
(3) Glutamic acid
(4) Serine
(5) Glycine
(6) Threonine
(7) Alanine
(8) Tyrosine
(9) Lysine
(10) Arginine
(11) Proline
(12) Valine + methionine
(13) Phenylalanine
(14) Leucine + *iso*leucine

The identification of these amino-acids was checked by control experiments with mixtures of pure amino-acids under identical conditions.

It is known that valine + methionine (12) and leucine + *iso*leucine (14), when using the above-mentioned solvents, do not separate in the chromatogram. We therefore carried out two parallel one-dimensional chromatograms at pH 8·4 with *m*-cresol[5]: one with the crotoxin hydrolysate, the other with a mixture of pure valine and methionine. This showed clearly that valine as well as methionine are present in the hydrolysate.

Two one-dimensional chromatograms in *n*-butanol + benzylalcohol[5] run in parallel, one with a mixture of leucine and *iso*leucine, showed that these two amino-acids are both present in the hydrolysate.

The determination of histidine proved difficult at first. Although we could detect traces of a colour spot with ninhydrin in a one-dimensional chromatogram on Whatman paper No. 1 (using the *n*-butanol – acetic acid mixture), no sign of this amino-acid appeared in the two-dimensional chromatogram (see figure). We therefore ran another one-dimensional chromatograph, on Whatman paper No. 3, which makes it possible to apply larger amounts of hydrolysate and still obtain a good separation.



Hydrolysate of 150 μgm. crotoxin applied at +. Run with butanol + acetic acid in direction *A* → *B*, then in direction *A* → *C* with phenol in an ammonia atmosphere; Whatman paper No. 1

The existence of a small quantity of histidine in the crotoxin was proved by the following procedure: two chromatograms of the hydrolysate were run under identical conditions and developed, one with ninhydrin, the other with consecutive sprays of sodium carbonate and diazotized sulphanilic acid solutions. By means of this reaction (Pauly), the two red spots characteristic of histidine and tyrosine were found.

To detect hydroxyproline, one-dimensional chromatograms of hydrolysates of 100–200 μgm. crotoxin in buffered *m*-cresol were run on Whatman paper No. 1 and 3; neither with ninhydrin nor with isatin[6] were we able to detect any trace of hydroxyproline. From the molecular weight of 30,000[2] it can be computed that, if only one molecule of hydroxyproline is included in the crotoxin molecule, hydroxyproline would represent 0·4 per cent of the crotoxin. But even with amounts of hydrolysate corresponding to 1,000 μgm. of crotoxin on Whatman paper No. 3, it was not possible to detect any trace of hydroxyproline, either with ninhydrin or isatin, although control experiments showed that 3–4 μgm. hydroxyproline are easily made visible in this way.

As tryptophan had already been determined in crotoxin[7], we did not examine any alkaline hydrolysate.

A recently published paper[8] describes the electrophoretic separation of the neurotoxic part of the venom of *Crotalus terr. terr.* By hydrolysation and two-dimensional paper chromatography, the presence of fifteen amino-acids was established; the results differ from ours in that arginine, histidine and valine were not found.

Summarizing our results we can now assert, beyond any doubt, that crotoxin contains the following eighteen amino-acids: arginine, histidine, lysine; aspartic and glutamic acid; phenylalanine, tryptophan, tyrosine; glycine, alanine, valine; leucine, *iso*leucine; proline; serine, threonine; cystine, methionine.

We are indebted to the Instituto Pinheiros, São Paulo, which generously provided crude rattle-snake venom for our experiments.

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Tyrosinase and Polyphenoloxidase; the Role of Metallic Ions in Melanogenesis

SOME years ago it was suggested that the first step in melanogenesis, the oxidation of tyrosine to *o*-dihydroxyphenylalanine, can be represented by the following general reactions:

(1) *o*-dihydroxyphenol → *o*-quinone → intermediate products → melanin;
(2) *o*-quinone + monohydroxyphenol + H_2O = 2 *o*-dihydroxyphenol;

and that of these reactions only the first is really enzymic[1].

The apparent different specificity of enzymes of animal and of vegetable origin towards monohydroxy- and *o*-dihydroxy-phenols has led me to re-examine the possible role of metallic ions in the enzymic oxidation of *o*-dihydroxyphenylalanine and of tyrosine.

In this work the copper-free protein of potato-polyphenoloxidase was used, prepared in a manner similar to that described recently[2]. The total reaction volume in each Warburg flask was 2·5 ml.; this included 0·25 ml. of enzyme (corresponding to 15 enzyme units as defined by Lerner *et al.*[3]), varying amounts of metals (between 0·00005 and 0·0016 millimol. in presence of phosphate, and between 0·00005 and 0·02 millimol. in presence of citrate buffer) and the substrates (in side-arms).

I found, in agreement with Kubowitz[4] and with Keilin and Mann[5], that copper is strictly specific and cannot be replaced by any other metal as the prosthetic group of the enzyme. Once the enzyme is saturated by the relatively small amount of copper which it requires, it becomes fully active towards catechol and *o*-dihydroxyphenylalanine (reaction 1), and this activity cannot be augmented by excess of copper or of any other metal. However, I found that reaction 2 between *o*-quinone and tyrosine, that is, the oxidation of tyrosine, is catalysed by free and non-protein-bound metallic ions. Here, there is very little specificity: cobalt, nickel, vanadium and copper are all active, though copper is about 2·5 times as active as the other three. Iron, zinc, chromium, manganese and magnesium are inactive. Vitamin B_{12} appears to be inactive, or not more active than the cobalt which it contains, although physiologically it seems to participate in tyrosine metabolism[6]. Cytochrome *c* is not only inactive but also it inhibits slightly reaction 2. It is interesting to note the complete inactivity, in both *o*-dihydroxyphenylalanine and tyrosine oxidation, of zinc, which catalyses specifically the reaction 2-carboxy-2,3-dihydroindole-5,6-quinone → 5,6-dihydroxyindole[7]; the formation of these compounds thus appears even more problematical, or can only be of secondary importance, in melanogenesis[2].

EFFECT OF METALS ON THE RATE OF OXIDATION OF *o*-DIHYDROXYPHENYLALANINE (DOPA) AND OF TYROSINE

Molar concentration	Time (min.) required for half-oxidation of 1 mgm. Dopa	Time (min.) required for half-oxidation of 0·90 mgm. tyrosine + 0·05 mgm. Dopa
0·00002 Cu	9	180
0·001 Cu + 0·00002 Cu	9	40
0·001 Ni + 0·00002 Cu	9	95
0·001 Co + 0·00002 Cu	9	102
0·001 V + 0·00002 Cu	9	109

Although the transformation of tyrosinase in polyphenoloxidase during the purification process has been known for a long time and has given rise to much theorizing[8], this is the first time, so far as I know, that polyphenoloxidase has been transformed into tyrosinase.

Tyrosinase corresponds to the system polyphenoloxidase + *o*-quinone + metallic ions, the latter functioning probably as electron transmitters in the non-enzymatic reaction between tyrosine and *o*-quinone. Consequently it is difficult to see any justification for retaining the term 'tyrosinase', except as a reminder of the fundamental researches of G. Bertrand and H. S. Raper.

Details of this work will be published elsewhere.

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Fertilizing Capacity of Spermatozoa deposited into the Fallopian Tubes

IN the natural sequence of mammalian fertilization, the spermatozoa await the arrival of ova in the Fallopian tubes. The time of waiting may vary from 6 hr. (rabbit), 24 hr. (ferret), 20–30 hr. (pig, sheep and cattle) up to perhaps several months (bat)[1]. Since the transportation of sperm from the vagina to the upper part of the tube is very rapid (a few minutes to 6 hr.[1]), and since the number of spermatozoa present at the site of fertilization is very small[1], this time interval is not necessarily for the accumulation of a large number of spermatozoa to ensure fertilization. The following experiment demonstrates that such a period of time in the female tract is required for the spermatozoa to acquire their fertilizing capacity.

Doe rabbits were injected intravenously with sheep pituitary extract to induce ovulation, which occurs about ten hours later. Ejaculated sperm collected with an artificial vagina was diluted about 1 : 10 with Ringer solution containing penicillin. At various intervals before or after ovulation, four to six does were operated on under ether or nembutal anæsthesia. Flank incisions were made, and about 0·03–0·05 ml. of sperm suspension (0·2–1 million of spermatozoa) was deposited into the upper part of each tube through the infundibulum. Care was taken to avoid injury of the tube and the connective tissues. The animals were sacrificed 36–42 hr. after operation. The ova were recovered from the tubes and examined immediately under stereoscopic and compound microscopes. Only regularly cleaved ova, very often with sperm in the zona pellucida or in the perivitalline space, were regarded as fertilized. The results are presented in the accompanying table.

FERTILIZING CAPACITY OF RABBIT SPERMATOZOA DEPOSITED INTO THE FALLOPIAN TUBES AT VARIOUS INTERVALS

Tubal insemin. Hr. before (+) or after (−) ovulation	No. of rabbits	Ovulation points	Ova recovered	
			Total	Per cent fertilized
−2	5	58	40	0
−1	2	14	10	0
+2	5	42	31	0
+4	5	39	34	6
+6	4	49	41	78
+8	5	50	47	55
Controls (mating) −2	2	20	14	43
Controls (mating) +2	1	13	13	100
Controls (uterine sperm) −2	2	20	15	13
Controls (uterine sperm) +2	2	13	12	75

It is quite clear that fertilization occurs when the spermatozoa have been in the tube for six hours before ovulation, which is perhaps the time required for a physiological change in the spermatozoa enabling them to attain fertilizing capacity.

Sperm were observed in the albumen coat of unfertilized ova following tubal insemination shortly before ovulation. Lack of fertilization from tubal inseminations two hours before or after ovulation was not due to a substance in seminal plasma harmful to the ova[2]. When epididymal sperm were employed (one animal in each group) similar results were obtained. Nor was it due to such a substance in the sperm, or to the harmful effects of operational procedures. Control experiments were performed in which tubal insemination, two hours before or after ovulation, was made to does mated with fertile bucks; all control females had ova fertilized.

Fertilization by sperm deposited into the tube two hours before or after ovulation was, however, obtained when the sperm used had previously been incubated in the uterus of another doe. The semen used in this experiment had been recovered five hours after injection into the œstrous uterus.

Hammond[3] has estimated the period for which the ovum remains capable of being fertilized. He obtained an average litter size of 0·2 young from does mated two hours after ovulation. Assuming four hours for transport of sperm, he concluded that fertility of the ovum after ovulation lasted about six hours at the most.

If this estimate is accepted, it would seem that lack of fertility from tubal insemination four hours before ovulation (or later) was due to loss of fertility in the ova before it was gained in the sperm. It may be, indeed, that the time needed for sperm transport is less than four hours and hence, possibly, the maximum duration of fertility of the ovum is also less. If so, sperm deposited in the vagina in Hammond's experiment must, in passing through cervix and uterus, have acquired fertilizing capacity more rapidly than sperm placed, in the present experiment, directly into the Fallopian tube.

On the other hand, if those sperm required six hours to develop fertilizing capacity, the estimate of duration of fertility in the ovum has to be slightly extended. Another possibility is that sperm are 'activated' in the œstrous uterus, but not when that organ comes under the influence of progesterone.

Fertilized rabbit ova[4] and normal pregnancy of mice[5] were observed when sperm was deposited into the tubes. So far as I am aware, no previous experiment for determining the time relationship between the deposition of sperm and ovulation has been reported. The metabolism of epididymal spermatozoa differs from that of ejaculated spermatozoa[6], demonstrating an influence of environment on the physiology of sperm. The present finding indicates a possible physiological change of spermatozoa in the female tract; this may also explain the lack of success of attempts to fertilize mammalian ova *in vitro* with ejaculated or epididymal sperm. Further study may explain aspects of sterility due to incompatibility between the environment of the female tract and spermatozoa.

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Birth Coats of Australian Merino Lambs

WITH one exception, little attention appears to have been paid to the birth coats of lambs, despite the great variability which exists and their potential value in selection in practical animal breeding. The exception is the work initiated by Dry[1,2] with the Romney Marsh breed in New Zealand.

Using the South Australian (Bungaree) merino, observations on birth coats were commenced at this College in 1944. Initially the investigation comprised two phases: (*a*) the genetic background of the birth-coat differences, and (*b*) the use of birth-coat characters as an indicator of adult fleece characters. During the past two years, an additional phase has been added, namely, the gross morphology of the fibre types and their relationship to the series of grades used.

Grading is based on the nature of the coat over the lumbar and sacral regions, and is carried out when lambs are 1–4 weeks of age. For recording purposes a series of six grades have been used. Grade 1 represents a fine birth coat in which the locks are arranged in small spiral tufts. The succeeding three grades are based on an increasing abundance of halo hairs, which appear as a long outer coat above the fine and short inner coat. In grade 5 the halo hairs are so dense that there is no obvious distinction between outer and inner coats. Grade 6 is an extreme development in which it is also impossible to distinguish outer and inner coats and in which the fibres are grouped in large spiral tufts.

The study of the morphology of the fibre types and their incidence in the various grades is not yet complete; but it seems certain that the principal types of fibres described by Dry[1] are also found in the Australian merino.

The work of Dry and Fraser (cited by Fraser[3]) suggested that the coarse birth-coat grades of the New Zealand Romney Marsh breed were the result of a single dominant gene. This observation led us to dichotomize the data between grades 4 and 5, and to examine the results on a 'fine' v. 'coarse' classification. It was postulated that the 'coarse' grades were the result of a single dominant gene and that all parents graded 'coarse' were heterozygous. Examination of pedigrees and breeding performance indicated that this latter postulate was quite reasonable. There is evidence that, as mature animals, there has been some selection against the 'coarse' grades; this selection may have been more severe against homozygous dominants. Denoting coarse grades by *Aa* (heterozygotes) and fine grades by *aa*, the accompanying table shows the results of the three possible matings.

Mating	Progeny grading	
	Coarse (*AA* + *Aa*)	Fine (*aa*)
Aa × *Aa*	17	7
Aa × *aa*	69	84
aa × *aa*	6	108

With the exception of matings in line 3, there is good agreement with the single dominant gene hypothesis. The occurrence of 'coarse'-coated progeny from the mating of fine-coated parents at first sight appears to invalidate the postulate. However, such a position could arise either from misgrading of animals or from complications arising from incomplete penetrance and expressivity. As the six individuals and their parents are in grades 1, 2 or 3, misgrading is unlikely to be the cause of the discrepancy. The fact that the six individuals are all progeny of one ram suggests that the latter alternative is more probable, and that this ram, with birth-coat grade 3, had, in fact, a 'coarse' genotype. Fraser[3] records similar discrepancies in the Romney Marsh breed.

Observations to date on the correlation between birth-coat grade and characters of the adult fleece may be summarized as follows. Increasing birth-coat grade is associated with increasing variability of fibre diameter and decreasing number of crimps per inch; but it does not appear to be associated with mean fibre diameter. Under favourable nutritional conditions there is a close association between mean fibre diameter and crimps per inch in the fine birth-coat grades, but a much lower association in the coarse grades. There is a suggestion in our data that this association in the fine grades does not hold so strongly under conditions of poor nutritional environment.

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Cultivation of Canine Hepatitis Virus in Embryonated Hen's Eggs and its Subsequent Transmission to Dogs

Virus hepatitis of dogs was described by Rubarth[1] in 1947 in Sweden, and since then a natural epidemic of the disease has been observed in Britain[2]. From the organs of two dogs dying during this epidemic, the infective agent has been cultivated by the inoculation into the yolk sac of embryonated hen's eggs for twelve successive passages, after which it was passaged back to dogs with reproduction of the disease.

Portions of the liver and lungs from the two original cases or, later, parts of the yolk sac and embryo liver were prepared as inocula by grinding with sand and mixing with broth containing 70 per cent inactivated horse serum and 7·5 per cent glucose to make a 10 per cent w/v suspension, and storing at – 70° C. After the addition of 500 units of penicillin and streptomycin per ml., or filtration through a 'Gradocol' membrane of average pore diameter of 640 mμ, 0·2 ml. of the inoculum was inoculated into the yolk sac of 6th-day embryonated hen's eggs. The first-passage eggs were harvested on the sixth day after inoculation and no abnormalities were detected. In subsequent passages, half the four to six eggs inoculated were harvested on the sixth day thereafter and the remainder on the tenth day. In the second passage, one of four embryos died while three of the four showed hæmorrhages in the liver. With succeeding passages the proportion of deaths increased until, during the fifth passage and after, half the embryos died before the tenth day. These eggs were bacteriologically sterile on culture. From the fifth passage also nearly every embryo inoculated showed hæmorrhage and necrosis of the liver, with ascites in some cases. Macroscopically the liver lesions varied from small pale opaque areas near the lower margin to a condition approaching complete necrosis, which microscopically were confirmed as circumscribed or large areas of necrosis with either karyorrhexis or complete disappearance of the nuclei. In the areas in which hæmorrhages were present, there was evidence of necrosis of the wall of small vessels with damage to the endothelial cells. Inclusion bodies were not found.

Material from the twelfth passage was made up as a 2 per cent suspension in serum broth, filtered through a 'Gradocol' membrane of 750 mμ average pore diameter and passed back to dogs by inoculating 0·05 ml. intraocularly under general anæsthesia into two seven-weeks-old greyhound pups born and reared in isolation. The reaction of these animals to inoculation was followed by clinical observations for twenty-one days and by testing for specific antigen and antibodies by Larin's technique[4].

Pup 1 showed no eye reaction, nor any clinical signs of illness for twenty-one days, but the complement fixation test demonstrated the subsequent development of specific antibodies. Pup 2 developed a marked diffuse dense central opacity of both corneas on the third day after inoculation, which decreased slowly without any vascular reaction until the eighth day. From the third to the sixth day the pup showed increasing malaise, reduced food intake and unformed stools, with a rise of temperature of less than 1° F. The dog was destroyed when clinically convalescent on the eighth day. Macroscopically the internal organs were normal, but microscopically the liver showed vacuolation of cytoplasm and loss of nuclei in the centrilobular liver cell columns; no inclusion bodies were seen. Serological examination showed no antibodies in the blood, but the presence of specific antigen was detected in the liver, from which the virus was passaged to a third dog.

Liver from pup 2 stored at − 30° C. for three months was made up as a 10 per cent w/v purified suspension in saline[4] and inoculated into an eight-weeks-old mongrel pup No. 3, injecting 0·05 ml. into each eye and 10 ml. intraperitoneally. The pup developed a diffuse light central opacity of both corneas on the seventh day, which disappeared in 48 hr. without any vascular reaction, coinciding with which was a morning hyperthermia of 103·6°–104° F.; the dog thereafter was normal. Serological tests showed the presence of specific antigen in the blood on the ninth day and the appearance of antibodies from the twenty-eighth day onwards.

The clinical signs of systemic illness produced were mild, but quite definite; a similar syndrome, including the corneal lesions, has been observed in natural epidemics[2] and in experimental infections[3] of canine virus hepatitis. This diagnosis of specific virus hepatitis is supported by the detection of antibodies in the survivor of the first passage (pup 1) and of antigen in the liver of pup 2, and the confirmation of the presence of virus in this liver by the second passage inoculation into pup 3, which afterwards showed clinical illness with specific antigen and antibody in the blood.

These results show that from cases of virus hepatitis in dogs an agent can be grown in embryonated hen's eggs after yolk-sac inoculation, and that material from the twelfth egg passage filtered through a 'Gradocol' membrane can cause the clinical disease in dogs with the occurrence of specific antigen in liver and blood and of specific antibodies in the blood.

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Rapid Rate of Turnover of Potassium Ions in Kidney Slices

The steady-state turnover-rate of potassium ions in guinea pig cortex slices *in vitro* was measured by the isotope procedure developed by Krebs, Eggleston and Terner[1]. There is a rapid initial loss of potassium when kidney slices are placed in physiological saline solutions, but if 0·01 *M* α-ketoglutarate is present, the slices reabsorb the lost potassium[1] and maintain the initial concentration during at least the interval from 25 to 35 min. after the start of the incubation. When this steady state had been reached, potassium-42 chloride was added to the medium and the tissue removed either two or four minutes later. Measurements were then made of the radioactivity and the potassium content of tissue and medium with a liquid counter[2] and a flame photometer[3]. Typical results are shown in the accompanying table.

Turnover of Potassium in Kidney Cortex Slices

Guinea pig tissue suspended in 2 ml. bicarbonate saline containing 0·03 *M* glucose and 0·01 *M* α-ketoglutarate. Potassium-42 chloride added after 25 min. preliminary incubation

Incubation time after addition of potassium-42 ions		2 min.
Fresh weight of tissue		240 mgm.
Potassium ions in tissue	before incubation	17·5 μmol.
	after incubation	17·3 μmol.
Potassium ions in medium		12·6 μmol.
Radioactivity of medium	before incubation	5,320 counts/min.
	after incubation	3,680 counts/min.
Potassium ions exchanged		2·8 μmol./min.
Turnover of tissue potassium ions		16 per cent/min.

The turnover-rate (v/b) was determined from the formula[1]:

$$v = \frac{ab}{t(a + b)} \ln \frac{bx_0}{x(a + b) - ax_0},$$

where v is quantity of total potassium passing from tissue to medium, and in the opposite direction, per unit time; a is quantity of total potassium in medium; b is quantity of total potassium in tissue; x_0 is quantity of potassium-42 added to the medium at time $t = 0$; x is quantity of potassium-42 in medium at time t.

The average rate of turnover from eight experiments was 15 per cent/min. This means that an amount equal to the whole potassium content of the cells leaks out, and is absorbed against a concentration gradient, about every seven minutes. This rate of nine times an hour or more than two hundred times a day is the fastest so far found, being nearly twice that in retina[1], four times that in brain[1] and about five hundred times that in red blood cells[4-6].

A full account of this work will be submitted for publication in the *Biochemical Journal*.

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Non-adaptive Characters in Evolution

In a recent communication[1], Dr. A. J. Cain holds that we must now accept that there is no evolution of non-adaptive—or neutral—characters in Nature. He holds this on the ground that certain characters that were previously thought to be neutral have been shown to be correlated in distribution with environmental conditions, and may therefore have some selective value. He thinks that selective value should be assumed in all characters until the contrary is proved.

The subject is controversial; many biologists believe that much differentiation, especially of the minor or trivial differences of micro-evolution, is non-adaptive[2]. Also the subject is complex, and not one that can be adequately discussed in letters in *Nature*. But it may be worth while stating some general grounds for not agreeing with Cain's conclusion, even if we were to admit the selective value of the recently investigated characters that he mentions.

I think it is true that the present position is as follows. Wright[3] has given a theoretical basis for belief that non-adaptive evolution is possible under certain conditions. Many biologists accept his theoretical views and believe that the required conditions occur commonly in Nature. So long as no objections generally accepted by biologists as valid are raised against Wright's theory, we cannot, I think, disregard it, though our estimates of the relative importance of adaptive and non-adaptive evolution must in the end certainly depend on observation and experiment. Differentiations in natural populations are exceedingly various and of different genetic types, and unfortunately very few have yet been adequately investigated.

To assume on the evidence of these few investigations that all differentiation is adaptive seems to me unjustified. I believe that we should at present adopt a more cautious attitude. We must, I think, accept non-adaptive evolution as theoretically possible and, until it is shown to play no significant part in natural differentiation, we must give it a place in our general view of evolutionary theory. In the future we may be able to reach a sounder estimate of its importance, and the many biologists who now believe that it plays a significant part may then be shown to be wrong. We cannot now assume that they are. This was the attitude that I tried to adopt in writing the account of evolutionary theory[4] to which Cain refers.

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The Interglacial Beds at Hoxne, Suffolk

RECENT attempts by Woldstedt[1,2] to correlate the Pleistocene sequence in south-east England with that in northern Germany are based on the two marine horizons in each area: the correlation of the March Gravel in England with the Skaerumhede Series on the Continent is probably correct on faunal grounds, and the correlation of the Corton Beds of East Anglia with the deposits of the Holstein Sea in Germany is possibly right, though more confirmation is needed from the fossils. Woldstedt's chief difficulty was to fit the three glacial stages of Germany to the four glacial stages found in East Anglia, and this problem turns on the recognition of an equivalent of the Hoxne Interglacial of Suffolk in Germany. It is therefore important to summarize what is known so far of the interglacial beds at Hoxne.

The general geology of the surroundings of Hoxne is well known, consisting of a till or boulder clay made mostly of Bunter and Jurassic material with some chalk and flint, resting on chalky sand and gravel with occasional marine shells and plates of barnacles. This series forms a plateau at about 130–150 ft. above sea-level, and is eroded by the present stream valleys. The freshwater beds at Hoxne have been formed in a hollow in this plateau boulder clay, and all past investigators agree that they are earlier than the erosion of the modern valleys[3–7]. Enlargement of the brickworks in recent decades has exposed sand and stony brickearth overlying the freshwater series, which have been considered as formed under glacial or peri-glacial conditions[6–8].

The freshwater series represents a climatic succession which has been worked out in great detail, and plant remains collected by Clement Reid[5] show that the oldest clay (Bed *E*), resting on the bottom till, was formed in still water in a temperate climate; after this, a lignite Bed *D* was formed, representing an alder thicket; lacustrine conditions were next responsible for a black loam (Bed *C*), with some arctic plants; a cold climate continued, with the formation of peat and thin gravel layers (Bed *B*); and finally, temperate conditions returned during the deposition of the top blue silt (Bed *A*). The whole of these lacustrine and marsh beds were finally covered by the stony loams representing arctic conditions. The freshwater shells from the lacustrine series confirm the evidence of the plant remains, and the pollen analyses from Beds *B* and *A* point to surrounding birch and pine forest during stage *B* giving place to oak–alder forest with elm and lime at the beginning of Stage *A*[7]. Few large mammals have as yet been traced to definite horizons, but mammoth and ? reindeer have been recorded from Bed *B*, and horse, red deer and beaver from Bed *A*. On the evidence we have at present, it is not advisable to consider the cold episode *C* as a separate 'glaciation'.

Unfortunately, these mammals cannot yet be used for long-distance correlations; but the matrix and erratics in the till at the base of the series are identical with those in the Lower Chalky (Lowestoft) Till of this region, and a completely new assemblage of erratics appears in the top glacial or peri-glacial stony bed, which agrees with that in the Upper Chalky (Gipping) deposits in the areas south and west of Hoxne. So far as our present evidence goes, therefore, the bottom glacial deposit at Hoxne is the upper glacial deposit of the sequence farther east in Suffolk[8], and the top glacial bed at Hoxne is contemporaneous with the lower glacial bed at Brandon[9] and in the Fen District[10]. The main erratics from this top bed used for correlation include a lump of orthoclase felspar, olivine-basalts, schistose grits and augen gneiss. These rock-types are unknown in Suffolk earlier than the Gipping glacial horizon. This geological evidence can be summed up by saying that the Hoxne freshwater beds were formed during an important interglacial stage, and that this stage is the second of the three interglacials so far recognized in Suffolk.

This geological dating agrees well with the archæology. Implements have only been found in place in Beds *A* and *B*, and include High Lodge or Clactonian III flakes[7] and Acheulean bouchers or hand-axes. The bouchers were called "Late Acheulean" by Moir; but a recent examination of about thirty specimens, including ten found recently, has shown that none of them is as late as the Final Acheulean of the French classification, and in my opinion should be identified with the "Late Middle" Acheulean at the end of the Swanscombe series in Rickson's pit[11]. This conclusion is based on a combination of characters including the proportion of ovates (30–40 per cent of those examined), thickness in relation to width, number and depth of flake scars, amount of controlled flaking and secondary work and the extent to which tranchet blows were used. Also an unusually high percentage (44 per cent) have twisted edges. Finally, Levalloisian specimens make their first appearance in the Hoxne sequence in the top glacial bed, which helps to confirm the conclusion that the Hoxne interglacial is contemporaneous with Swanscombe but earlier than Brundon.

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Light Filters of Coloured 'Perspex'

Light filters of coloured glass and gelatin are in common use for visual and photoelectric photometers. They are satisfactory, on the whole; but the glass filters are easily broken, and those of gelatin require to be mounted between glass to protect them from water. The transparent polymethyl methacrylate 'Perspex' is now obtainable in several colours and in sheets. This material is very tough and difficult to break, but is easily worked, and can be cut with a saw. The spectral characteristics of the different kinds of coloured 'Perspex' are not such as to make them directly usable as light filters in photoelectric photometers, because of considerable transmission in the red and infra-red by those which are violet, blue and green (Fig. 1); but by combining sheets of the coloured 'Perspex' with the Ilford copper red-absorbing gelatin filter 803, a set of nine serviceable light filters, covering the visible spectrum, has been prepared (Fig. 2), and these have been found to be sturdy and almost unbreakable, and well suited to laboratory use.

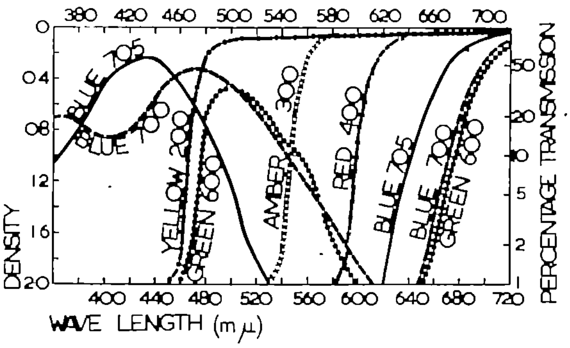

Fig. 1. Spectral transmissions of coloured 'Perspex', ⅛-in. sheets.

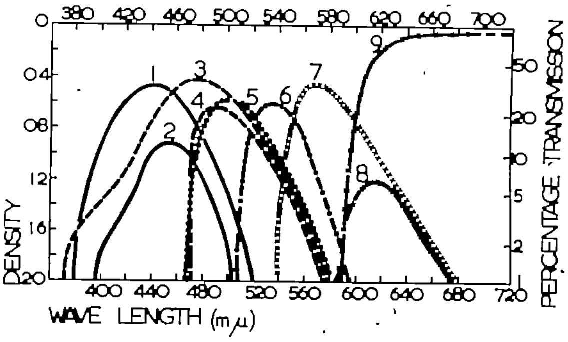

Fig. 2. Spectral characteristics of light filters made from coloured 'Perspex' and Ilford gelatine filter. (See table)

The gelatin filter is placed between two sheets of 'Perspex', either coloured + colourless or of different colours, and the edges bound with 'Perspex' cement, 'Cellophane' tape or gummed paper. The combinations which have been found most useful for photoelectric colorimeters are given in the accompanying table. The 'Perspex' used was cut from coloured ⅛-in. sheet material; and the red-absorbing filter was Ilford sheet gelatin No. 803. Messrs. Allan Industries, Farnham Common, Bucks, prepared the filters for use.

Light Filters of Coloured 'Perspex' and Ilford 803

Final colour	Max. transmission (mμ)	Coloured 'Perspex' No.	Ilford gelatin
1. Violet	440	Blue, 705	803
2. Blue-violet	455	Blue, 705 +blue, 700	803
3. Blue	470	Blue, 700	803
4. Blue-green	490	Blue, 700 +yellow, 200	803
5. Green	500	Green, 600	803
6. Yellow-green	530	Yellow, 200	803 + 110
7. Yellow	570	Amber, 300	803
8. Orange	615	Red, 400	803
9. Red	>630	Red. 400	—

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Solution of Polynomial Equations with the Aid of the Electrolytic Tank

A. Bloch[1] recently extended to complex coefficients Lucas's method[2] of the solution of polynomial equations with the aid of an electrolytic tank. Points of the tank represent complex numbers either directly or after a conformal transformation. In the extended method, sinusoidal currents, in complex vector notation proportional to the residues of a certain rational function with simple poles, are impressed at points corresponding to these poles. Then the points at which the electric field is circularly polarized correspond to the roots of the polynomial equation. The root-points can be found by exploring the tank systematically.

Bloch gave no indication of how his extension could be practically realized. Relevant practical tank measurements[3,4] had been carried out with all electrode currents in phase and one electrode earthed. Consequently the twin-probe assembly which, up to this time, had been used to measure electric field gradients had to be connected to a differential amplifier.

We found that a very satisfactory system of establishing adjustable complex electrode currents can be based on the use of a transformer with a floating and tapped secondary winding. Sets of small numbers of parallel admittances, say six, that are in the ratios 1 : 10 : 100 : $(1 + j)$: $(10 + 10j)$: $(100 + 100j)$, are connected to a limited number of tappings, say, at 0, ± 20, ± 40, ± 60, ± 80 and ± 100 volts. Then any current can be adjusted with an accuracy of 1 in 1,110, any point of the electrolyte can be earthed and an ordinary amplifier and a vibration galvanometer used as detector. A Wagner auxiliary earth eliminates the entry of undesired additional currents at the earthed point. For picking up the gradients in two perpendicular directions a quadruple probe assembly can be used, and it is possible to employ a passive network composed of resistors and condensers that has zero output when the field applied to the quadruple probe assembly is circularly polarized. A passive differential network consisting of a parallel twin-T of resistors and condensers can be designed in such a way that the effects of a maladjustment of the Wagner earth are minimized, so that the Wagner earth requires only occasional adjustment while the tank is explored. Further, it was found that the effect of rotating the quadruple probe assembly when exploring the tank, and injecting in series with the vibration galvanometer a suitable small external voltage, was to make the influence of stray voltages induced in the leads and the amplifier innocuous.

The accuracy of the procedure described can be predicted by mathematical formulæ into which values for the estimated inaccuracy in the setting of the electrode currents and in the positions of the electrodes, as well as the value for the sensitivity of the detector, are substituted. An iterative procedure can be developed which permits the accuracy in determining the roots of polynomial equations to be increased at will.

The quadruple probe assembly can be employed also at a fixed point of the tank, and the current from, or the position of, an additional electrode can be considered the variable by the adjustment of which the field at the probe assembly becomes circularly polarized. This technique makes possible the quick computation of the values of a rational function with given poles for any complex argument. If the rational function has poles of higher order, these can be simulated by simple poles arranged symmetrically around the point in question. The currents to be impressed at these simple poles follow from the coefficients of Laurent's expansion representing an individual higher-order pole by formulæ which are similar to those used in the symmetrical components treatment of polyphase systems.

Theoretical and experimental work has been carried out at the Electrical Engineering Department of the University of Sydney and will be described in the *Australian Journal of Scientific Research.*

L. Tasny-Tschiassny
A. G. Doe

Electrical Engineering Department,
University of Sydney.
May 7.

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[1] Bloch, A., VIIth International Congress of Applied Mechanics, 4, Paper No. 28, 324 (London, 1948).

[2] Lucas, F., *C.R. Acad. Sci., Paris*, 106, 645 and 1072 (1888).

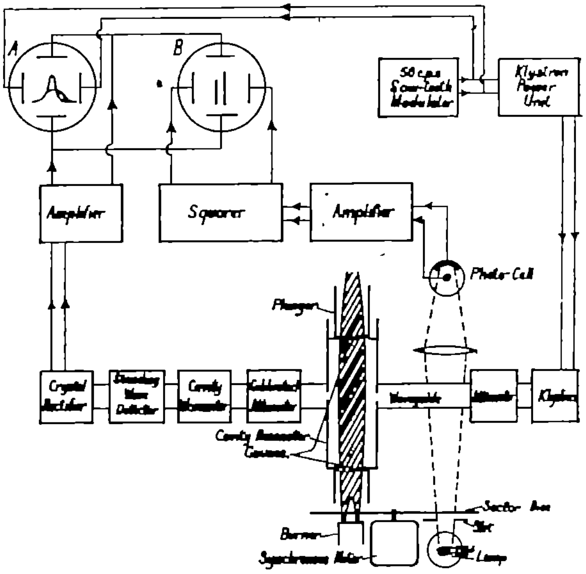
[3] Hansen, W. W., and Lundstrom, O. C., *Proc. Inst. Rad. Eng.*, 33, 528 (1945).

[4] Boothroyd, A. R., Cherry, E. C., and Makar, R., *Proc. Inst. Elec. Eng*, Pt. 1, 96, No. 99 (May 1949).

A Cavity Resonator Method for Electron Concentration in Flames

In the course of investigations on the electron concentration produced by evaporation of electrons from the carbon particles in the luminous flames of acetylene and air, it was found that the method of microwave attenuation described by Belcher and Sugden[1] was not sufficiently sensitive. A more sensitive method of obtaining this concentration is to determine the conductivity of the flame by measuring the change in characteristics of a cavity resonator when the flame is inserted in it.

The apparatus (see diagram) consists of a cylindrical water-cooled copper and brass cavity resonator, tuned by a plunger to oscillate in the $(TE,0,1,1)$ mode at about 9,800 megacycles per second. A cylindrical flame passes axially through platinum gauzes, at the base of the cavity and in the tuning plunger. These gauzes consist of radial and circular wires spaced so as to reflect most of the radiation falling on them, without noticeably impeding the flame. Energy from a 723 A/B klystron oscillator, frequency-modulated by a 50 c./s. saw-tooth wave, is fed into the cavity through an iris, and the transmitted energy passes through another iris into the receiving waveguide system, which includes a calibrated attenuator, a cavity wavemeter and crystal detector.



The output of the crystal is applied to the Y plates of two oscilloscopes A and B. The X plates of oscilloscope A are connected to the saw-tooth modulator so that it shows the frequency/amplitude characteristics of the resonator. The most convenient way of taking measurements has been achieved by chopping the flame at 12·5 c./s. with a rotating sector disk, which also interrupts light falling on a photocell, the output of which is amplified and applied to the X plates of oscilloscope B, giving two vertical signals relatively displaced, with amplitudes corresponding to the maximum power transmitted with and without flame; these amplitudes can be compared using the calibrated attenuator. This chopping also serves the useful purpose of preventing distortion and melting of the gauzes by the flame.

In this apparatus the change of resonant frequency of the cavity by the dielectric effect of the flame is small compared with resonance damping due to conduction in the flame, given by the following formula[2]:

$$\sigma = \frac{0 \cdot 00169\, R(t^{1/2} - 1)}{r^2 Q},$$

where σ(mho-cm.) is the conductivity of the flame of radius r cm. in a cavity of radius R cm., and with a Q factor of Q in the absence of flame; t is the ratio of the power transmitted by the cavity in the absence of flame to that in its presence. On the basis of the theory developed by Margenau[3,1], it can be shown that σ is proportional to the electron concentration, the factor of proportionality being sensibly constant under the present conditions and having a value of $1 \cdot 3 \times 10^{16}$. Whereas the direct attenuation method of Belcher and Sugden was only capable of measuring electron concentration to about 5×10^{9} per c.c., the present method is capable of extending this down to about 10^{8} electrons per c.c., that is, a pressure of 2×10^{-8} atmosphere at flame temperatures in the region of 2,000° K.

The flames studied contained about 20–30 per cent of acetylene and gave temperatures ranging from 2,240° to 2,180° K., both by Kurlbaum's method[4] and the sodium line reversal method[5], the cooler and more luminous flames being the acetylene-rich ones. According to a theorem of statistical thermodynamics[6] the number of electrons per c.c. in equilibrium with a solid is given by:

$$n = \frac{2(2\pi m_e kT)^{3/2}}{h^3} \cdot \exp(-\chi/kT),$$

where m_e is the electron mass and χ the thermal work-function of the metal. If the solid is not infinite in extent, however, and consists of N spherical particles per c.c. of mean radius $\bar{r}$, the exponential term will be modified to:

$$-[\chi + f(r)]/kT,$$

where $f(r) = (300\ ne)/(N\bar{r})$ electron volts. Preliminary observations by electron microscopy of the particles have shown $\bar{r}$ to be about 200 A., and theoretical calculation of the amount of carbon indicated 10^{11}–10^{12} particles per c.c., which should make $f(r)$ negligible compared with χ, which is 4·34 electron volts according to Reimann[7].

The results obtained with this apparatus show an electron concentration very near the theoretical value for flames very rich in acetylene, but falling off as the flame becomes hotter and richer in air to values of about one-quarter of theoretical. This is a greater divergence than corresponds with the estimated $f(r)$; but the methods of measurement of N and $\bar{r}$ require further development, and may allow of an explanation of this. The detailed results will be described elsewhere.

T. M. SUGDEN
B. A. THRUSH

Department of Physical Chemistry,
University of Cambridge.
May 22.

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[1] Belcher and Sugden, *Proc. Roy. Soc.*, A, 201, 480 (1950).

[2] Adler, *J. App. Phys.*, 20, 1125 (1949).

[3] Margenau, *Phys. Rev.*, 69, 508 (1946).

[4] Kurlbaum, *Phys. Z.*, 3, 187 (1902).

[5] Lewis and von Elbe, "Combustion, Flames and Explosions of Gases", chapter 19 (Camb. Univ. Press, 1938).

[6] Fowler and Guggenheim, "Statistical Thermodynamics", par. 1112, (Camb. Univ. Press, 1939).

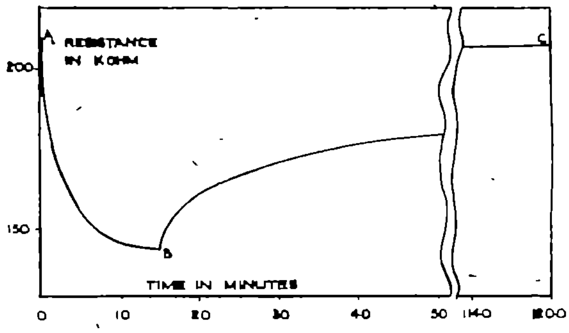
[7] Reimann, *Proc. Phys. Soc.*, 50, 496 (1938).

A Photo-conductive Effect in Tellurium Film

IN the course of measurements of the electrical resistance of thin films of tellurium on glass plates, it became clear that the resistivity of a film decreased on exposure to sunlight.

A tellurium film was placed in a dark box for a few days in order to make sure that it was settled in the dark state. Leads through the sides of the box permitted the measurement of the resistance of the film. The lid of the box was then removed so that direct sunlight could fall on the film. It was found that the resistance decreased rapidly at first and then slowly until a steady state was reached after about 15–60 min. exposure to light. The steady-state resistance value depended upon the light intensity but was about two-thirds of the resistance in the dark. On closing the box it was found that the film recovered its resistance value after about a day in darkness.

Measurements were made on a number of films prepared at different times, and in each case the effect was much the same. A typical resistance–time curve is shown in the accompanying graph. It was observed that the speeds of response of the various specimens were quite different even for samples which had been adjacent in the evaporating chamber.



AB, exposed to sunlight; *BC*, recovery in darkness

The speeds of response and recovery were compared by measuring the time taken for the resistance to reach the geometric mean of the initial and steady values. The recovery measurements were the more reliable as it was easier to maintain steady conditions in the dark box than when facing the summer sky. The response times as defined above varied between 2 and 14 min., and the recovery times between 20 and 100 min. There was no simple correlation between the response and recovery times. It will be noticed that the time-scale for this effect is very much greater than for those utilized in the normal photocells, which have response times of a small fraction of a second. It is thought that this effect might be used in photocells required to be insensitive to rapid fluctuations in illumination.

The tellurium films were formed on 3-in. by ½-in. glass slides. Platinum end contacts were deposited on the glass from a solution and fired at 700° C. The tellurium was deposited upon the slide by vacuum evaporation. The film thickness was of the order of 3×10^{-6} cm.

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W. T. BLACKBAND

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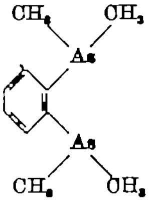
June 8.

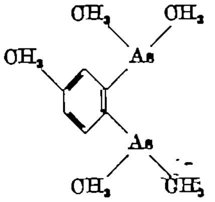
Stereochemistry of Gold

In its complex compounds, tervalent gold appears to be invariably four-covalent, the four bonds being co-planar and pointing to the corners of a square, as in $\mathrm{K[AuBr_4],2H_2O}$ [1]. This suggests the use of $5d6s6p^2$ bonds, which is in accordance with the observed diamagnetism of tervalent gold compounds[2]. The stereochemistry of univalent gold, however, is less well defined. As a rule, the co-ordination number is two, and examples of this include the anion[3] $\mathrm{[AuCl_2]^-}$ and the phosphine complexes of the type $[R_3\mathrm{P,Au}X]$, where X = halogen[4]. In those cases which have been investigated by X-rays, the two bonds to the gold atom are co-linear[5].

In contrast to the behaviour of univalent copper and silver, univalent gold shows a co-ordination number of four only very rarely. Meyer[6] reported a compound of the formula $\mathrm{(NH_3)_2AuCl}$, while Levi-Malvano[7] has described the triethylphosphine complex ammine $\mathrm{(NH_3)_2(Et_3P)AuCl}$. Complex thiosulphates of the type $M^{\mathrm{I}}_3\mathrm{[Au(S_2O_3)_2]}$ are well known[8], but it is uncertain whether the thiosulphate group behaves as a chelate group or is attached through one sulphur atom only; in the latter case the gold atom would be two-covalent. The compound $\mathrm{K[Au(CN)_2,dipyridyl]}$ has been studied by X-rays[9], and it was reported that the gold atom is square co-ordinated; this result is unexpected, for one might anticipate that four-covalent aurous complexes would be tetrahedrally co-ordinated, as is the case for the four-covalent complexes of univalent copper and silver[5]. The subject of the preparation and structure of the four-covalent complexes of univalent gold clearly offers a considerable field for investigation.



I



II

It seemed that the preparation of these complexes should be favoured by the use of suitable strong chelate groups, since the attachment of one molecule of the chelate compound, owing to its shape, prevents the use of linear *sp* bonds and hence might be expected to favour the addition of a second chelate molecule, resulting in the formation of four sp^3 tetrahedral bonds. Using the ditertiary arsine chelate group, *o*-phenylene*bis*(dimethylarsine) (I), a series of complexes of univalent gold, similar to those of univalent copper[10], has been prepared. By treating an alcoholic solution of chlorauric acid with the ditertiary arsine in the presence of a small amount of hypophosphorous acid and adding a little of the corresponding halide, compounds of the general formula $\mathrm{[Au(diarsine)_2]}X$, where X = a halogen, have been prepared. They are exemplified by the bromide, $\mathrm{[Au(diarsine)_2]Br}$, which is obtained as yellow crystals, melting point 226° C. (found, C, 28·0; H, 4·2 per cent; $\mathrm{C_{20}H_{32}As_4BrAu}$ requires: C, 28·3; H, 3·8 per cent). These compounds react with perchloric acid in alcoholic solution to yield the compound $\mathrm{[Au(diarsine)_2]ClO_4}$ as a white insoluble powder (found: C, 27·96; H, 3·8 per cent; $\mathrm{C_{20}H_{32}As_4O_4ClAu}$ requires: C, 27·7; H, 3·7 per cent). This substance decomposes with explosive violence when heated above 300° C. Its salt-like character is demonstrated by the conductivity of its solution in nitrobenzene (molecular conductivity = 28·2 mho at a concentration of $3{\cdot}05 \times 10^{-3}$ molar); the molecular conductivity of uni-univalent electrolytes in nitrobenzene[11] at the above concentration is usually about 20–30 mho. The formation of this perchlorate provides good evidence for the existence of the $\mathrm{[Au(diarsine)_2]^+}$ cation. These aurous compounds are diamagnetic, suggesting the use of $6s6p^3$ tetrahedral bonds. Their physical and chemical properties are being investigated further. Since the ditertiary arsine is strongly attached to the aurous atom, it is proposed to prepare the corresponding gold complexes of the unsymmetrical chelate group (II); if the four bonds to the gold atom are arranged tetrahedrally, it may be possible to effect a resolution into optically active forms, thereby establishing the stereochemistry.

Oxidation of these compounds yields complexes of the type $\mathrm{[Au(diarsine)_2]I_3}$, obtained as dark red crystals, melting point 246° C. (found: C, 21·1; H, 3·1; I, 32·6; Au, 16·9 per cent. $\mathrm{C_{20}H_{32}As_4I_3Au}$ requires: C, 20·9; H, 2·8; I, 33·1; Au, 17·15 per cent). Although this compound could be a perhalide, involving the $\mathrm{I_3^-}$ ion, its properties indicate that the gold atom is tervalent. If this be so, then the cation $\mathrm{[Au(diarsine)_2]^{+++}}$ will be square like the corresponding red diamagnetic nickel ion[12] $\mathrm{[Ni(diarsine)_2]^{++}}$.

A more detailed discussion of the preparation and properties of these compounds will be published elsewhere in due course.

R. S. NYHOLM

Sir William Ramsay and
Ralph Forster Laboratories,
University College,
London.
June 5.

[1] Cox and Webster, *J. Chem. Soc.*, 1635 (1936). See also Sidgwick, "The Chemical Elements and Their Compounds", 183 *et seq* (Oxford, 1950).

[2] Selwood, "Magnetochemistry", 103, 182 (Interscience, 1943).

[3] Wells, H. L., *Amer. J. Sci.*, 3, 315, 417 (1922).

[4] Mann and Purdie, *J. Chem. Soc.*, 1235 (1940).

[5] Sidgwick, "The Chemical Elements and Their Compounds", 137 *et seq.* (Oxford, 1950).

[6] Meyer, *C.R. Acad. Sci., Paris*, 143, 280 (1906).

[7] Levi-Malvano, *Atti R. Accad. Lincei*, 17, 857 (1908).

[8] McCluskey and Eichelberger, *J. Amer. Chem. Soc.*, 48, 136 (1926).

[9] Dothie, Llewellyn, Wardlaw and Welch, *J. Chem. Soc.*, 426 (1939).

[10] Kabesh and Nyholm, *J. Chem. Soc.*, 38 (1951).

[11] Foss and Gibson, *J. Chem. Soc.*, 3063 (1950).

[12] Nyholm, *J. Chem. Soc.*, 2061 (1950).

Dipole Moments of Aliphatic and Aromatic Amines

An investigation of the influence of the solvent on the dipole moments of aliphatic and aromatic amines was commenced some years ago[1]; but many of the results have not yet been published. A recent paper[2] has duplicated some of the work of this research. The accompanying table includes a selection of the measurements of the dipole moments of amines, some of which have not previously been determined. In the case of *n*-propyl and *n*-butylamines, the substituted anilines, with the exception of *n*-propyl and ethyl-*n*-propylanilines, and diphenylamine, which were investigated in benzene at 25° by Le Fèvre *et al.*[3], the agreement between the two sets of results is very good. No values of the dipole moments of di-*n*-propyl, tri-*n*-propyl, di-*n*-butylamines, *n*-propyl and ethyl-*n*-propylanilines, and of the other compounds in solvents other than benzene, are available. In the aromatic series, aniline has been studied in solution[1,3] and aniline and dimethylaniline in the vapour state[4].

The polarization at infinite dilution ($P_{2\infty}$), the electronic polarization (P_E) and the dipole moment (μ) in Debye units refer to solutions of the highly purified specimens of the amines in the solvents stated at 20·0° C. No correction is applied for the atomic polarization, and P_E is taken as the molecular refraction for D light of the pure compound.

Amine	Solvent	$P_{2\infty}$ c.c.	P_E c.c.	μ
n-Propylamine	hexane	59·0	19·4	1·38
	benzene	57·3	19·4	1·35
Di-*n*-propylamine	hexane	55·5	33·5	1·03
	benzene	57·1	33·5	1·07
Tri-*n*-propylamine	benzene	59·5	47·7	0·75
n-Butylamine	hexane	62·0	24·1	1·35
	*cyclo*hexane	61·8	24·1	1·35
	benzene	64·5	24·1	1·39
Di-*n*-butylamine	hexane	65·8	42·8	1·05
	benzene	67·3	42·8	1·09
Methylaniline	hexane	96·6	35·7	1·71
	benzene	93·4	35·7	1·67
Dimethylaniline	hexane	92·7	40·7	1·58
	benzene	93·5	40·7	1·59
Ethylaniline (see ref. 5)	hexane	100·2	40·4	1·70
Diethylaniline	hexane	120·8	50·2	1·84
	benzene	120·0	50·2	1·83
n-Propylaniline	hexane	104·8	45·1	1·69
	benzene	104·1	45·1	1·68
Ethyl-*n*-propylaniline	hexane	124·1	54·9	1·82
	benzene	125·2	54·9	1·84
Diphenylamine	hexane	79·7	58·2*	1·02
	benzene	79·9	58·2	1·02

* Obtained from measurements on solutions.

Measurements of the dipole moments of *n*-propyl and *n*-butylamines in the vapour state and in solution in benzene[2] have shown that both these compounds exhibit a positive solvent effect, that is, an increase of dipole moment in solution as compared with the value for the vapour. The present results in benzene confirm, and those in hexane extend, this conclusion.

The increase of dipole moment from ethyl to diethylaniline, which may be compared with the increase from *n*-propyl to ethyl-*n*-propylaniline, is found in both hexane and benzene.

In most of the examples in the table, the dipole moment changes only slightly with the solvent, while in others no differences between the moments are found.

E. G. Cowley

Acton Technical College,
London, W.3.
June 13.

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[1] Cowley and Partington, *J. Chem. Soc.*, 1598 (1938).

[2] Barclay, Le Fèvre and Smythe, *Trans. Farad. Soc.*, 47, 357 (1951).

[3] See, for example, Le Fèvre, Roberts and Smythe, *J. Chem. Soc.*, 902 (1949). Few and Smith, *J. Chem. Soc.*, 3057 (1949).

[4] Groves and Sugden, *J. Chem. Soc.*, 1782 (1937).

[5] μ = 1·68 D. in benzene at 20°: Cowley and Partington, *J. Chem. Soc.*, 1255 (1933).

Formula for Creep Curves of Metals

MANY formulæ have been presented for the time-strain curves of metallic creep, among which Andrade's formula[1],

$$l = l_0 (1 + \beta t^{1/3}) \exp (kt),$$

seems to have attracted much attention; but it has not been possible to find a satisfactory explanation of it. Hence we thought it worth while to look for another equation which agrees well with experimental results.

Table 1. POLYCRYSTALLINE COMMERCIAL ALUMINIUM AT 320° C. UNDER THE STRESS OF 1·78 × 10⁸ DYNES PER SQUARE CM.

Time (sec.)	Length observed (mm.)	Length calculated from our formula (mm.)	Length calculated from Andrade's formula (mm.)
7	50·857	50·872	50·465
25	51·429	51·325	51·280
118	53·187	53·130	53·278
439	57·345	57·355	57·468
1,110	64·973	65·010	64·782

Table 2. SINGLE CRYSTAL OF COMMERCIAL ALUMINIUM AT 350° C. UNDER THE RESOLVED SHEAR STRESS OF 8·5 × 10⁷ DYNES PER SQUARE CM.

Time (sec.)	Shear strain observed	Shear strain calculated from our formula	Length observed (mm.)	Length calculated from Andrade's formula (mm.)
95	0·0225	0·0223	50·515	50·438
318	0·0511	0·0471	51·142	51·176
990	0·1122	0·1118	52·568	52·568
3,156	0·2475	0·2521	55·847	55·593
8,040	0·4548	0·4516	61·133	61·515
12,205	0·5886	0·5866	64·728	66·537
19,260	0·7869	0·7946	70·241	75·525

We have carried out extensive experiments on the creep of polycrystals and single crystals of high purity and commercial grade aluminium at elevated temperatures under constant stresses. The constant stress device used was the same as that of Andrade[2] in the case of polycrystalline materials, and was somewhat modified in the case of single crystals to keep the stress constant in the slip direction in the slip plane. After examining all the experimental results, we got the following time-strain equation:

$$s = a - \frac{1}{bt + c} + kt,$$

where s is the resolved shear strain at the time t in the case of single crystals, or the logarithm of the ratio of the length of specimen at the time t to its initial length in the case of polycrystalline materials; a, b, c and k are constants independent of time. If we consider only the transient component, it is readily shown that

$$\frac{ds}{dt} = b(a - s)^2,$$

which is similar to the equation of a second-order chemical reaction. Our equation agrees with the experimental results just as well as Andrade's does in the case of polycrystalline specimens, as shown in Table 1; and it proved to be far better than Andrade's for large strains of single crystals, especially after long times, as is seen from Table 2. Results sufficient to illustrate these points only are included in the tables; full details will be published later.

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TOSIRO OWADANO

Department of Metallurgy,
Faculty of Engineering,
University of Tokyo.
June 1.

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[1] Andrade, E. N. da C., *Proc. Roy. Soc.*, A, 84, 1 (1910); A, 90, 329 (1914).

[2] Andrade, E. N. da C., and Chalmers, B., *Proc. Roy. Soc.*, A, 138, 348 (1932).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 22

Society of Dairy Technology (in the Lecture Room, New Hall, Royal Horticultural Hall, Greycoat Street, London, S.W.1), at 10.30 a.m.—Annual General Meeting.

British Society for the History of Science (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Dr. Joseph Needham, F.R.S.: "A Re-valuation of Chinese Astronomy".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Place of Electricity in a National Fuel Policy" (to be opened by the President).

Society of Chemical Industry, Fine Chemicals Group (at the Royal Institution, Albemarle Street, London, W.1), at 7 p.m.—Prof. A. R. Todd, F.R.S.: "Vitamin B_{12}". (Members of the London Section are invited.)

Textile Institute, London Section (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Mr. K. W. L. Kenchington: "Science of Clothing in relationship to Comfort and Human Efficiency in Cold Conditions".

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Prof. Frank Debenham: "The Kalahari To-day".

Tuesday, October 23

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. J. B. S. Haldane, F.R.S.: "Inborn Differences between Human Beings".*

Society for Applied Bacteriology (at the Medical Society of London, Chandos Street, Cavendish Square, London, W.1), at 4 p.m.—Symposium on "The Effect of Cold on Micro-organisms".

University of London (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Prof. Charles Singer: "Technology and History". (Hobhouse Memorial Lecture.)*

Institution of Civil Engineers, Public Health Engineering Division (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. R. H. MacDonald: "Relation between Daily Rainfall and Flow of the River Shin". (Members of the Royal Meteorological Society are invited.)

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Mrs. Elise J. Baumgartel: "Archæology and Earliest Egyptian Religion".

Royal Society of Medicine (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Sir Alan Rowlands: "The Changing Incidence of Disease" (Presidential Address).

Society of Chemical Industry, Chemical Engineering Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. G. M. Rowell: "Some Sulphur Recovery Processes in Refinery Operations".

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. E. H. Thompson: "Some Aspects of the Development of Photogrammetric Plotting Machinery".*

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. W. T. Astbury, F.R.S.: "The Scientific Basis of Medicine, 5, Studies by X-Ray Analysis, Electron Microscopy and Supporting Techniques of the Structure of Biological Macromolecules and the Tissues Formed from Them".* (Further Lectures on October 25 and 30, November 2, 5, 7, 14, 16, 20, 23, 27 and 29, December 4, 6 and 11.)

Royal Society of Medicine, Psychiatry Section (at 1 Wimpole Street, London, W.1), at 8 p.m.—Dr. Jules H. Masserman (Chicago): "Biodynamics and Psychiatry".

Wednesday, October 24

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. Arnold Sorsby: "Prospects in the Control of Genetic Disease".*

Society of Chemical Industry, Nutrition Panel of the Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Dr. R. P. Cook: "The Physiology and Psychology of Alcohol".

Manchester Metallurgical Society (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. H. O. Smerd: "Recent Developments in Electrically Welded Chains".

Thursday, October 25

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. A. J. Arkell: "The Beginning of Civilization in Egypt".*

Physical Society (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. Frank Twyman, F.R.S.: "Sir Charles Parsons and Optical Engineering" (1951 Parsons Memorial Lecture).

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. B. C. J. G. Knight: "The Scientific Basis of Medicine, 6, Aspects of Bacteriostasis".* (Further Lectures on October 30, November 2, 5, 7, 14, 16, 20, 23, 27 and 29, December 4, 6 and 11.)

British Ornithologists' Union (at the Zoological Society of London, Regent's Park, London, N.W.8), at 6 p.m.—Dr. Gustav Kramer: "Orientation Mechanisms of Migrating and Homing Birds".

Textile Institute (at 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Herr Hans Locher: "Electronic Sliver and Yarn Regularity Testers".

Friday, October 26

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion.

Chemical Society, Newcastle and Durham Section (in the Chemistry Building, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. A. C. Chibnall, F.R.S.: "Recent Advances in the Chemistry of Insulin" (Bedson Club Lecture). (All Fellows are invited.)

Institution of Mechanical Engineers (joint meeting with the Applied Mechanics Group, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. W. C. F. Hessenberg and Mr. R. B. Sims: "The Principles of Continuous Gauge Control in Sheet and Strip Rolling".

Manchester Statistical Society, Statistical Methods Study Group (at the Albert Hall, Peter Street, Manchester), at 5.30 p.m.—Mr. D. C. Shaw: "Prices and Margins in the Cotton Industry".

Geographical Association, Manchester Branch (in the Geography Room, Central High School for Boys, Whitworth Street, Manchester), at 6 p.m.—Mr. H. B. Rodgers: "The Oil Industry in the Middle East".

Friday, October 26—Saturday, October 27

Society of Public Analysts and Other Analytical Chemists, Biological Methods Group (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 2.30 p.m. and 10 a.m.—Symposium on "The Evaluation of Chemotherapeutic Substances".

Saturday, October 27

British Psychological Society, Scottish Branch (in the Psychology Department, The University, Edinburgh), at 2.30 p.m.—Symposium on "The Psychology of Art".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant (Grade A) to teach Mathematics and Physics, and an Assistant (Grade B) to teach Chemistry, in the Department of Science, County Technical College, Wednesbury—The Director of Education and Clerk to the Governors, Dept. F.E., County Education Offices, Stafford (October 27).

Assistant Chemist in the Fuels and Lubricants Section of the Central Laboratory, Chiswick—The Staff Officer, (F/EV.191), London Transport Executive, 55 Broadway, London, S.W.1 (October 27).

Assistant Director (with a good honours degree and research experience, preferably in engineering) in the Central Research Establishment, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/380 (October 27).

Assistant Experimental Officers (with a degree in engineering or physics, or equivalent) in the Horticultural Department—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds (October 27).

Assistant Lecturers (with a degree in mining or engineering, or equivalent)—The Principal, Technical College, Longport, Canterbury (October 27).

Lecturer (with a degree in engineering and good industrial and teaching experience in structural work) in the Department of Engineering, County Technical College, Wednesbury—The Director of Education and Clerk to the Governors, Dept. F.E., County Education Offices, Stafford (October 27).

Lecturer (with a special honours degree in chemistry; industrial or research experience desirable) in the Science Department—The Principal, County Technical College, Stoke Park, Guildford, Surrey (October 27).

Lecturer in Physics (university degree in physics essential) to teach the subject, including Nuclear Physics and Electrons, to Final B.Sc. and Higher National Certificate standard, and an Assistant, Grade B (university degree essential) to teach Physics up to Intermediate B.Sc. standard and some Mathematics, at the Oxford Schools of Technology, Art and Commerce—The Chief Education Officer, 77–79 George Street, Oxford (October 27).

Principal (honours graduate with experience of technical education and industry) of the Wallasey Technical Institute—The Director of Education, Town Hall, Wallasey (October 27).

Senior Clinical Psychologist (with an honours degree in psychology, or equivalent qualification, and experience in clinical psychology)—The Physician-Superintendent, St. John's Hospital, Stone, Aylesbury, Bucks (October 27).

Teacher in the Department of Chemistry and Biology (with a good degree in either biology or chemistry, and qualified to teach the other subject up to Inter. B.Sc. standard at least), Leeds College of Technology—The Chief Education Officer, Education Department, Leeds 1 (October 27).

Technical Assistant in the Department of Agriculture (Fisheries Branch)—The Secretary, Civil Service Commission, 43 Upper O'Connell Street, Dublin (October 30).

Engineering Inspector (Civil Engineering) in the Ministry of Commerce—The Director of Establishments, Ministry of Finance, Stormont, Belfast (October 30).

Biochemist to undertake research and laboratory investigation in connexion with urological disease—The Secretary, Institute of Urology, Henrietta Street, London, W.C.2 (October 31).

Honours Graduate in Physics, mainly for research and development work in the clinical uses of radioactive isotopes—The Secretary and House Governor, Mount Vernon Hospital, Northwood, Middx. (October 31).

Lecturer in Applied Mathematics—The Secretary to Council, Westfield College, Hampstead, London, N.W.3 (October 31).

Lecturer in Land Surveying at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

Senior Lecturer in the Department of Civil Engineering, University of Natal—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

Senior Lecturer or Lecturer in Anatomy at the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 31).

Lecturer (with an engineering degree or equivalent qualification, and experience in the engineering and/or process industries) **in Work Study** (method, motion and time study) in the Department of Engineering Production—The Secretary, The University, Edmund Street, Birmingham 3 (November 1).

Assistant Lecturer or Lecturer in Engineering—The Registrar, University College, Cathays Park, Cardiff (November 3).

Scientific Technologist in the Coal Survey Laboratory at Cardiff—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/379 (November 3).

Lecturer in Engineering—The Secretary, The University, Aberdeen (November 7).

Biophysicist (Principal Scientific Officer grade) with first- or second-class honours degree, research experience in general physics and some experience in the application of physics to physiological problems, at the R.A.F. Institute of Aviation Medicine, South Farnborough—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4077/51 (November 8).

Principal Scientific Officer (Sociologist) (with a first- or second-class honours degree or high qualifications in one of the social sciences, and considerable experience in the use of social survey methods or operational research technique) in the User Requirements Division of the Building Research Station of the Department of Scientific and Industrial Research—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4084/51 (November 8).

Electrical Engineers in the Admiralty—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.210/51 (November 15).

Senior Scientific Officers (2, with a first- or second-class honours degree in botany, and well qualified in systematic botany) **in the Department of Botany**, British Museum (Natural History), for research work in the Herbarium and the identification of plants and plant products—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4083/51 (November 15).

Senior Scientific Officers (4 Chemists and 2 Biologists) in the Forensic Science Laboratories at Birmingham, Bristol and Wakefield—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4085/52 (November 15).

Aeronautical and Mechanical Engineers (Scientific Officer grade) mainly in the Aerodynamics and Structures Departments of the Royal Aircraft Establishment, South Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.596/51A.

Area Scientist (with a good honours degree and sound experience in fuel technology and coal analysis) in Cannock, Staffs—The Divisional Establishment Officer, National Coal Board, West Midlands Division, Himley Hall, Dudley, Worcs.

Assistant Lecturer (Grade B) **in the Department of Mathematics**, College of Technology and Commerce—The Director of Education, City Hall, Cardiff.

Assistant Technical Examining Officer (male, temporary) **in the Victualling Department** of the Admiralty—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.60/51A.

Chemists (Scientific Officer grade) at a Ministry of Supply research establishment in the South Midlands area, to specialize in a semi-conductor research—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.698/51A.

Chemists, Physicists, Electrical Engineers and **Biologists** at the Tropical Testing Establishment, Port Harcourt, Nigeria: **Senior Scientific Officer** (Ref. A.23/51A) to lead a group of physicists and engineers studying the effects of tropical conditions on service materials and equipment, a **Scientific Officer** (Ref. F.686/51A) to work on analytical or biochemical investigations in connexion with deterioration of equipment under tropical conditions, and a **Senior Scientific Officer or Scientific Officer** (Ref. G.349/51A) to study the biological attack on materials and equipment under tropical conditions—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

Civil and Mechanical Engineers by the Ministry of Supply in London, Christchurch, Farnborough, Pendine, Salisbury, St. Helens, Malvern, and elsewhere, for design, development, installation and quantity surveying in structural and plant engineering fields, chemical plant, buildings and plant for aerodynamics and armament research, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting E.450/51BA.

Electrical Engineers and **Physicists** (Experimental Officer grade) by the Ministry of Supply at experimental establishments near Southend, Carlisle and in South Wales, for work connected with out-of-door instrumentation: **Physicists or Electrical Engineers** preferably with some knowledge of experimental range technique and procedure—for some posts (Ref. A.262/51A) a knowledge of electronics or mathematics is required, and for others (Ref. A.263/51A) experience in design of electronic apparatus and interest in technical photography is desirable, a **Physicist** with interest in chemistry (Ref. A.264/51A), and a **Physicist** with interest in mathematics (Ref. A.261/51A) to examine experimental records obtained during trials—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

Electrical and Electronic Engineers by the Ministry of Supply in London, Malvern, Chertsey, Bromley and Sevenoaks, and elsewhere—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2 quoting D.408/51.A.RA.

Engineer III by the Ministry of Supply in Lancashire, to assist in the design and supervise the testing and installation of chemical plant, and the temporary erection and testing of individual units—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.607/51A.

Lecturer in Bacteriology—The Assistant Registrar, Trinity College, Dublin.

Lecturer (with a good honours degree and conversant with recent research in the chemistry and physics of rubber and similar polymers) **in Rubber Science**—The Clerk, National College of Rubber Technology, Northern Polytechnic, Holloway, London, N.7.

Mathematicians (Scientific Officer grade) at a Ministry of Supply experimental establishment near Salisbury, for the study of theoretical problems of stability and control and the application of statistics to aircraft testing requirements—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.273/51A.

Metallurgists and **Physicists** (Scientific Officer grade) as leaders in the X-Ray and Electron Microscope Group in the Metallurgy Division of the Royal Aircraft Establishment, South Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.285/51A.

Pasture Officer, Somaliland Protectorate, to advise the Director of Agriculture and Veterinary Services on technical matters relating to pasture control, to devise and carry out experimental work etc.—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. No. 27059/259.

Plant Pathologists to form a pool from which a plant pathologist can be detailed or seconded to any Colonial territory to undertake a comparatively short-term investigation of any particular problem as required; when not overseas, the plant pathologists would work at the Institute under the Director on the taxonomy of fungi or plant pathological work of importance to the Colonies—The Director Commonwealth Mycological Institute, Ferry Lane, Kew, Surrey.

Scientific Officer in the Department of Marketing and Exports, Nigeria, for research work on problems relating to insect infestation of food products, survey work and experimental treatments of infestation—The Director of Recruitment, Colonial Office Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. No. 27059/297.

Senior Assistant (Scientific) at the Atomic Energy Research Establishment, Harwell, to assist in work with high-pressure apparatus with radioactive materials, with remote handling apparatus, and with high vacuum furnaces—The Ministry of Supply, Est.3.C.1, Room 829.D, Adelphi, London, W.C.2, quoting V.R.703, or the Employment Exchange, Harwell Site Office, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Order No. 185.

Senior Experimental Officer at the Ministry of Supply London headquarters, for duties concerned with research and development of aircraft textile materials in all forms (fabrics, cordages, ropes, etc. and involve technical consultations with industry and research organizations, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2 quoting F.697/51A.

Senior Experimental Officers, Experimental Officers and **Assistant Experimental Officers** at the Atomic Energy Research Establishment, Harwell: **Physicists** (Ref. A.266/51A), **Senior Experimental Officer** to take charge of, and **Experimental Officer** to assist in, the industrial applications of radioactive isotopes, involving complex techniques; **Chemical Engineers** (Ref. F.670/51A), **Experimental Officers** and **Assistant Experimental Officers** with experience in erection and operation of chemical plant on the pilot or semi-technical scale, or in process development on the laboratory or larger scales; **Chemical and Metallurgical Analysts** (Ref. F.670/51.A.EO), **Experimental Officers** and **Assistant Experimental Officers** for analytical work (two of the posts are connected with the analysis of heavy metals, rare elements and their alloys) **Metallurgists** (Ref. F.669/51A), **Experimental Officer or Assistant Experimental Officer** with experience in heat treatment, to operate small vacuum melting and precision heat-treatment furnaces **Development Engineers** (Ref. C.565/51A), **Senior Experimental Officer or Experimental Officer** for development of special type of plant and instruments requiring remote control or for operation under onerous conditions of temperature, pressure and corrosion, for example, pumps, valves, filters, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

Senior Plant Pathologist (Senior Principal Scientific Officer) at the West African Cocoa Research Institute, Gold Coast—The Under-Secretary of State, Colonial Office, Research Department Sanctuary Buildings, Great Smith Street, London, S.W.1.

Statistician for work on the investigation of the short-term effect of different controlled thermal conditions on the physiological responses and performance of groups of human beings, and a **Biochemist** to carry out work on physiological problems of the adaptation of human beings to hot climates, at the Royal Naval Tropical Research Unit, Singapore—Dr. O. G. Edholm, Medical Research Council Laboratories, Holly Hill, Hampstead, London, N.W.3.

Statistician in the Department of Genetics, to work on problems and methods in genetics and biological experimentation—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts.

Teacher of Telecommunications Engineering—The Clerk Northern Polytechnic, Holloway, London, N.7.

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TECHNICAL AND TECHNOLOGICAL EDUCATION IN GREAT BRITAIN

A DISAPPOINTING feature of the fourth report of the Advisory Council on Scientific Policy, the general features of which were discussed in *Nature* of September 22, is its failure to give a clear lead on the question of higher technological education in Great Britain. The contents of the subsequent White Paper on Higher Technological Education are equally disappointing (see *Nature*, September 29, p. 543). Presented to Parliament by the Chancellor of the Exchequer, the Lord President of the Council, the Minister of Education and the Secretary of State for Scotland, it is marked above all by anxiety to avoid giving offence. With an ingenuity which compels the admiration even of those who deplore its shortcomings, it evades all the important issues and contributes nothing to the necessary long-term policy. For the present there is prescribed the mixture as before: the universities will strengthen their existing departments of technology, and one or two may be enabled to expend much more considerably. The civic pride of anything up to sixty-six local authorities will be satisfied by additional financial assistance to their technical colleges, and expansion will begin along lines shortly to be announced.

In a measure, these proposals meet the imperative need for early decision so that the universities and the technical colleges can make their appropriate plans. How far this expansion will meet the real national needs, and above all that to which the Percy Committee directed attention more than six years ago, cannot well be judged until the detailed proposals for making improved financial assistance available for selected technical colleges and courses are made known and until the University Grants Committee announces the results of its examination of the proposals for university expansion, presumably in connexion with its plans for the next quinquennium. Meanwhile, however, a College of Technologists is to be established with responsibilities limited to granting awards and the approval of courses, thus shearing of some of its dangers the ill-considered recommendation of the National Advisory Council on Education for Industry and Commerce.

It is not suggested that the expansion of the university departments of technology and of the technical colleges will not give some useful increase in the number of highly trained technologists as distinct from technicians. That distinction is not made clear in the report, in spite of the recognition that industry needs recruits of a wide range of types, outlook and experience. What is clear from the statement is that university expansion in this field and the expansion of the technical colleges shall continue to proceed independently. The need for one body capable of taking an impartial and a national view is ignored.

This is the first major defect in the proposed policy, and until it is remedied it is idle to talk of using available resources so as to give the best results in the short as well as in the long run, or to make the most appropriate use of existing institutions. No comprehensive and satisfactory national system of higher technological education can be evolved in its absence. Six years ago, the Percy Committee recorded the general view that the position of Great Britain as a leading industrial nation was being endangered by a failure to secure the fullest possible application of science to industry, and that this failure was partly due to deficiencies in education, especially to a shortage of scientific workers and technologists who can also administer and organize, and can apply the results of research to development.

That is the background to all subsequent discussions on higher technological education in Britain, and in his recent book, "The Neglect of Science", Prof. F. E. Simon states that a visit to the United States strengthened his conviction that the most important thing needed to make our industry competitive is the reform of technological education in Britain. Such reform will not be secured by patching the existing system; and, disregarding for the moment Prof. Simon's own preference for at least two new technological institutions of university rank, the first step to a coherent national policy of higher technological education is to make its supervision the responsibility of some one body, whether it is carried out in university institutions or in appropriate technical colleges. If for valid reasons the establishment of a special Technological Grants Committee—a suggestion to which the National Advisory Council on Education for Industry and Commerce gave inadequate attention—is impracticable, the duty should be entrusted to the University Grants Committee with appropriately enlarged terms of reference.

The first essential is a body that can take independent and long views, with authority and standing sufficient to resist sectional pressure. The importance of this condition is at once apparent when we consider the question of the selection, from among the sixty-six existing colleges said to be providing higher technological education in Great Britain, of those which are to receive increased financial assistance. There is no indication as to who is to make the selection or the grounds on which it is to be based. From the national point of view, it is unnecessary and undesirable to upgrade to university status more than about six such institutions. The National Advisory Council in its report suggested that the actual selection should be made after consultation with the regional academic boards, which were established by the Ministry of Education to give advice in the field of technology. There are, however, ten such boards, and it would be optimistic to expect that such boards will take a national point of view and not incline to favour colleges in their own area. Ruthless decisions in favour of a few institutions, in fact, can scarcely be expected of such bodies; but without such ruthlessness there is grave danger that the limited amount of money available will be distributed too widely to make any real improvement anywhere.

The second essential condition for the development of higher technological education in the technical colleges is a matter not of finance but of status. The White Paper fails as completely as the report of the National Advisory Council on Education for Industry and Commerce to show any appreciation on the importance of the question of independent governing bodies and full academic freedom for the selected colleges. The issue is evaded or ignored; but this question of status and of academic freedom is of vital importance.

Unless the selected colleges are able to attract teachers of high standing and ability there is little hope of any real improvement in their status. More generous financial support and the full adoption of the new Burnham awards will be insufficient while the control by local authority and the Ministry of Education remains. Incidentally, it should be remembered that, even if that obstacle were removed, there are insufficient teachers of high calibre available to conduct the requisite courses in more than a fraction of the present sixty-six colleges. Such teachers are unlikely to be obtained unless they can be offered conditions of service fully comparable with those at the universities by removal of the subjection of the colleges to local authority and Ministry.

This question of staff is critical. Unless the difficulty is faced and overcome, the selected colleges will never acquire the status which will enable them to attract students of high quality, and no awards made by the College of Technologists will be comparable with either a university degree or the qualifications of the professional institutions. The proposal for a College of Technologists contributes nothing new and bypasses all the real difficulties. It cannot even be described as putting the cart before the horse, for if the real problems of upgrading a few selected colleges to university level are handled with courage and vision, a new award would be superfluous, just as it will be valueless if those problems are not solved.

Half-hearted solutions which merely avoid difficulties will get us nowhere, and so far as can be judged at present there is to be no real change in policy Some return will be secured from the expansion in the university departments of technology now being made in the universities, but as regards the technica colleges less confidence can be felt. There is real dange that the available resources will be distributed to widely to make any effective contribution anywhere t the provision of technologists of the calibre required and the White Paper gives no indication that th situation will be handled with vision and imaginatio

The White Paper does not, it is true, exclude indefinitely the possibility of a technological university. The proposal is rejected for the present o account of the capital outlay required, and because such a project for an entirely new centre woul involve at least five or six years of planning and building, so diverting large resources required els where and yielding no return in the form of graduate for at least ten years. Even the expansion of a existing institution would involve heavy capital co and building commitments, and here again no rapid return could be expected.

These, and especially the last, are the wron reasons. There are no firm grounds for assumin that in any foreseeable time more resources will favour experiment. The situation is more likely to deteriorate than to improve, as is indicated by the remarks made on October 1 by the retiring vice-chancellor of the University of Cambridge on the financial anxieties of the University in view of rising costs. The most promising methods of reform are usually expensive; but caution and a predilection for ways that have been found wanting are no policy for a nation in difficulties.

It may have been right to reject the idea of founding an entirely new technological university, though the White Paper would have been more convincing had it faced frankly the arguments in its favour, and particularly the danger that expansion of technology in the universities themselves may distort their balance of teaching and research. This problem has already been discussed by Prof. A. R. Ubbelohde and others. Technological research is liable to involve expensive and specialized equipment to a greater extent than academic research, except perhaps in some fields; and we cannot ignore the possible effect on the university departments if expansion takes place in the main at the universities. Equally, whatever expansion is planned at selected colleges of technology must provide for research as well as for teaching, and the same problem, possibly in even greater measure, will arise there also.

We are forced, therefore, to conclude that not only must the expansion of higher technological education in Great Britain be planned by one body, but also that that body must be competent to take account of the work of the research institutes and research associations and to advise on the best location of specialized equipment from the national point of view, having regard to teaching as well as research. Unless this is done, it is idle to talk of the wisest and most effective use of limited resources. It is right that there should be a reasonably wide range in the type of provision to be made for higher technological education: the universities, the colleges of technology, possibly also the research associations and other research institutions have their contribution to make, and, if only on the ground of variety, it is to be regretted that further experiment by establishing a higher technological institution is not to be undertaken.

There is an additional reason, not mentioned in the White Paper, for regretting that decision. In his recent Redwood Lecture before the Institute of Petroleum, on "The Training of a Technologist", Prof. F. H. Garner, professor of chemical engineering in the University of Birmingham, made much the same point as Lord Hankey emphasized in his Centenary Lecture on higher technical and scientific man-power a little more than a month earlier. Both stressed the importance of the technologist possessing certain qualities of character and leadership, and the desirability of providing in his training the conditions which encourage the development of such qualities. It is worth noting that Dr. P. Dunsheath, commenting on his recent visit to the United States as a member of the team sent by the Anglo-American Council on Productivity to study relations between the universities and industry, remarked that industry there also is looking for like qualities, and the universities are seeking to develop them.

There are some pertinent observations on this topic, as well as some useful suggestions, in the Walker Trust Lecture, "The Universities and Cultural Leadership", which Sir Walter Moberly delivered before the University of St. Andrews last February, and in which he firmly maintained that education for social responsibility is still a legitimate and necessary task for universities. Sir Walter denounced as heresy the doctrine that the only business of the universities is to turn out specialists, and the doctrine is no less pernicious when it is applied to the colleges of technology. But what is most significant in the present connexion is not that Sir Walter expressed a view which has been strongly endorsed from the industrial side in recent discussions on higher technological education, but rather his reminder that the universities develop such qualities not merely by requiring their students to submit to the basic intellectual disciplines of mathematics and classics, but chiefly by bringing together teachers and students who represent a wide circle of interests and providing them with a stimulating community life.

There, in short, is a compelling reason for experimenting with a technological university. The stimulus which might be derived from bringing together leading minds in many different technologies in one university centre has been overlooked. This was plainly as much in Prof. Garner's mind as in Sir Walter Moberly's, and such contacts are one means of encouraging the awareness and study of human relationships which Prof. Garner rightly stressed as an essential element in the training of engineers, or of other technologists, who throughout their careers will be concerned with human as well as with technical problems. Moreover, such a centre is in a far better position to dispel the notion which still persists that a career in technology is in some way inferior in status to that in some other professions, particularly if in organizing its courses of study care is taken to avoid keeping them in water-tight compartments.

The segregation of various departments of knowledge in existing university departments is one cogent reason for desiring to experiment with a new institution, without at the same time ceasing to encourage the expansion of some existing university departments of technology or of selected colleges of technology. Part of the value of a new technological institute may well lie, in fact, in its influence on the colleges of technology and the university departments. The graduate schools of technology, for which Prof. Garner pleaded in conclusion, could find their place either in the universities or in the expanded and upgraded colleges of technology, but would probably prove most fruitful in a new institution of the type of the Massachusetts Institute of Technology. Even in present circumstances, with the full support and co-operation of industry, such an experiment should not be beyond our resources; and the indirect results, as well as the technology, should be considered before rejecting such a proposal.

Prof. Garner in his Redwood Lecture recognizes frankly that the techniques of industry are not appropriately taught in a university, nor indeed in a college of technology: they must be acquired in industry itself. In the university or the college of technology, the student should be taught why different techniques are used and the principles on which they are based. If the teaching is at the same time directed to encourage the development of the personalities of individual students, those administrative defects to which, like Lord Hankey, Dr. R. P. Russell, Sir Handley Page and others, Prof. Garner directed attention, are less likely to be in evidence.

Those defects are due primarily to the lack of a balanced outlook on the part of a technologist or scientific worker who is called upon to assume administrative responsibilities. In his book "The Impact of Education on Society", Mr. W. O. Lester Smith suggested three years ago that the right answer to the Barlow Report might be found in a nobler conception of the technical college rather than in a multiplication and expansion of universities. Prof. Garner's Redwood Lecture is only one indication of the extent to which a nobler conception of technological education as well as of the technical colleges marks current contributions to the discussion on higher technological education in Britain. That conception is conspicuously absent from the White Paper. Without it, without imagination, enterprise and the readiness to experiment, neither the formulation of policy nor its execution in practice is likely to meet what is now one of the most urgent needs if the industrial future of Great Britain is to be made secure.

THE TEACHING OF PHYSICAL CHEMISTRY

The Structure of Physical Chemistry

By Sir Cyril Hinshelwood. Pp. viii+476. (Oxford: Clarendon Press; London: Oxford University Press, 1951.) 35*s*. net.

THE presentation of physical chemistry to students presents difficulties to the teacher. Sometimes the subject is broken down into separate chapters and dealt with as a series of specialisms; sometimes various aspects and ideas are taken up as tools to be used in other fields of chemistry; and sometimes the subject is dealt with in a broad sweep of impressionism. All these methods have their own advantages and disadvantages.

It is right that the student should study in detail the important specialized aspects of his subject, so that he may be able to use the tools of physical chemistry sharpened, and with the skill of a good craftsman. But such studies alone tend to obscure the nexus of ideas which connect these specialisms and to lose the threads which run through the subject as a whole.

It is right that as early as possible the student should see the subject as a whole, and should appreciate the position of physical chemistry between physics, concerned with the general principles governing matter, and chemistry, concerned with the individual behaviour of substances and their variety. The young student should, like the children of France, 'speak French well': it is exciting and inspiring for him to use his new-learnt language in other branches of chemistry and to discuss organic reactivity and the manifoldness of inorganic phenomena in terms of the pattern-forming ideas of physical chemistry. But such a broad sweep of ideas —this early speaking of the new language of physical chemistry—may lead to looseness of thought and communication, to lack of rigour and to a false impression of real understanding. Sir Cyril Hinshelwood quotes from Alice: "Somehow it seems to fill my head with ideas—only I don't exactly know what they are".

This problem—this conflict between the synthetic view and appreciation of the subject and detailed and rigorous study—is one which every serious teacher of physical chemistry must face and resolve. The reconciliation of these conflicting ends is in a sense one of artistic presentation. It is an artistic problem; because the subject must be apprehended as a whole, because by touches of the author's brush light and shade must be introduced—the masses of facts, the planes of thought and the tenuous lines of imagination must stand in harmonious relation to one another; and because the work must be stamped with honesty and integrity of thought and understanding. In this sense "The Structure of Physical Chemistry" is a work of art. I would recommend this book to all students of physical chemistry.

The following outline of the scope of the book under notice may indicate the general development of the treatment. The fundamental ideas that matter is made of atoms and molecules, and heat is mechanical motion of atoms and molecules, governed by Newtonian laws, are first introduced. These two ideas, which reached quantitative formulation in the past century, are applied to lead to the numbers and sizes of molecules, their speeds, and the frequency of molecular encounter. The discussion of molecular motion and chaos develops naturally to the introduction of entropy, to statistical mechanics and thermodynamics. Energy at this stage is left as an empirical quantity. But already, very early in the book, the reader has the beginnings of statistical thermodynamics and has heard that most important and recurrent *Leitmotif*—the opposing influences of entropy and energy in chemical equilibrium and change. These ideas are then applied to both physical and chemical equilibria: thermodynamics, statistical mechanics and kinetic theory are used in the discussion, and their essential unities, their various limitations and powers are thus revealed in relatively simple applications.

The furtherance of these questions requires a closer knowledge of the energy states which have already been envisaged in the discussion of entropy; this leads to the introduction of the quantum rules for molecular motion and to the simple evaluation of the partition functions of vibration, rotation and translational motion, and a return to a more detailed discussion of equilibrium and the factors determining its position. But it is not sufficient to accept the energy changes which arise from forces between molecules to give stages of aggregation or, between atoms, to give chemical compounds, as empirical data; and the further investigation introduces the electronic constitution of atoms, the description of states by wave functions and the architecture of atoms and molecules.

The reader is now in a position to be given a more complete discussion of assemblages—of electrons and atoms in metals, of molecules and ions in crystals and in liquids and solutions. He can understand more clearly the ordering effect of van der Waals, Coulomb and valency forces and the opposing effect of random motions. The three fundamental ideas which form the basis of modern chemistry are thus combined: matter is made of atoms, heat is mechanical motion of atoms and molecules, and particles have a wave-like nature.

The equilibrium patterns of chemistry are manifold and varied, but changes of pattern give "vitality and movement to the scene"; and the last section of this book gives a beautiful discussion of chemical changes. Collision theory, transition state theory, thermodynamic analogies, and energy and entropy factors are discussed with clarity, rigour and simplicity; their fields of usefulness in the theory of reaction rates and their limitations are set out. Typical reaction mechanisms are outlined: bond breaking, ionization, atom transfer, electron transfer, energy transfer, chain reactions—and the student is shown how in all these problems our knowledge of valency forces, molecular configuration and motion has made our ideas of chemical changes more precise; and how, here as in equilibrium, ordering into pattern carries with it the concomitant increase of entropy.

This book will give the student the right picture of the subject as a whole; it brings together the various lines of attack, showing clearly their several powers and limitations. It will inculcate rigour of thought and a critical approach—but at the same time will stimulate the student to take up tools which are so attractively presented to him, to sharpen them, and to use them for himself. He will go to his specialist monographs and lectures on thermodynamics, quantum theory or statistical thermodynamics with a proper understanding of their positions and their uses.

The specialist will understand his specialism the better for seeing it set in the subject as a whole.

The research worker will be stimulated to thought and investigation by the problems which are hinted at or are thrown into relief: there is none of the finality of the last word about this book; the inquiry goes on—"that is perhaps the greatest fascination of its adventure".

The book is beautifully written: there are occasional flashes of wit and asides of philosophy—indeed, teaching in its highest form: that sense of intimate conversation with a master. M. G. Evans

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PURE AND APPLIED CHEMISTRY OF ACRIDINE COMPOUNDS

The Acridines

Their Preparation, Physical, Chemical and Biological Properties and Uses. By Prof. Adrien Albert. Pp. xiii+381. (London: Edward Arnold and Co., 1951.) 70s. net.

THE investigation of acridine compounds has, in recent years, been to a large extent in the hands of Prof. A. Albert and his collaborators, and it is gratifying to know that the considerable experience which they have gained should now be available, with much else besides, in this volume. To the average student of organic chemistry the subject of acridine is all but a closed book, and the present work should dispel any ideas that may be abroad to the effect that the chemistry of acridine derivatives is dull and uninspiring.

The first eight chapters (Part 1) of the book deal with preparative methods for the synthesis of acridines, acridans and acridones, and it is early apparent that the author has written into its pages a wealth of sound practical experience. A number of preparations, either of acridine derivatives or of essential intermediates, are described at the end of each chapter, and the style is simple and direct, although occasionally a laboratory colloquialism replaces the more formal language of the text-book.

Part 2, also of eight chapters, discusses physical and chemical properties of acridines, preparation and properties of substituted acridines, aminoacridines, quaternary acridine derivatives, reduced acridines, acridones, thioacridones and binuclear derivatives. The degradation of substituted 5-aminoacridines in alkaline solution with hydrogen sulphide, noted by Hammick and his pupils, is not specifically mentioned although the reference is given in a misleading context. Apart from this slight criticism, the first two sections of the book are written in a balanced and critically objective manner.

The first chapter of Part 3, dealing with the utilization of acridines in clinical medicine, has been written a little more enthusiastically and somewhat less objectively than preceding and later chapters. Obviously Prof. Albert sees in the acridines a potential source of valuable drugs in addition to mepacrine and the existing aminoacridine antiseptics; for he asks the leading question (p. 234), "Have the possibilities of using acridines in therapy been exhausted ?" and adds, "The answer is most emphatically no", going on to say that ". . . the clinical possibilities of 'the acridines' are potentially as fertile as those of 'the benzenes' (which recently contributed sulphanilamide, p-aminosalicylic acid and chloramphenicol)", although it is conceded "that, as with other nuclei, the acridine ring contributes only a fraction to the biological action of its derivatives". Part 3 continues with a stimulating chapter on chemical constitution and antibacterial action; but the chapter dealing with the antimalarial action of acridine derivatives would have gained somewhat in perspective by even brief mention of chloroquine, which is derived, at least in theory, from mepacrine by ablation of one of the benzene rings.

The remaining chapters of the book cover tinctorial properties of acridines, the connexion between constitution and colour in the acridine series, and fluorescence and chemiluminescence among acridines. The work ends with a really excellent reference and author index, together with a good subject index and an index to the preparations described.

The author is to be congratulated on the completeness with which he has covered his subject and on his ability to write authoritatively and with equal facility on so diverse a range of specialized aspects of pure and applied organic chemistry. Most organic chemists and many biologists will find much to interest them in this volume, and its well laid-out tables, ninety-nine in all, will save many time-consuming searches in the literature for data on acridine and its derivatives. All concerned with the production of this book, author, printers and publishers, may derive satisfaction from the certain knowledge that their work will be gratefully received by a wide range of readers. J. Walker

SPIDERS OF BRITAIN

British Spiders

By G. H. Locket and Dr. A. F. Millidge. Vol. 1. (Ray Society Vol. 135 for the Year 1949.) Pp. ix+310. (London: Ray Society, c/o British Museum (Natural History), 1951.) *27s. 6d.*

SEVENTY years is a long time to wait for a book, and yet Pickard-Cambridge's "Spiders of Dorset", published in 1881, was, until now, the latest attempt to describe all the spiders of Britain. The absence of a recent book of this kind has been felt more and more seriously for more than half a century: now at last help is forthcoming in this the first of two volumes from the Ray Society. It is a work on which the authors, Mr. G. H. Locket and Dr. A. F. Millidge, who speak with the voice of experience and authority, can be unreservedly congratulated.

The opening chapter, a contribution from Dr. W. S. Bristowe, is a historical account of the study of British native species, in which Bristowe appreciatively surveys the work of his predecessors. He happily takes notice of their individual qualities and makes a human story of what might have been a dull record of specialized zoology. Wisely he emphasizes again the fact that nearly all our knowledge of British spiders is due to the devotion of men otherwise engaged on their own professional duties, while the British Museum (Natural History), for more than forty years, has sacrificed spiders to mites.

Mr. Locket and Dr. Millidge have tackled their systematic and descriptive problem in an engagingly workman-like manner. After the customary paragraphs on collecting and preserving spiders, and an account of their external features which is, perhaps, rather longer than necessary, they print a dichotomic key to twenty-four British families, with adequate illustrations and the addition of fifteen very helpful 'notes'. The families follow in turn, each with a summary of its characteristics, a key to its genera, and descriptions of its species.

Diagnostic work of this kind can never produce dramatic writing: a reviewer can but look for the underlying principles and try to judge the help afforded to readers who, less familiar with the animals themselves, are trying to name spiders from these pages. In so doing I find, first, descriptions which emphasize the essentials and are not overburdened with repetition and detail. Blackwall's description in 1861 of the common species *Xysticus cristatus* occupied a thousand words; Locket and Millidge are more practically helpful in two hundred. They tell their readers exactly what to look for in each species, and give accurate drawings of genitalia and other features that they may expect to see. British araneology has never before had anything like this; within its own sphere it is an outstanding contribution to taxonomy.

Because of this it is unfortunate that, while most of the admirable drawings have been clearly reproduced, some have not reached the high standard that we have become accustomed to expect in Ray Society volumes. Fig. 21 (*Ciniflo similis*) is an example of this: the fault lies not with the artist but in the process of reproduction, and is particularly regrettable.

The notes on the distribution of each species are ecological in character, not geographical. Here again, it is on the practically helpful information that the emphasis has fallen. This volume, which covers 205 species in seventeen families, has not reached the Linyphiidae, the most 'difficult' group, but it includes several of the genera in which separation of the species is sufficiently puzzling. One turns to these genera—*Lycosa* and *Clubiona* are examples—with interest, and finds the same practical guidance, the genera being conveniently split into groups and the contrasting characteristics of closely related species displayed in tabular form.

As I have said, this book was badly wanted and has not disappointed me. I look forward to its successor with keen anticipation of even greater satisfaction. T. H. Savory

DYNAMICS FOR MATHEMATICIANS

Advanced Dynamics

By E. Howard Smart. Vol. 1: Dynamics of a Particle. Pp. xi+420. Vol. 2: Dynamics of a Solid Body. Pp. xi+420. (London: Macmillan and Co., Ltd., 1951.) 40s. net each Vol.

IN these days a book on dynamics rarely describes recent discoveries; it is normally a presentation of long-established facts. It is to be classified according to the class of student for whom it is written, and the clarity and interest of the presentation. The recent work by the late E. H. Smart, entitled "Advanced Dynamics", is for mathematical students (though not wholly for honours mathematicians) and embodies the substance of lectures given to students preparing for London degree examinations. It begins at first principles; but it is not a beginners' book, since even in the first chapters more advanced ideas appear side by side with the elementary ones. The first volume covers such parts of particle dynamics as can be discussed without using generalized co-ordinates. The second deals with rigid dynamics in two and three dimensions, including a full treatment of Lagrange's and Hamilton's equations, but omitting other more advanced analytical topics. Within these limits, the whole forms a full and comprehensive treatise.

It is the book of a teacher. No pains are spared to enable the student to apply dynamical principles. Dozens of examples are worked in the text; and the collections of examples for the student are long and numerous. On the other hand, the discussion of physical principles occasionally leaves something to be desired; subjects of more formal interest—for example, the motion of chains, impulsive motion, and initial accelerations and curvature—are discussed more fully; and the emphasis of the treatment sometimes suggests that the need of getting students through examinations had an undue influence.

The presentation shows the marks of a lecturer; it is bright and interesting, discursive, a little unsystematic, and not infrequently repetitive. It shows that disregard for pure mathematical niceties (especially as regards differentials and limits) which often characterizes lecturers in applied mathematics; it is noteworthy, however, that lax statements are not permitted in proofs on which examination questions can be set. Vector ideas are frequently used, but in an unsystematic manner, the basic results being proved over again for new vectors. I should have preferred to have seen more discussion of the use of complex numbers in oscillatory problems, and of those parts of dynamics used in quantum mechanics. An interesting feature is the historical notes given in the text and at the end of some of the chapters.

The work was produced under difficulties, and the publishers deserve credit for the pertinacity through which it was finally produced. E. H. Smart died in 1945; Mr. F. G. W. Brown undertook the final revision of the manuscript and read most of the proofs; he died in 1949, and his work was finished by a colleague. Partly because of this, the book (especially the first volume) contains a number of slips and misprints, sometimes surprisingly ingenious ones. More unfortunate are a number of actual errors or unsound statements, particularly in Chapters 4 and 9 of the second volume; and an occasional lack of co-ordination between the different sections. Because of these, one would hesitate to recommend the book to a student working by himself; but it is one which teachers of the subject ought to possess.

T. G. Cowling

AN APOSTLE OF HUMUS

The Weed Problem

A New Approach. By F. C. King. Pp. xii+164. (London: Faber and Faber, Ltd., 1951.) 8s. 6d. net.

Mr. F. C. King is the Don Quixote of the self-styled "apostles of humus". He tilts at windmills, with a fervid belief in their aggressive antagonism. He displays the same half-bewildered air of sweet reasonableness alternating with fierce resentment against those who, in his mind alone, dare to seem to disagree with the central article of his faith. His new publication, though ostensibly concerned with the virtues of weeds in gardens, is but a thinly-veiled reiteration of the "muck-and-mystery" creed. It is astonishing that the upholders of this faith seem entirely unable to believe that soil scientists and plant physiologists can see any value in organic material in the soil. To them, the soil scientist is one who advocates the use of inorganic fertilizers alone for the maintenance of soil fertility and, above all, the use of sulphate of ammonia, that *anathema maranatha* of the "composters". One can only charitably conclude that they read solely within their own circle and are unable, therefore, to appreciate that the soil scientist attributes just as great importance to humus-forming materials as they do themselves but for different and more logical reasons. They persist in the view that inorganic fertilizers and organic manures are opposite and alternative instead of being, as the scientist appreciates, complementary.

Although they cannot themselves see it, the whole matter has become for them a cult, an esoteric mystery, in which Nature occupies the theistic role. Their favourite phrase, used repeatedly in Mr. King's book, is "the immutable laws of Nature", and the greatest crime is to transgress these laws, which appear to have been revealed to them alone.

Mr. King's theme in the present book is that we must "preserve the earth's green carpet in accordance with the immutable law of Nature which demands a covering for all fertile land", and this is to be achieved by "controlled weed growth" within the crops. There is much vague and loose discussion of "symbiosis" between weeds and crop plants which abundantly confirms the conclusion that the author has rarely read and certainly not understood scientific publications. Perhaps most astonishing of all is the author's method of explaining away facts contrary to his views by unjustified assumptions from untested premises.

The author gives no really clear-cut practical directions for the application of his ideas on weed control combined with no-digging, but patient seeking through the book brings one to the conclusion that basically his notion is little more than the principle of green manuring with surface-cultivation such as is achieved by rotary tillage, though this latter method is never specifically mentioned. He has obviously thought deeply and observed closely, but lacks the background of knowledge correctly to interpret his observations.

R. H. Stoughton

TECHNOLOGY OF DEFECTS IN PAINTS

Paint Film Defects

Their Causes and Cure. By Manfred Hess. Pp. xvii+544+65 plates. (London: Chapman and Hall, Ltd., 1951.) 50s. net.

This book is the first English edition of the original German book published in 1938; but the present volume has been brought well up to date. Its very title will arouse interest among those who are concerned with the many diverse problems associated with paint deterioration, for, as the author says, "it is the first extensive collection of paint failures ever made". On first consulting this book in a general way one is at once impressed not only by the large amount of effort and time expended in the collection of the necessary material, but also by the thought given to the classification of the experimental results. When, however, one settles down to study a selected topic—following the instructions thoughtfully provided by the author for finding one's way through the labyrinth of possibilities—one realizes that while each topic is discussed exhaustively in all its aspects, the book is essentially practical and not scientific in its approach. It is for this reason that one feels that a word of caution must be given to those readers not versed in scientific methodology. The author has not been discriminating in his selection of the experimental evidence; a host of really useful information based on sound scientific evidence tends sometimes to become smothered by statements of a more superficial character, sometimes contradictory and often open to query. Apart from this criticism, the book is an excellent one; the author is to be congratulated upon its production, as it fills an important gap in the bibliography dealing with paint and allied subjects.

The subject-matter is considered under four main headings, divided into sections, dealing respectively with faults which may develop during storage, during application, shortly after application, and on finished objects when in use. There is also a useful postscript giving an alphabetical list of terms and definitions connected with paint failures. The bibliography is good and the indexing and cross-references—on which the practical value of the book ultimately depends—are extremely thorough. Errors arising from translation are very few, and the book is also remarkably free from misprints. It is a work which cannot be read conveniently section by section, since there is no continuity. It is essentially a reference book, and as such can be strongly recommended as a convenient *vade mecum* for a wide circle of paint technologists.

A. E. A. Werner

Thorpe's Dictionary of Applied Chemistry

Fourth edition, revised and enlarged. Vol. 10: Plagioclase—Sodium. Pp. xi+913. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1950.) 100*s*. net.

WITH the advent of the letter "S" in the tenth volume of the new edition of "Thorpe's Dictionary of Applied Chemistry", the editorial board is within sight of the end of its vast undertaking. One further volume ("SO to Z") and a general index will complete the work. The Dictionary does more than give the latest information on plagioclase, sodium and the rest: it epitomizes the present vitally intimate relation between the science of chemistry and its application in technology. The articles have been contributed almost equally from universities and from the chemical and allied industries. They emphasize that advances in chemical technology are now dependent on and inseparable from advances in chemical science, and will only be made by trained scientific workers. This is a lesson of paramount importance to-day when higher technological education is so much under discussion. There is no short cut to the best technology: it can only grow out of the best science.

The level of the articles has been kept remarkably high. Indeed, I cannot remember a volume of 'Thorpe' so full of informative and interesting material. The editors have made an admirable choice of contributors; to choose at random: Wilson Baker on plant pigments; Bate-Smith on preservation of meat by drying; Brock on pyrotechny; Kellaway on snake venoms; A. R. Powell on platinum; Simonsen on pulegone and other terpene subjects, and so on. Symbolically, there are two excellent articles on rubber—one from a strong British team on natural rubber, and one from an equally strong American partnership on synthetic rubber. Another admirable article is that on quinones by a team from the Dyestuffs Division of Imperial Chemical Industries, Ltd.

To sum up, this is an altogether excellent production giving a vast amount of up-to-date information in a clear and understandable form, and at a reasonable price. A small point may be mentioned: Could something be done to make more obvious the authorship of the individual articles? True, the reader has the necessary clues to enable him to solve the mystery; but is there any need for a mystery?

R. P. LINSTEAD

Annual Review of Physical Chemistry

G. K. Rollefson (editor), R. E. Powell (associate editor). Vol. 1. Pp. viii+382. (Stanford, Calif.: Annual Reviews, Inc., 1950.) 6 dollars.

THIS "Annual Review of Physical Chemistry" makes its début in a volume of eighteen chapters covering a considerable area of the domain of physical chemistry. The majority of the articles are restricted to developments occurring in the period 1948–49 (for example, radiation chemistry, spectroscopy, X-ray structural crystallography, chemical kinetics, photochemistry), but others review more than the past decade (for example, thermochemistry, radioactivity and nuclear theory, theories of valence, experimental molecular structure, statistical mechanics of the crystalline and liquid states).

The articles reflect the modern tendency of physical chemists towards specialization in a particular branch of the subject, for few readers will be able to assimilate the full content of this book in detail. Yet the careful reader will find that the ideas and techniques of one field of specialization often overlap with and have application in another, so that, paradoxically, he advances his own specialization by a knowledge of some other.

Excluding the section on thermochemistry—which is not a review but a remarkable and invaluable bibliography of 825 references—the individual articles achieve a careful delimitation on their choice of material. In consequence, overcrowding is avoided, and criticism and emphasis have not been sacrificed—as witness, for example, the articles by Crawford and Mann on spectroscopy, Beach on molecular structure, Daniels on chemical kinetics, and Longuet-Higgins and Wheland on theories of valence.

This new series of "Annual Reviews" has made a promising beginning, and physical chemists generally will find it useful and stimulating.

H. A. SKINNER

Geschichte der Chemie in kurzgefasster Darstellung

Von Prof. Dr. Georg Lockemann. Band 1: Vom Altertum bis zur Entdeckung des Sauerstoffs. (Sammlung Göschen, Band 264.) Pp. 142+4 plates. (Berlin: Walter de Gruyter und Co., 1950.) 2.40 D. marks.

THIS small book gives a very interesting and competent survey of the history of chemistry from the earliest times to the discovery of oxygen. The author is known for his articles on the subject in German chemical journals and has an excellent knowledge of recent publications on the history of chemistry. His text is therefore based on recent investigations. The amount of information given is quite surprising when the size of the book is considered, and there are eight portraits on art paper at the end. The bibliography contains exclusively German books, and there is not space for detailed references. Some names are given incorrectly, and as these errors are distributed impartially among nationalities, including German, it must be assumed that they are due to careless proof-reading and may be corrected in later printings of this very useful little work.

J. R. P.

Electronics

By P. Parker. Pp. viii+1050. (London: Edward Arnold and Co., 1950.) 50*s*. net.

THE scope of a course on electronics has undergone a gradual change during the past fifteen years. Before the War what was required was, in general, an introduction to radio communications engineering. In a text-book on this subject one expected to find a brief introduction on electron tubes or radio valves, followed by a discussion on power supplies, amplifiers and oscillators. Propagation of electromagnetic waves and aerial systems would be dealt with fully, and finally a few typical circuits of receivers and transmitters would be examined.

The present volume makes, and needs, no apologies for the fact that the words electromagnetic waves, automatic volume control and telegraphy do not appear in its index. It is intended as an introduction to the physics of electron tubes, and circuits are dealt with only so far as they illustrate the properties of the tube. Vacuum and gas-filled tubes of great diversity are dealt with, including cavity magnetrons, on one hand, and Geiger counters, on the other. Throughout the book there is an emphasis on the physics of the devices considered: thus there is a good introduction to electron optics.

The book is stated to require no more than an advanced school knowledge of physics, and this accounts for explanatory notes on, for example, the Bohr atom and kinetic theory. There are good bibliographies with suggestions for further reading at the end of every chapter, and exercises with answers to numerical problems are provided.

U. W. ARNDT

Electricity and Magnetism

Classical and Modern. By Dr. G. B. Deodhar and K. S. Singwi. Pp. viii+507. (Allahabad and Benares: Students' Friends, 1949.) 15 rupees.

THE authors, who are members of the staff of the Physics Department of the University of Allahabad, have covered the main topics in the subjects of electricity and magnetism at a level which is adequate for a pass degree in physics. Some of the material included, such as Maxwell's electromagnetic equations, goes beyond the usual range of a pass degree course, but generally the treatment is neither sufficiently advanced nor sufficiently comprehensive to meet the full needs of an honours course in physics.

The book is divided into two sections, classical and modern. The classical section covers the usual field, particular prominence being given to measuring instruments and their uses. The modern section outlines the subjects of the conduction of electricity through gases, electronics, positive ray analysis and isotopes, atomic structure, X-rays, photoelectricity, natural radioactivity, artificial transmutation of elements, electron waves, cosmic rays, terrestrial magnetism and atmospheric electricity.

The book is lucidly written and well illustrated, and because emphasis is laid on experiments and physical concepts it should appeal to students with limited mathematical attainments. The quality of the printing and the trimming of the pages leave much to be desired.

A. H.

Die elektromagnetische Schirmung in der Fernmelde- und Hochfrequenztechnik

Von Dr. Heinrich Kaden. (Technische Physik in Einzeldarstellungen, herausgegeben von W. Meissner, Band 10.) Pp. viii+274. (Berlin, Göttingen und Heidelberg: Springer-Verlag; München: J. F. Bergmann, 1950.) 38 D. marks.

AS is justly remarked in the preface, no collected and systematic presentation of the principles of electromagnetic screening has hitherto been available. The author, with his long experience in these problems at Siemens–Halske, has been successful in filling the gap with this present book. Though the approach is essentially theoretical, it is concise and thorough and contains material, much of which is new, and most of which will prove valuable to the communications engineer who is concerned with screening at audio and radio frequencies.

The first part, "Screening against Disturbing Fields", which lays somewhat more emphasis on magnetic than on electric screening, deals with both closed and open screens and with the effect of slits, holes and gaps. Screening by grids and meshes of wires is only rather briefly treated. The second part, "Screening against Disturbing Currents", is concerned with undesired pick-up on the inner conductors of a cable due to imperfections of conductivity or continuity in the outer screen and with cross-talk between cables.

There is a short appendix which summarizes the properties of Bessel and Legendre functions and gives a selected bibliography of forty-nine references. A moderate level of mathematical knowledge in the reader is assumed, but the author has been careful to introduce and develop the techniques in a manner which is readily applied to similar problems having different boundary conditions.

R. E. BURGESS

L'Analysis situs et la géométrie algébrique

Par S. Lefschetz. (Collection de monographies sur la théorie des fonctions.) Pp. vi+154. (Paris: Libr. Gauthier-Villars, 1950.) 650 francs.

THIS reprint restores to currency one of the most famous of the Borel tracts. The study of algebraic functions of a single variable rested securely on the pillars of function theory and topology, but the extensions and generalizations to higher dimensions were unsatisfactory until Lefschetz took the whole matter in hand; his investigations up to 1924 are summed up in this volume—not altogether easy reading and in places displaying some of the roughness of pioneering work, but full of ideas and brilliantly stimulating. The central position of topological notions in the field of algebraic geometry is clearly brought out in studying algebraic surfaces, systems of curves on algebraic surfaces, algebraic varieties, and the related Abelian integrals. From this guiding clue much of the very considerable progress made during the past twenty-five years in the domain of algebraic geometry has arisen. An account of this progress is to be found in Prof. W. V. D. Hodge's presidential address to the London Mathematical Society in 1949 (*J. Lond. Math. Soc.*, 25, Part 3; July 1950), in which the great debt owed to Lefschetz by all algebraic geometers is fully acknowledged. The impact of Lefschetz's contributions on the topic is so weighty that his tract, even in unrevised form, is still an indispensable text for the serious student of the subject.

Functional Operators

By John von Neumann. Vol. 1: Measures and Integrals. (Annals of Mathematics Studies, No. 21.) Pp. vii+261. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1950.) 22*s*. 6*d*. net.

THE general mathematical theory of operators has been much advanced by von Neumann's lectures at the Institute for Advanced Study, Princeton, now printed in the "Annals of Mathematics Studies". The first volume is almost entirely devoted to the theory of integration, which is given in a completeness probably beyond what will be required in the second and succeeding volumes.

About one-third of the book deals with the theory of Lebesgue measure and integration, in n-dimensional spaces, giving a concise and fairly comprehensive account of the basic concepts and theorems on the Lebesgue integral. The rest of the book is divided about equally between two chapters, one of which generalizes the measure theory to abstract spaces, and incidentally provides a definition of the Lebesgue integral independent of the topological ideas usually involved; the last chapter gives a thorough discussion of the general integral, and deals in detail with the derivative of one set function with respect to another.

The whole treatment is detailed, accurate and painstakingly thorough. It will, of course, appeal only to the pure mathematician with a taste for abstract spaces, but to such a reader the exposition will present no great difficulty.

ARCTIC AEROBIOLOGY

POLLEN GRAINS AND OTHER SPORES OBSERVED ON STICKY SLIDES EXPOSED IN 1947

By PROF. NICHOLAS POLUNIN
McGill University, Montreal*

PREVIOUS communications on this subject have been mainly concerned with preliminary explanations and observations[1] and with the fungi and bacteria[2] which colleagues were able to isolate from colonies developing on nutrient plates that I exposed when flying northwards to the Arctic Ocean and the vicinity of the North Magnetic Pole in 1947. Already in the first paper it was explained how, in conjunction with each such exposure, a 'Vaselined' microscope slide was so held in a specially constructed wood and metal holder that ". . . the sticky surface was exposed against the air-stream for five minutes in about the same position outside the aircraft as the nutrient plate", and a subsequent communication[3] mentioned that, ". . . on some of the slides exposed near the Arctic Ocean coast there are represented spores of three of the most important airborne pathogens of cereal crops of Canada, namely, wheat stem-rust (*Puccinia graminis tritici*), wheat leaf-rust (*P. rubigo-vera = P. triticina*), and foot-rot of barley and rye (*Helminthosporium sativum*)".

It is the object of the present paper to give numerical and other details of the findings, by direct microscopic observation, of pollen grains, pteridophytic and bryophytic spores, and the spores of pathogenic or other fungi, that proved to be present on these slides which I exposed on the four air sorties described in the next paragraph, and which were early sent for examination to Dr. B. Peturson, Dominion Laboratory of Plant Pathology, Fort Garry, Manitoba, and to Dr. N. W. Radforth, of McMaster University, Hamilton, Ontario. To these two workers, and their assistants, my warm thanks are due—as also to Dr. Roger P. Wodehouse, of the Lederle Laboratories, Pearl River, N.Y., for further help and his expert guidance particularly in the matter of pollen grains. I would also like to take this opportunity of acknowledging indebtedness to the Royal Canadian Air Force for the splendid facilities afforded, and of expressing personal admiration for my two friends and principal pilots, Flight-Lieutenant J. F. Drake and Squadron-Leader William Carr.

The four sorties on which the exposures were made in 1947 were as follows: (1) on August 12 in a single-engined 'Norseman' aircraft from an unnamed lake (which I called Canso Lake, lying north-west of Great Bear Lake) in a northerly direction to Langton Bay on the Arctic Ocean coast, and thence in a north-westerly direction to the mouth of the Horton River near Cape Bathurst, the most northerly point of the western Canadian mainland; (2) on August 26 in a twin-engined 'Canso' flying-boat from Cambridge Bay, Victoria Island, in a north-easterly direction to the southernmost extremity of Somerset Island, then northwards until bad weather intervened in about latitude 73° N.; (3) on August 27 in the same flying-boat from Cambridge Bay in a south-south-westerly direction to Yellowknife, Northwest Territories; (4) on September 5 in the same flying-boat almost due south to Edmonton, Alberta. These routes were indicated on a sketch-map in the first communication[1], and the approximate positions of exposure were spotted in the second paper[2], which also indicated the approximate times of exposure, airspeeds, geographical co-ordinates, and altitudes. The positions of exposure are more accurately indicated in the accompanying sketch-map (Fig. 1), on which the Roman numerals refer to the individual sorties. With the altitude generally around one mile and the airspeed some 100 knots (115 m.p.h.), an attempt was made to expose a fresh slide and plate every twenty air miles during the first two sorties, and every thirty air miles during the third and fourth; but bad weather, icing, and preoccupation with landing and my other duties resulted in some irregularity and particularly lengthy gaps at the beginnings of flights 3 and 4. Apart from these gaps, it was possible to obtain an almost unbroken transect in the form of these periodical exposures extending over some 1,500 miles from the vicinity of the North Magnetic Pole to Edmonton, Alberta—besides the 'preliminary' northwards to the Arctic Ocean coast farther west.

The results as well as other pertinent data are indicated in the accompanying table, which scarcely requires explanation except as regards the unfortunately high proportion of uncertainties among the pollen grains and bryophytic spores, particularly; they are due to discrepancies between the observa-

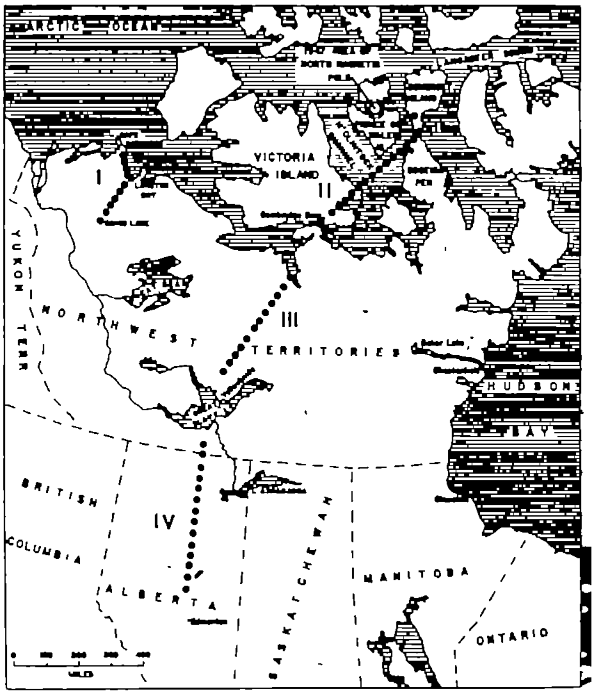

Fig. 1. Exposure of plates over north-west Canada in 1947. Roman numerals refer to individual flights

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* Now on leave of absence with a Guggenheim Fellowship and Honorary Research Fellowship at Harvard University, Cambridge, Mass. This paper was prepared during the winter of 1949–50; but the results here published were not fully cleared until more than a year later. In the meantime an account of part of the same material has been published independently in *Phytopathology* (40, 682; 1950). (Footnote added in proof.)

POLLEN GRAINS AND SPORES OBSERVED ON 'VASELINED' SLIDES EXPOSED OVER NORTHERN CANADA 1947

Slide No.	Pollen grains, etc., per slide (doubtful totals in brackets)				Identified fungal spores per slide					
	Angiosperms	Gymnosperms	Pteridophyta	Bryophyta	Stem rust	Leaf rust	*Alternaria* spp.	*Helminthosporium* spp.	Smut	Other
Flight I, from Canso Lake to Cape Bathurst (slides 1–11), August 12. Fair 9/10 overcast (ceiling 5,000) at start. Air-mass coming from N.W. after travelling E. over ocean										
1	—	—	1	(? 5)	—	1	2	1 *H. sativum*	—	2
2	(? 1)	—	—	—	1	—	—	1 *H. sativum*	—	1
3	(? 2)	—	—	(? 2)	—	—	—	—	—	1
4	—	—	—	(? 1)	—	—	1	2 *H. sativum*	—	—
5	1	—	—	—	—	—	—	—	—	—
6	1	1	—	—	—	—	—	—	—	—
7	—	—	1	—	—	—	—	—	—	1*
8	—	—	1	(? 1)	—	—	—	—	1	1*
9	—	1	—	—	—	—	—	—	—	2
10	—	—	—	—	—	—	1	—	—	1
11	1	—	1	(? 3)	1	—	—	—	—	3
Flight II, from Cambridge Bay to Somerset Island (slides 13–27), August 26. At start 9/10 low cloud; high overcast as well. Strong N.W. wind on ground; air-mass in south coming from N.N.W. and towards northern end of flight from N. after sweeping around from E. In both cases apparently of arctic Canadian origin										
13	1	—	(? 1)	—	—	—	—	—	—	8
14	—	—	1	—	—	—	—	—	—	—
15	(? 1)	—	—	—	—	—	—	—	—	—
16	(? 1)	—	—	—	—	—	1	—	—	—
17	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	1	—	—	—
21	1	—	—	(? 1)	—	—	—	—	—	—
22	—	—	—	—	—	—	—	1 *H. sativum*	—	—
23	—	—	—	—	—	—	—	—	—	—
24	1	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	1
26	—	—	—	—	—	—	—	—	—	—
27	—	—	—	(? 1)	—	—	—	—	—	—
Flight III, from Cambridge Bay to Yellowknife (slides 28–39), August 27. Wind westerly on ground at start; continuous low cloud but few above. Air-mass coming from N.N.W. in north, apparently of arctic Canadian origin, but from N.W. towards southern end of flight										
28	—	—	—	—	—	—	—	—	—	—
29	—	—	—	(? 1)	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	—	—
31	—	—	—	—	—	1	—	—	—	—
32	—	—	—	—	—	1	—	—	—	—
33	—	—	—	—	—	—	—	—	—	—
34	—	—	—	—	—	1	—	—	—	—
35	—	1	1	—	—	—	—	—	—	2
36	—	—	—	—	—	—	—	—	—	—
37	—	—	—	—	—	—	2	1 *H. sativum*	—	2
38	(? 1)	—	—	—	—	—	—	—	—	—
39	(? 1)	—	—	—	—	1	—	—	—	1
Flight IV, from Yellowknife to Edmonton (slides 40–53), September 5. Winds easterly for past 12 hours on ground at Yellowknife. Air-mass in north variable but apparently of southern origin (*see* text), in middle of flight coming from W.N.W. (presumably Alaskan origin), and in south coming from W.										
40	2	(? 1)	12	3 (? 14)	20	74	—	—	1	18
41	(? 2)	—	19	1 (? 4)	23	68	1	—	34	34
42	—	—	6 (? 7)	2 (? 3)	4	14	1	—	9	3†
43	(? 2)	—	—	—	—	1	—	—	—	—
44	—	—	—	—	—	—	—	—	—	—
45	—	—	—	—	1	4	—	—	—	1
46	1 (? 4)	—	1	1 (? 3)	4	20	—	—	—	3
47	(? 2)	—	2	(? 9)	4	24	1	—	—	—
48	(? 1)	—	3	(? 9)	3	9	—	1	38	4
49	—	2	3 (? 4)	(? 4)	4	29	—	1	29	37
50	(? 3)	—	1	3 (? 11)	4	7	1	—	21	36
51	(? 3)	—	1	3 (? 5)	—	14	—	1	10	9
52	(? 1)	—	5	(? 5)	2	14	4	7	30	80
53	—	1	1	(? 2)	4	11	4	5	2	99

* Probably *Cladosporium* sp. † Including one teliospore of *Puccinia* sp.

tions of different specialists who were either looking for other things or trying valiantly to observe without staining (for fear that treatments planned for the future might be precluded by such an operation). It is also possible that some of the grains had been accidentally removed in the meantime, for the slides were loose in their individual, though well-wrapped, containers. In all, fifty-two slides were exposed (No. 12 was omitted) and their full re-examination in this connexion was not attempted—more because it would have been of doubtful validity in view of all that the slides had by then been through than because of the considerable labour involved.

Although the results given in the table seem practically to speak for themselves, a few items are considered worthy of comment; nevertheless, it should be emphasized that it would be dangerous to generalize except perhaps in the most tentative manner from such limited experiences and relatively few observations as these 'preliminary studies' afford.

(1) These observations evidently confirm the presence of pollen grains and the spores of Pteridophyta and pathogenic fungi in the air above remote treeless and even ice-bound regions northwards at least beyond the seventieth parallel of north latitude —cf. Meier and Lindbergh[4], whose "Fig. 12. Types of objects trapped above the Arctic Circle on slide 15" ("exposed on August 6 for forty minutes at an average altitude of 3,000 feet above sea level over the coast of Greenland between Scoresby Sound and Clavering Island, north of 70 degrees latitude" in 1933) appears to include items representative of each of these three categories. Unfortunately these authors' promised detailed results were never published, owing to Meier's untimely death, and I have been unable to

locate any of their material—at least, in a suitable state for working out.

(2) On the earliest flight, the northernmost catch of a winged pollen grain of a coniferous plant was made in latitude 69° 28′ N., which is well north of the nearest likely source (cf. the recent report by Dyakowska[3] of their persistence in the air near sea-level off the west coast of Greenland at least as far north as the vicinity of Godthaab (lat. 64° 11′ N.), although in this case, in spite of the lower latitude, the nearest likely source was much more distant).

(3) Spores of various all-too-familiar pathogenic fungi were found far north of their probable nearest point of origin—in the case of uredospores of wheat stem-rust to 70° 02′ N. at a point which, as already reported[3], "... is the better part of 1000 miles north of the Peace River region, which is the nearest likely source of supply of any real extent, and would seem to extend remarkably the much-cited 'at least 200 miles' that spores of [this] important parasite (which alone has caused an estimated loss in western Canada through injury to the Wheat crop of as much as $200,000,000 in a single year) are known to have been disseminated". Although with these small numbers the possibility of error due to contamination is by no means ruled out, the general conditions and controls and other observations suggest that it is slight and indicate the probable validity of these results. So supposedly there is frequent danger of infection as a result of such long-distance dispersal, though it may be noted that the positive and plentiful smut spore observations were practically limited to the two air-masses of supposedly southern Canadian origin—see (6). Indeed, the only exception identified is expressly noted by Dr. Peturson as "not a cereal Smut . . . possibly a grass Smut" (a considerable range of Ustilaginales parasitize Cyperaceæ, Polygonaceæ, etc., very plentifully and widely in the Canadian Arctic as noted by Linder[4]).

(4) Although spores of *Helminthosporium sativum* and *Alternaria* spp. (not necessarily pathogenic) were very widespread, they appeared to be relatively sparse; the only counts at all high of spores identified on these slides were obtained on the southernmost flight and involved chiefly stem and leaf rusts and smuts, which alone assumed numbers suggestive of epidemic conditions (cf. the mimeographed Twenty-seventh Annual Report of the Canadian Plant Disease Survey, 1947). It is also mainly in the southernmost forested regions that other bodies, including the spores of Pteridophyta and Bryophyta, appear to have become relatively plentiful—possibly suggesting loss by gravitational sedimentation or removal by precipitation to the north, although the high counts of rusts and smuts from not so far south of Yellowknife as to be still well north of the belt of widespread cultivation would seem to indicate that such loss is not necessarily rapid. One is apt to get a picture of sweeping gusts and upward air-eddies in the sun-heated, cultivated plains of the south carrying disseminules to high altitudes—at which they may travel northwards on strong winds until they meet a cold front, for example, when precipitation contingent on this meeting may remove them from the air, or, if it does not, turbulence will be likely to confuse the issue. Farther north, in the real Arctic, the precipitation tends to be very slight and the winds almost perpetual, so that any particles which lie aloft in the atmosphere may be expected to stay up for a long time. What proportion remains viable under the radiation and other conditions obtaining, and for how long, might be worth investigating, though at present it seems likely that ultra-violet radiation may be less harmful to micro-organisms in the Far North than to the south.

(5) Actually, the probable explanation of the high counts on the first three slides exposed after leaving Yellowknife is that I was then flying in a different air-mass from that encountered thereafter—with such surprising rapidity that I noticed the marked temperature rise on my hand as I put it out to make the fourth exposure. Warm air persisted throughout the remainder of the flight to Edmonton, and according to the trajectory analyses kindly furnished by Mr. K. T. McLeod, of the Air Services Meteorological Division, Department of Transport, Canada, was of south Alaskan origin in its northern part and almost due westerly in its southern part. But only this southern part of the warm air of westerly origin had come over much southern, cultivated land; and it was this southern part which gave most of the high counts. The other high counts were afforded by the first three slides exposed on this last flight, and it is remarkable that the trajectory of this air-mass, although it was travelling eastwards just then, indicated that it had so swept around that eighteen hours previously it was travelling westwards some two hundred miles to the north and, a few hours before that, had been much farther to the south-east—with some indication of having previously come over the cultivated prairie regions like much of the air encountered near Edmonton. The air-mass trajectories for this fourth flight are indicated in Fig. 2. The correlation in this case is extraordinarily close, and is supported by the spores of the higher plants as well as those of fungi; thus whereas on the first three slides exposed after leaving Yellowknife (Nos. 40–42, while I was in air of probably southern origin) there were found no less than 349 identifiable spores, etc., on the next three (Nos. 43–45, exposed in Alaskan air) there were identified but seven, and six of these were on the sixth slide (No. 45),

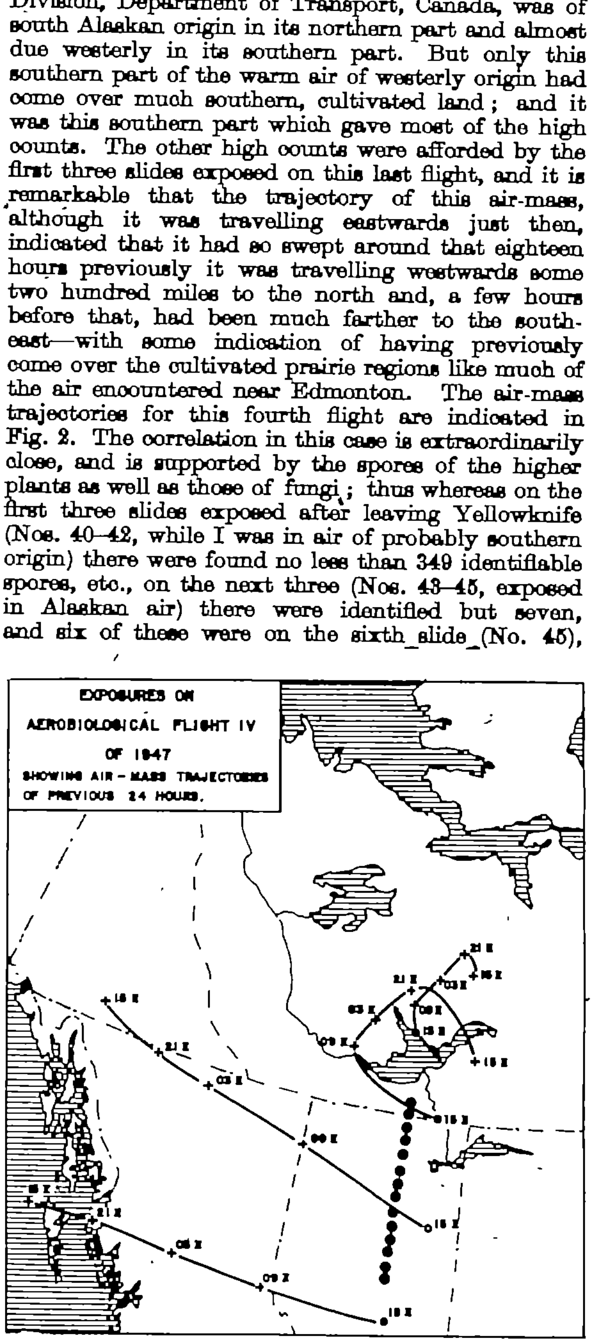

Fig. 2

after which numbers rose rapidly—presumably as the southern air from the west was encountered. Such a clear and potentially valuable correspondence between air-masses and their spore, etc., load is largely to be expected when we think in terms of regions of origin, and perhaps is not necessarily much confused by mixing or loss by sedimentation, etc., even during long and tortuous travels.

(6) Analysis of the paths of the air-masses in which the other flights were made seems less significant, and in any case Mr. McLeod warned that in these instances the lack of upper-wind data made their earlier movements doubtful. However, it seems that the second sortie was in northerly winds coming from arctic Canada, and probably of just that origin—which may well explain the lack of uredospores and gymnospermous pollen and the general paucity of material caught. The third sortie, however, is interesting in its seeming support of the implication of the previous paragraph that the load of particles, etc., carried by an air-mass depends more on its origin, or at least its history, than on its trajectory or actual position at any time: for whereas the early stages of this flight were made in air-masses coming from the north, as was the case in the second flight, and the results were similarly so nearly negative that the slides constituted a kind of control, the last stage coming in towards Yellowknife was in air of north-westerly origin, which appeared to have a trajectory not unlike that of the air-mass in which the first flight of all was made, and actually showed a more comparable spore load.

(7) It appears that although the smaller spores of crop pathogens are alone apt to be at all numerous, pollen grains and other spores of a wide variety of types and, especially of anemophilous species carry quite well in the atmosphere, and certainly some can occur at high altitudes[7] and in remote regions not merely over land but also over the ocean[8]. All too little is yet known of the extent to which they may remain viable; but it has been determined that a range of pollens of by no means hardy types can give a high percentage of germination and produce strong seedlings even after the greater part of a year of storage[9], and that low temperatures and light-ntensities and atmospheric pressure (but medium humidities) can favour pollen longevity[9,10]. In these and other circumstances, such as the almost perpetual windiness preventing particles from settling, it seems conceivable that the possibilities of long-range and hence 'absent-treatment' hybridization even among plants which do not practise the 'spring-flowering idea' may be greater in the Arctic than in some climatically more favourable regions where dense foliage, etc., impedes take-up and effective falling of 'pollen rain'—as well as where much of the atmospheric pollen is removed by precipitation—and may perhaps be one of the factors behind the tiresome 'plasticity' of many groups of arctic plants, including, particularly, the Gramineæ, Cyperaceæ, Juncaceæ, Salicaceæ, Cruciferæ, Rosaceæ, and Compositæ.

In conclusion, it should be re-emphasized that these suggestions are largely tentative, being based on too limited experience and too few data to allow sound generalization. It may even be objected that the small numbers of significant items observed on many of the slides are not beyond the possibilities of contamination; but the precautions taken, the advice of examining specialists, the working of controls, and the over-all picture now that it is possible to see it, all give confidence that even individual observations have value and probable validity. The above data are published with the approval of the Defense Research Board of Canada, which has generously supported the continuation of this work with an extra-mural grant in my name.

[1] *Nature*, 160, 876 (1947).

[2] *Nature*, 162, 379 (1948).

[3] Polunin, Nicholas, Pady, S. M., and Kelly, C. D., *Arctic*, 1, 60 (1948).

[4] Meier, Fred C. [and Lindbergh, Charles A.], *Scient. Mon.*, 40, 5 (1935).

[5] Dyakowska, J., *Bull. Internat. de l'Acad. Polonaise*... Série B, Sciences Naturelles (1), 1947 (Cracovie), pp. 25–33 (1948).

[6] In Polunin's "Botany of the Canadian Eastern Arctic. Part 2, Thallophyta and Bryophyta". Pp. v+573. (Ottawa: King's Printer, 1947.)

[7] Proctor, Bernard E., and Parker, Basil W., in "Aerobiology", ed. F. R. Moulton. Pp. x+289. (Washington, D.C., 1942.)

[8] Erdtman, G., *Acta Horti Gotoburgensis*, 12, 185 (1937).

[9] Pfeiffer, N. E., *Contr. Boyce Thompson Institute*, 9, 199 (1938); 13, 281 (1944).

[10] Pfeiffer, N. E., *Contr. Boyce Thompson Institute*, 8, 141 (1936); 10, 429 (1939).

THE JOULE MUSEUM, SALFORD

THE Joule Museum, which was opened on July 3 at Joule House, Salford, contains a permanent exhibition of apparatus and documents and is intended to be a comprehensive presentation, by original or replica, of J. P. Joule's major scientific work. The existence of this exhibition is due to the initiative of the British Society for the History of Science, which delegated the task of forming the Museum to Prof. L. Rosenfeld, University of Manchester; in this, Mr. J. A. Newth was a ubiquitous lieutenant.

The nucleus of the Museum is a collection of original apparatus and documents which had been acquired by the Manchester College of Technology—through the agency of Prof. W. W. Haldane Gee—after Joule's death, when his house and property at Sale were disposed of. They have since been preserved at the College of Technology, where they could not be properly exhibited for lack of space. This collection has now been completed by replicas from original apparatus preserved elsewhere, and the whole has been displayed in a room of a house at Salford in which Joule lived for some years, and which is now owned by Salford Corporation. A grant of money from the University of Manchester and the provision of this room in Joule House, arranged by Mr. A. J. Rivett, director of education for Salford, made it possible to display the collection to the best advantage.

The replicas of apparatus have been constructed by Mr. R. Bradford in the workshop of the Physics Department of the University of Manchester. Apparatus was lent for this purpose by the Science Museum, South Kensington, London, through the agency of Mr. J. Chaldecott, and by the Department of Natural Philosophy, University of Glasgow, with the co-operation of Prof. P. I. Dee. The documents comprise a large laboratory book, some notebooks, manuscripts and letters, which come from a variety of sources.

The exhibits are arranged in sections which follow each other chronologically. The early experiments sprang out of a desire to improve Sturgeon's electromagnetic engine, and to arrive at a quantitative estimate of its "duty" or efficiency. There are shown a number of toy-like models of electrical motors and cores of electromagnets of various constructions which were used to study their "lifting-power". This section recalls Joule's friendship for William Sturgeon, whose encouragement may have determined the direction of these early experiments.

In the next period (1840–43) was performed a series of experiments concerned with the connexion between electricity and heat. A reconstruction of the simple apparatus which Joule used to measure the heat produced in a conductor by an electrical current is shown, together with a replica of the remarkable arrangement by which he confirmed his allegiance to the theory that heat is a mode of motion, and first established the equivalence between work and heat. A coil is mounted inside a cylindrical calorimeter (25 cm. × 10 cm.) and can be rotated between the poles of a fixed electromagnet. Joule was able to show that heat is actually generated in the coil by the induced current and that this heat is proportional to the mechanical work done in turning the apparatus. Direct voltaic currents were superimposed on those induced in the coil, and the measurements of the heat produced led to the conclusion that, in these experiments, mechanical work was converted into heat through the intermediary of electricity.

In 1844 Joule turned to a study of the heat changes accompanying the expansion and compression of gases; the original apparatus used in this series of experiments is exhibited in a complete state. Two large cylindrical copper vessels were connected through a needle valve ("the invention of Mr. Ash, of this town"). One of the cylinders was evacuated; the other could be filled to a pressure of 22 atmospheres by 300 strokes of a hand-pump. By immersing the whole arrangement in a calorimeter and opening the valve, Joule discovered that "no change of temperature occurs when air is allowed to expand in such a way as not to develop mechanical power". Unknown to him, this law had already been found in 1806 by Gay-Lussac; it played an essential part in the reasoning by which Robert Mayer deduced in his own way the mechanical equivalent of heat in 1842.

The next period (1845–49) was occupied with the famous friction experiments. Replicas are shown of the two paddle-wheel calorimeters, for the friction of water and mercury, and of that which contained two metal plates in close contact and which was used to produce heat by the friction between solids. All these systems were activated by falling weights. Unhappily, the thermometers which were used in Joule's experiments and preserved by the Manchester Literary and Philosophical Society were destroyed in an air-raid; there remain but a few relevant documents, including the invoice from the French firm which supplied some of them.

One of the most important events of Joule's life was his meeting with William Thomson (later Lord Kelvin) at the British Association meeting of 1847. This was the beginning of a long period of fruitful co-operation and mutual stimulus. For Thomson, it was the starting-point of the investigations which led him, shortly after Clausius, to the recognition of the two fundamental laws of thermodynamics.

In exploring the consequences of these laws, Thomson pointed out that a gas would be cooled by allowing it to expand into a region of lower pressure, and in 1852 Joule and Thomson started a long series of experiments which confirmed this deduction. There are exhibited the wooden containers for the porous plugs which were used to separate the regions at high and low pressure, and the few other surviving parts of the apparatus.

Joule's last experimental work, in 1878, was a new accurate determination, by the paddle-wheel friction method, of the mechanical equivalent of heat. It was undertaken at the request of the British Association Committee on Standards of Electrical Resistance, in order to clear up a discrepancy between the previous friction value and that derived from the heating effect of a current passing through a resistance which had been compared with the standard issued by the Committee. A replica of the calorimeter used by Joule for this experiment is exhibited, together with Joule's British Association standard resistance. The resulting value for the equivalent was almost identical with that obtained thirty years before by the same method.

The last section of the exhibition is devoted partly to some instruments which were probably permanent features of Joule's laboratory, and partly to a selection from a number of odd pieces of apparatus used in minor investigations of a varied character—especially in a careful study of the mechanism of steam condensation. Joule's precision instruments were made by John B. Dancer, an optician and scientific instrument maker of great reputation who carried on business in Cross Street, Manchester, from 1841, and was himself a distinguished amateur of science.

Documents and letters of special interest are displayed at appropriate places in the various sections, and also in separate show-cases. On the walls hang a portrait of William Sturgeon and two portraits of Joule himself. One of them is a photograph of the portrait by Collier owned by the Royal Society, and exhibited by permission of the Council of the Society. The other is a large oil-painting on loan from the Manchester Literary and Philosophical Society, which replaces the original portrait by Patten destroyed in the air-raid of 1940.

While the scientific aspect of Joule's investigations can be reconstructed in a fairly complete way, it is a matter of regret that so few documents have been preserved which could throw light on his personality. Why did he devote himself to scientific pursuits when so much else might have been expected of a rich brewer's son? Who taught him the rudiments of his craft, and inspired his father to build him a laboratory? Whence came that almost arrogant courage which relied on the visual subdivision of a thermometer interval into twenty parts for the enunciation of a new law of Nature? What gave him such an ascetic devotion to a principle when his city was crying out for technical improvements and inventions?

It would be interesting to know more of his relations with people like Dalton and William Sturgeon, of his wife and family. There is some evidence that he was handicapped by a physical deformity that may have made him a recluse. It is certainly true that the last years of his life were given up to the infirmity of old age. But it is strange that so much can have been forgotten about a man whose life-span overlapped that of our fathers.

The Joule Museum is open to the public, on application to the offices of the Child Guidance Clinic on the ground floor of Joule House, 49 The Crescent, Salford; parties or individual visitors who would like to be accompanied by a member of the staff of the Physics Department of the University of Manchester should make arrangements in advance with Prof. L. Rosenfeld at the Department.

THE CHEMICAL RESEARCH LABORATORY, TEDDINGTON

THIS year 'open days' at the Chemical Research Laboratory, Teddington, were held during September 19–21, and many representatives of industrial firms, universities, government departments and the Press took the opportunity to view the work in progress. It may be mentioned that a new laboratory is under construction, although it was not open to inspection this year; this is designed for chemical work with radioactive materials and will be ready for occupation during 1952. In addition, plans for a new microbiological laboratory have been drawn up and construction will begin this year. A useful addition to the facilities of the Laboratory is a new glass-working hut, equipped with lathe and other apparatus for high-grade work. Researches were illustrated by many exhibits, and this article is confined to some indication of the general programme of the six research units, and a more detailed description of some of the newer exhibits.

The Corrosion of Metals Group is concerned with corrosion and its prevention in immersed, atmospheric and underground conditions. This includes work on the development of accelerated corrosion tests, the application of inhibitive methods, and new work on boiler-tube corrosion. The Group has a special interest in the surface films on metals, and the chief object of new work on the oxidation of metals below 250° C. is to provide experimental data that may be used to test or formulate theories on the oxidation of metals in this temperature range. In these experiments particular attention has to be paid to the physical and chemical nature of the metal surface employed. The properties of the electrolytically polished surfaces of polycrystalline copper sheet of high purity have been examined by the optical microscope, by electron diffraction and by an electrometric method. The last-named enables the very thin oxide films (~ 25 A.), formed during surface preparation, to be measured and provides a ready means of detecting the presence of certain undesirable contaminating layers on the surface, if they are present. Kinetic studies on the oxidation of these samples at pressures in the range 10^{-1}–10^{-4} mm. of mercury, using a manometric technique, have revealed that the oxidation-rate is markedly dependent on the oxygen pressure. This variation is of considerable theoretical interest, and a full-scale investigation using a micro-gravimetric procedure is now in progress.

Interesting work on the electrode-potential behaviour of metal specimens in anaerobic culture media inoculated with *Desulphovibrio desulphuricans* has been commenced. In particular, the polarization characteristics of the metals in conditions suitable for the vigorous proliferation of sulphate-reducing bacteria are being studied.

The Radiochemical Group is mainly engaged on a programme of work for the Ministry of Supply on the analysis of radioactive minerals and ores, and the concentration of metals from low-grade sources. A recent advance is the application of ion-exchange resins in separation processes. If a solution containing a mixture of metals is passed through a column of cation-exchange resin, the metals are absorbed in amounts depending on their concentration in the solution and their affinity for the particular resin used. Not only can a dilute solution be concentrated and freed from unwanted anions, but also, by choosing the correct conditions, the process can be selective for a particular metal. An exhibit demonstrated how a multi-column adsorption system can be employed for this purpose. Work on the separation of metals by paper-strip chromatography or cellulose columns has been continued, and a new separation exhibit was that of platinum and palladium from iridium.

The Inorganic Group has been working on a variety of topics, such as the extraction of gallium and germanium from flue dust, and the conversion of rock phosphate into fertilizer by methods designed to reduce the consumption of sulphuric acid. The Group is also responsible for the microanalytical and spectrographic analytical work required by the Laboratory.

Germanium continues to find an increasing use for micro-wave rectification and as a substitute for the triode valve. Considerable difficulty has been experienced in producing material of the necessary high degree of purity, one of the most troublesome impurities being arsenic. The problem has been studied using radioactive tracer methods, and a method of purification has been developed which yields germanium dioxide containing less than 0·01 p.p.m. of arsenic, and which is well suited to commercial application. Germanium metal derived from this oxide has a satisfactory electrical performance. The work is being continued with the view of the elimination of other elements, notably boron, which may be present in minute traces and may affect the electrical properties of the metal.

A feature of the work of the Organic Group is the preparation of organic compounds in a high state of purity and the determination of precise physicochemical data in collaboration with the National Physical Laboratory; this includes the lower hydrocarbons used for the calibration of mass spectrometers, cyclic and heterocyclic compounds, and long-chain fatty acids. The Laboratory is now equipped with low-temperature distillation units (including a Podbielniak 'Hyd-Robot') for the preparation of pure low-boiling hydrocarbons, and spinning-band fractionating columns for the distillation of the esters of long-chain acids.

Part of the work in collaboration with the National Physical Laboratory is the determination of the end-products of combustion of nitrogen-containing compounds in the bomb calorimeter. An oxygen-purifying train for the preparation of pure oxygen, and apparatus for analyses of the bomb contents, were on view. Studies of the synthesis of compounds containing labelled carbon have been continued, and some new syntheses, including ring-labelled aromatic compounds, were exhibited. γ-Resorcylic acid has been prepared for clinical tests for the Medical Research Council.

A discovery of great potential importance in connexion with the determination of molecular weights of polymers by osmotic measurements has been made in the High Polymers Section. It has been found that polyvinyl alcohol may be used for preparing improved semi-permeable membranes which possess the advantages of permitting very rapid passage of the common polymer solvents and yet enable rapid and accurate measurements to be made of the number-average molecular weights of polymers of considerably lower degrees of polymerization than heretofore. Furthermore, osmometers of very simple design may be used.

The shortage of sulphur has stimulated inquiry into new sources. The possibility of using micro-organisms for sulphur production from indigenous sulphates is being examined by the Microbiology Section. In June 1950 two members of the Section examined some sulphur-producing lakes near El Agheila in the Cyrenaican desert; they found that the formation of sulphur was due to the combined action of sulphate-reducing and photosynthetic sulphide-oxidizing bacteria. Details of the expedition, illustrated by maps and photographs together with many of the samples actually obtained, were exhibited. Of special interest was a demonstration of the production of sulphur by the symbiotic action of pure cultures of the two types of organisms isolated from the Cyrenaican lakes in a medium containing sulphate as the sole sulphur source.

Included in the Microbiology Section is the National Collection of Industrial Bacteria. Although still in its formative stage, the Collection now maintains more than five hundred strains. Its usefulness is indicated by the increasing world-wide demand for its cultures; last year, more than four hundred strains were supplied to twenty-seven countries. The multifarious activities involved in maintaining cultures were demonstrated, for example, the technique of vacuum freeze-drying; diagnostic bacteriological and biochemical tests used for identification and classification; card index system; package and storage. The use of specific types of bacteria for the assay of antibiotics was illustrated.

NEWS and VIEWS

National Science Foundation, Washington: Dr. Paul E. Klopsteg

Prof. Paul E. Klopsteg, professor of applied science and director of research of the Northwestern Institute of Technology, has been appointed assistant director of the National Science Foundation for the Division of Physical, Mathematical and Engineering Sciences. Dr. Klopsteg, formerly president of the Central Scientific Company, has long been associated with the administration of research. During the Second World War he served with the Office of Scientific Research and Development as chief of Division 17, Physics and Special Devices, of the National Defense Research Committee, which developed important equipment and devices for war-time use. Notable among the Division 17 developments were the three 4,000,000-volt X-ray machines built by the University of Illinois under contract with the Office of Scientific Research and Development, and the high-voltage Van de Graaff machine developed under contract with the Massachusetts Institute of Technology for the X-ray inspection of heavy military equipment. Later in the War, Dr. Klopsteg was appointed assistant chief of the Office of Field Service, which organized the supply of scientific consultants to the various theatres of war; in this capacity he was made chief of the Research Division, General Headquarters, Southwest Pacific Area in Australia and New Guinea in 1944. Dr. Klopsteg was awarded the Medal for Merit with Presidential Citation for his war-time work. Continuing his association with Federal research activities since 1945, he has been a member and chairman of the board of governors of the Argonne National Laboratory, operated by the University of Chicago under contract to the U.S. Atomic Energy Commission. Dr. Klopsteg has been director and treasurer of the American Association of Physics Teachers and chairman of the executive committee of the American Institute of Physics. In his leisure he has studied archery, and he is an honorary member and former chairman of the board of governors of the National Archery Association in the United States.

George Francis FitzGerald Centenary

The Royal Dublin Society will hold a special scientific meeting at 4 p.m. on October 30 to mark the centenary of the birth of George Francis FitzGerald. FitzGerald played a prominent part in many branches of theoretical physics during the last two decades of the nineteenth century, and was the first to show that the generation of electromagnetic waves by oscillating electric circuits was theoretically possible, a prediction verified a few years later by Hertz. He is probably best remembered to-day as one of the authors of the FitzGerald–Lorentz contraction hypothesis, a forerunner of the theory of relativity, which he and Lorentz put forward independently to explain the null result of the Michelson–Morley experiment. The meeting will accordingly be devoted chiefly to the presentation of communications dealing with some modern views on relativity theory. These will include the following papers: Dr. H. E. Ives, "The FitzGerald Contraction"; Prof. W. H. McCrea, "The FitzGerald–Lorentz Contraction—some Paradoxes and their Resolution"; Dr. G. J. Whitrow, "The FitzGerald–Lorentz Contraction Phenomenon and Theories of the Relativity of Galilean Frames"; Prof. J. L. Synge, "Effects of Acceleration in the Michelson–Morley Experiment"; and Prof. F. E. Hackett, "FitzGerald as revealed by his Letters to Heaviside". It is hoped that in addition Dr. E. H. Alton, provost of Trinity College, Dublin, and Prof. H. H. Dixon will contribute personal reminiscences of FitzGerald.

Training of a Technologist

In his Redwood Lecture "The Training of a Technologist", delivered to the Institute of Petroleum on October 3, Prof. F. H. Garner, professor of chemical engineering in the University of Birmingham, emphasized the importance of the applied scientist possessing, besides his technical knowledge, some understanding of the human mind, personal qualities of leadership and the knowledge of how to handle men, which can be gained only by personal contact and not through books. Prof. Garner did not agree that education should be based solely on the humanities, but he pointed out that the defects of such an education, particularly when it includes no training in science nor any scientific background, is due at least in part to the decay of the religious element and the Christian ideals or philosophy which, until the Edwardian era, had a more marked influence than the classical philosophies. There has been a violent change with our traditions, and it is always desirable that in traditions the rate of change should be slow. This is one of the real reasons why the educated part of the community is proving unfitted to deal with the problems of to-day;

but it is important that the technologist, who would have to deal with human problems throughout his career, should also be able to bring a balanced outlook to bear on the questions of human relations or of administration with which he might be confronted. Prof. Garner maintained that properly taught engineering represents a complete discipline and a philosophy in the sense of the ability to see a particular field of knowledge in all its human relations. He protested strongly against the tendency to compartmentalize knowledge and stressed the opportunities which are offered by borderland subjects like physical chemistry. With an educational training in the humanities, science, both pure and applied, can be taught so as to enable one to be clear, logical and objective, able to interest people, to assess evidence, form reasoned judgments and explain them clearly to others. It is Prof. Garner's opinion that contact with industry in teaching applied science is essential and can with advantage be improved, especially where the training is being given in industry.

Scientific and Technical Man-power in the United States

The feature of No. 4 of *News Report*, issued by the National Academy of Sciences—National Research Council (Washington, D.C.; July–August 1951) is an article by Dr. M. H. Trytten, director of the Office of Scientific Personnel, on the 'Manpower Shortage in the United States". Analysing the intake available to maintain over a long period the projected military strength of 3·5 million men, Dr. Trytten points out that this figure has been achieved because of the existence of several groups—the pool of males without military service between the ages of eighteen and twenty six, personnel in military reserve status, and the career personnel. There are probably 750,000 career men now in the Armed Services; but to maintain a military strength of 3·5 million will require more than two years of service from all able-bodied youths, even without exemptions. With exemptions the average length of service of all youths not exempted must increase. Without exemptions the whole technology of the nation is in jeopardy. Meanwhile, the demand for technological personnel has mounted, and this summer more than twice as many scientific workers and engineers as were available could have been absorbed in research, production or teaching. It is also estimated that the output of scientific workers and engineers, even without the impact of the draft, is likely to decrease until at least 1955. In view of this situation the Director of Defence Mobilization has established a policy committee to make recommendations on all issues of policy affecting the handling of problems in utilizing scientific and technical personnel. The National Academy of Sciences appointed early in 1951 a committee to examine the situation; and it is believed that the recommendations of this committee, which were adopted by the Academy in April and included the establishment of a National Scientific Personnel Board in the Office of Defense Mobilization to study intensively all such problems, will receive careful consideration when the problem of specialized manpower is discussed.

The Scientific Outlook in 1851 and in 1951

This is the title of a Discourse delivered at the Royal Institution by Prof. H. Dingle last March, and reproduced as an article in the August issue of the *British Journal for the Philosophy of Science*. Prominence has been given at the recent Festival Exhibitions to the difference that science has made in practical affairs during the past hundred years. It is most fitting that there should be a permanent record of another aspect of scientific development, namely, the change in scientific outlook. In the first part of the article, Prof. Dingle emphasizes the basic assumption of the scientific men of 1851 that there was lying before them a world of material objects, moving about in space and time with, as Whewell maintains, a "*substance*, which stands beneath the apparent qualities and supports them". The reality of the substance was held to be its weight. Yet, as Prof. Dingle points out, it was the roundness and colour of Neptune, not its intrinsic property of weight, which was taken to be the guarantee of existence. The revolution that came in the twentieth century was simply the overthrow of that false notion of what science was and is; science itself has pursued the same undeviating course from Galileo through Newton and Einstein to our own time. The implications of the special theory of relativity are incompatible with any form of materialism. Prof. Dingle continues his argument to show the fallacy of the so-called philosophy of dialectical materialism. His treatment is both convincing and stimulating; the nineteenth-century disputes between science and religion are shown in perspective, and of possible further conflict he believes that the highest wisdom lies in recognizing both the relations between experiences and the very different values of the things related. "The discarding of old prejudice and the cultivation of a new outlook are not matters that can be completed in a moment". Prof. Dingle's article is a valuable contribution toward establishing this new outlook in place of dogmatic assertions of a hundred years ago.

Errors in the Carbon-14 Method of Archæological Dating

New lines of investigation are almost always welcomed with enthusiasm, more particularly when they involve disciplines in another subject than the one upon which they may throw light. It is a long time ago now since prehistorians were told all about their subject by human anatomists, and more recently the help of pollen analysis and the fluorine test has been readily accepted. Fortunately, the last two have been introduced to prehistorians by true scientific workers who have not failed to impress upon them the limitations and dangers of the new disciplines. Finally, there has appeared upon the scene the method of accurately dating prehistoric objects in years by analysing the percentage of the rare carbon-14 isotope present in material relative to the ordinary carbon-12. There is no doubt that this is a very valuable new method of study, and it has been taken up enthusiastically in the United States. Equally obviously, there are numberless factors, not perhaps all yet clearly understood, which may completely vitiate the results. A recent short article, only two pages in length, entitled "Radiocarbon Datability of Peat Marl, Caliche, and Archæological Materials", by H. H. Bartlett (*Science*, 114, No. 2951; July 20, 1951), describes just one such example. The author points out that when samples for study are taken from a site where alternating layers of marl and peat occur, the readings may be entirely erroneous owing to the presence of an unknown quantity of 'dead' carbon-12 derived from geologically ancient calcium carbonate;

this may dilute the equilibrated mixture of carbon-12 and carbon-14. Warnings like this do not, of course, invalidate the carbon-14 method of study; but they do impress upon us that we must be slow in accepting as infallible new methods of study until all the possible factors and circumstances bearing upon them have been considered and studied.

Forestry and Conservation in South Africa

In a recent issue of the *Journal of the South African Forestry Association* (Pretoria; No. 20, April 1951), under "Editorial Notes and Comments", there is a strong note on forestry and conservation which is equally applicable to a good many other parts of the world. The note points out that the South African forester and his activities are often condemned by his compatriots when in other countries they would be regarded as constructive and conservational. At one time or another, the forester has been accused of causing erosion, desiccation, destruction of the indigenous vegetation, of championing the exotic against the indigenous tree, of despoiling the beauty of the countryside with artificial plantations (some of these complaints have been heard in Great Britain) and so forth. The note continues to the effect that, so far as South Africa is concerned, if these accusations could be substantiated they would apply with a far greater force to the agricultural operations carried out in that somewhat arid land during the past half-century; this view is supported and expressed by the editor of the *Journal of the Botanical Society of South Africa* (Part 35; 1949) in the following words. "The effect of afforestation upon water supplies has been ably analysed and discussed by Dr. C. L. Wicht (Department of Forestry Bulletin No. 33; 1949). Much is still uncertain and awaits the results of experiments which are in progress. But it is clear, incidentally, that the relative importance of this subject has been much exaggerated when compared with the obvious flagrant and destructive results of much current agricultural and pastoral practice over great areas in the Union. The work of the Forest Department is mainly constructive and conservational; our farming methods are largely exploitational."

Artificial Insemination of Birds

The first Supplement Number of *The Onderstepoort Journal of Veterinary Research* (1951. Gov. Printer, Pretoria. 5*s*., overseas postage 1*s*.) is devoted to a valuable paper, 212 pages long, by G. C. van Drimmelen, on artificial insemination of birds by the intraperitoneal route. The paper discusses the historical background of this subject, its literature, and the author's own extensive work. There are three appendixes, one on the intraperitoneal method of insemination, one on the fowl cocks and the semen samples used, and the third on the post-mortem examination of the genitalia of hens. The bibliography, 11½ pages long, will be useful to all workers on this subject.

University of Leeds

It has been announced from the University of Leeds that the title of emeritus professor has been conferred upon Prof. R. Whiddington on his retirement from the Cavendish chair of physics. Dr. J. G. Wilson, senior lecturer in physics in the University of Manchester, has been appointed to a chair of physics at Leeds as from June 24, 1952.

The following lecturers (in the subjects and/or departments as shown) have been appointed: R. L. Holmes (anatomy), G. A. Mogey (pharmacology), K. G. Towers (veterinary officer and lecturer in veterinary hygiene in the Department of Agriculture), Dr. F. K. Sutcliffe (research lecturer in the Department of Colour Chemistry and Dyeing), and Dr. R. Reed (Department of Leather Industries).

The Night Sky in November

Full moon occurs on Nov. 13d. 15h. 52m., U.T., and new moon on Nov. 29d. 01h. 00m. The following conjunctions with the moon take place: Nov. 10d., 06h., Jupiter 4° S.; Nov. 24d. 11h., Mars 4° N.; Nov. 25d. 10h., Saturn 6° N.; Nov. 25d. 18h., Venus 6° N.; Nov. 30d. 14h., Mercury 2° N. In addition to these conjunctions with the moon, Venus is in conjunction with Saturn on Nov. 21d. 10h., Venus being 0·6° S. Mercury sets too soon after the sun during the greater portion of the month for favourable observation; the planet attains its greatest elongation east on November 28, and on November 30 sets nearly an hour after sunset, when it can be seen in the western sky for a short time. Venus, a morning star, rises at about 2h. 40m. up to the middle of the month, and at 3h. 20m. at the end of the month, with stellar magnitude −4 and the visible portion of the illuminated disk varying between 0·42 and 0·58. Mars is a morning star, stellar magnitude 1·7, rising a little before 2h. throughout November. Jupiter is visible throughout the night, setting at 3h. 45m. on November 1 and at 1h. 45m. on November 30, stellar magnitude −2·3; the planet is stationary on November 30, after which it has an eastward movement in the constellation Pisces. Saturn is a morning star, rising at 4h. 10m., 3h. 20m., and 2h. 30m. on November 1, 15 and 30, respectively, and is easily recognized a little south of γ Virginis in the early part of the month. Only one star brighter than magnitude 6 is occulted in November; on Nov. 10d. 17h. 40·6m., δ Piscium disappears (observable at Greenwich). The Leonid meteors, towards the middle of the month, which have been very feeble for many years, will be difficult to observe owing to moonlight.

Announcements

H.R.H. THE DUKE OF EDINBURGH has been elected an honorary fellow of the Institute of Navigation.

The Royal Society of New Zealand has awarded the T. K. Sidey Medal and Prize for 1951 to Prof. V. A. Bailey, professor of experimental physics in the University of Sydney, for "research in Radiation as bearing on Human Welfare". This Award is the most important made by the Royal Society of New Zealand by virtue of its international character. It was established to commemorate the passing by the New Zealand Parliament of the Summer Time Act, 1927, and was raised by shilling subscriptions, thus making possible a tribute by all to the value of the measure to human welfare.

The following appointments have been made in the University of Sheffield: Dr. T. H. Barton, lecturer in electrical engineering; Drs. W. H. Evans, H. C. Grimshaw, E. M. Guenault, W. C. F. Shepherd and F. V. Tideswell, to be honorary lecturers in mining. The John Stokes Research Fellowship has been awarded to Mr. H. L. Kornberg, who will work in the Department of Biochemistry; a Knoop Research Fellowship in Economics has been awarded to Mr. D. C. Corner.

A FAST CONTINUOUS ELECTRODIALYSER FOR HYDROPHILIC COLLOIDS, AND A FAST CONTINUOUS ELECTRODECANTER FOR HYDROPHOBIC COLLOIDS

By Prof. A. J. RUTGERS and R. SWYNGEDOUW
Laboratory for Physical Chemistry, University, Ghent

DURING the past three years, Dr. G. Jacobs[1] has carried out in our Laboratory researches on centrifugation potentials in colloidal solutions of arsenious sulphide; this sol can be prepared by passing a stream of hydrogen sulphide through a solution of arsenious hydroxide; no foreign electrolyte is produced, hence no dialysis is required. If we want, however, to extend these researches to other colloidal solutions, the difficulty arises that these sols cannot be prepared from base plus acid; they must often be prepared by a reaction like:

$$AgNO_3 + KI = AgI + KNO_3.$$

Thus an indifferent electrolyte (KNO_3) is formed, and dialysis is required in order to remove it. This takes time, especially if a considerable quantity of a highly concentrated sol is required. We have therefore constructed a fast continuous electrodialyser. This apparatus (Fig. 1) fulfilled expectations when used for the dialysis of hydrophilic colloids; if, however, hydrophobic colloids were handled in this apparatus, immediate electrodecantation occurred. We then decided to make a virtue of necessity, and to effect a separation of the hydrophobic sol into a dilute part and a concentrated part by electrodecantation; for this purpose the apparatus had to be duplicated in the direction of its longitudinal axis (Fig. 2).

The apparatus of Fig. 1 can be considered as a further development of a dialyser devised by Brinkman[2]; this dialyser consisted essentially of a glass tube around which a sausage skin fits. This system is placed in distilled water; dialysis takes place in the space between the glass tube and the sausage skin. We developed this apparatus into an electrodialyser (Fig. 1). Around the central glass tube we put first a platinum gauze, then a sausage skin, then a somewhat longer sausage skin; this system was placed inside a glass tube, which carried on its inner wall another platinum gauze. In this way we obtained an inner washing space, a space for the sol, and an outer washing space; feed and outlet pipes for each of these compartments could be fitted inside the central tube; they pierce its walls in the appropriate places. Molten paraffin is poured inside the central tube; after solidification it holds the numerous glass tubes firmly inside the central tube.

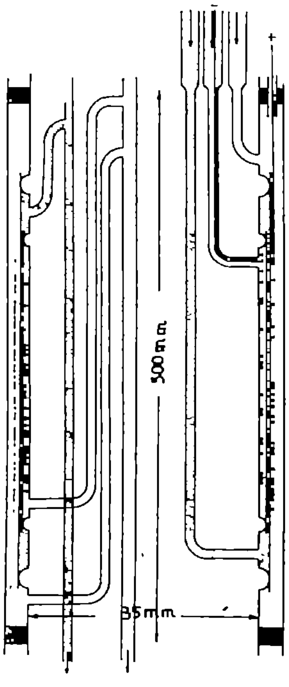

Fig. 1. Fast continuous electrodialyser for hydrophilic colloids

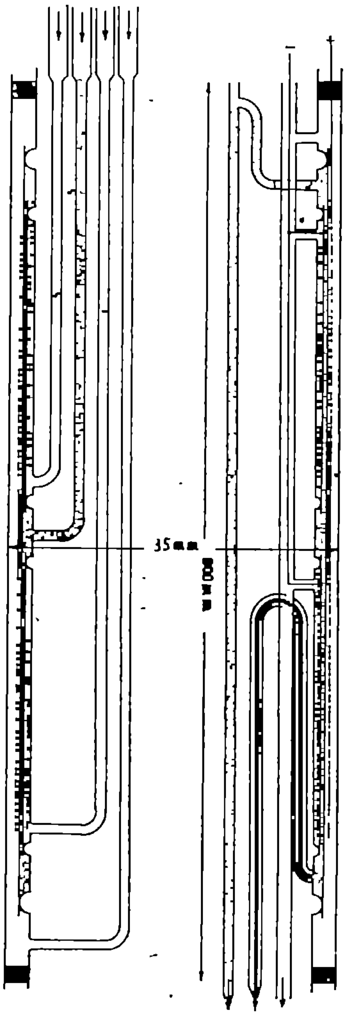

Fig. 2. Fast continuous electrodecanter for hydrophobic colloids

During dialysis, the counter-current principle is used. The sol enters at the bottom and leaves at the top; the washing water flows in the opposite direction. Hydrostatic pressure must be highest in the inner wash-chamber, medium in the sol-chamber, lowest in the outer wash-chamber. This can be obtained by giving a suitable shape to the outlet pipes.

With this apparatus (diameter of inner tube 38 mm., of outer tube 55 mm.; length of platinum gauzes 200 mm.), 200 cm.^{3} per hour of a hydrophilic sol could be freed from electrolyte (current density 3 m.amp./cm.^{2}; current about 0·7 amp.; voltage 100).

There is no reason for expecting the new apparatus to be efficient in removing non-electrolytes, such as urea; this was confirmed by experiment. It is unfortunate, for a simple apparatus capable of removing urea with good efficiency would be of great medical value (artificial kidney).

If a hydrophobic sol, for example, a silver iodide sol, is introduced into the apparatus shown in Fig. 1, electrodecantation occurs, and the concentrated sol sinks to the bottom, where it mixes with the freshly introduced sol. If the apparatus is slightly changed, so that the sol can be introduced at the top, it sinks rapidly to the bottom, and appears not to be dialysed at all; moreover, the liquid leaving the apparatus at the top always contains a considerable amount of silver iodide.

We therefore decided to duplicate the apparatus in the direction of its longitudinal axis (Fig. 2); the sol is introduced in the middle, at a speed of 200 cm.^{3} per hour; decantation takes place; the concentrated sol sinks to the bottom, while a liquid containing only a little silver iodide leaves the apparatus at the top; if electrolyte is carried off by this liquid, so much the better. The concentrated sol at the bottom is taken from the apparatus by a siphon-shaped capillary of 0·4 mm. diameter (a tap should not be used); it carries off 20 cm.^{3} per hour; this sol is about seven times as concentrated as the original sol. A litre of this concentrated sol can be prepared in two days; this quantity can be further dialysed in a Pauli dialyser in one operation, in order to obtain it free from electrolyte.

[May 8.

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PREVENTION OF SWAYBACK SYMPTOMS IN LAMBS BY ADMINISTRATION OF COPPER SULPHATE TO THE PREGNANT EWE

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In a previous paper[1] it was shown that the occurrence of swayback in lambs, which was enzootic on a hundred farms covering an area of forty square miles in north Derbyshire, could be prevented by the provision of copper to the pregnant ewes. In a later paper[2] control of the disease was obtained by the addition of copper to the diet of the ewes twenty days before the ewes began to lamb.

Recently Cunningham[3] has shown that the development of ataxia may be averted by regular drenching of the lambs with copper sulphate twice a week from birth until they are four months old. Each dose administered to the lambs consisted of 35 mgm. $CuSO_4.5H_2O$ (approximately 9 mgm. copper) in 0·5 oz. water. Administration of the doses was carried out on Monday and Friday of every week after the first lamb was born.

Bennetts found in 1937 that the disease was prevented by supplying copper to the mother before lambing occurs. Administration of a single dose of copper sulphate to affected lambs did not prevent development of the symptoms. Bennetts and Beck[4] showed that the feeding of copper to affected lambs arrested the progress of the disease.

Preventive measures for the control of the disease as it occurs in the west of Scotland have been studied for a number of years. Each year during March and April, farmers have reported to this Department that symptoms of the disease have appeared among the lambs in their flocks shortly after the commencement of the lambing season. This is usually the first indication that numerous cases of the disease will occur among the lambs yet to be born from the ewes in the flock.

Some method of control was desirable by which the ewes in the flock still to lamb would produce normal lambs which later would remain free from symptoms of swayback.

In 1940 and 1941 experiments were begun for testing practicable preventive measures; but during these seasons on low-ground farms there was no incidence of swayback in the experimental flocks. In 1942, 10 ml. of copper sulphate solution containing 200 mgm. copper was administered to each ewe still to lamb on one farm carrying Cheviot ewes which had been mated with a Border Leicester ram. The treatment was given one week after lambing had commenced in the flock, when a high percentage of the lambs already born had developed swayback. The incidence during previous years had also been appreciable. Following treatment of the pregnant ewes, no further cases of swayback occurred.

Similar results were obtained in another flock during the following year, while the original flock, in which the pregnant ewes were treated immediately before lambing commenced, showed no cases of swayback in the lambs.

The full results are presented in the accompanying table. This also shows experiences in other flocks subsequent to 1943. In these all the pregnant ewes after dosing gave birth to normal lambs. Ewes which were not treated produced a high percentage of abnormal progeny.

Treatment of Flocks susceptible to Swayback with Copper Sulphate

Flock	Year	No. lambing ewes	Date of treatment	Date lambing commenced	Per cent swayback during lambing in 1st wk.	2nd wk.	3rd wk.	4th wk.
A	1941	360	None	Mar. 14	13	8	14	17
A	1942	360	Mar. 20	Mar. 14	28	0	0	0
B	1942	84	None	Mar. 14	21	27	8	19
A	1943	360	Mar. 13	Mar. 14	0	0	0	0
B	1943	160	Mar. 20	Mar. 15	17	0	0	0
B	1944	160	Mar. 10	Mar. 14	0	0	0	0
C	1946	200	Mar. 16	Mar. 9	27	0	0	0
C	1947	200	Mar. 3	Mar. 9	0	0	0	0
D	1947	350	Mar. 15	Mar. 8	18	0	0	0
E	1947	320	Mar. 20	Mar. 15	17	0	0	0
F	1947	100	Mar. 17	Mar. 11	33	0	0	0
D	1948	350	Mar. 6	Mar. 8	0	0	0	0
E	1948	320	Mar. 8	Mar. 11	0	0	0	0
F	1948	100	Mar. 1	Mar. 11	0	0	0	0

In the west of Scotland it is now common practice to treat all ewes which may produce swayback progeny with copper at udder locking (within one week of lambing) or immediately swayback is observed in the lamb crop. One gram of copper sulphate dissolved in 30 ml. water is administered to each ewe.

No cases have been reported of the occurrence of swayback progeny in more than four thousand susceptible ewes treated in this way.

The administration of copper to the ewes immediately before lambing appears to provide complete control of swayback in the lamb crop on susceptible grazings.

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THE *IN VITRO* FORMATION AND DISPOSAL OF CARBON MONOXIDE IN BLOOD

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CARBON monoxide is constantly exhaled in human respiration, even when every possible external source of carbon monoxide is excluded[1]. It has also been shown that if blood is incubated at 38° C. for 10–24 hr., there is a constant increase of a factor which is determined as carbon monoxide. This increase is especially pronounced after hæmolysis[1,4].

This latter observation has now been confirmed and amplified in a further series of experiments (Table 1). In these investigations, the carboxyhæmoglobin concentration was determined by Horvath and Roughton's method[2], and also by the method described by Siösteen and Sjöstrand[3]. Both methods gave the same results within the respective experimental errors for the concentrations involved (0·1 per cent and 7 per cent carboxy-hæmoglobin).

Table 1. Increase in Concentration of Carboxy-hæmoglobin in Hæmolysed Blood after Incubation at 38° C. for 20 hr.

Method	Species	No. of separate exp.	Per cent carboxy-hæmoglobin before incubation (I)	Per cent carboxy-hæmoglobin after incubation (II)	$\frac{II-I}{I} \times 100$
Horvath and Roughton	Man	12	0·44	0·75	75
	Cow	6	0·50	0·97	94
Siösteen and Sjöstrand	Man	12	0·45	0·66	47
	Cow	10	0·51	1·05	100
	Pig	2	0·34	0·74	118

Therefore, it is possible to draw the following conclusions about the factor under investigation. (1) It is chemically combined with hæmoglobin. (2) It is liberated on oxidation of hæmoglobin to methæmoglobin. (3) It is oxidized at room temperature in the presence of hopcalite. (4) The heat liberated on oxidation corresponds to the heat of combustion of carbon monoxide. It has also been found that: (5) the factor is absorbed by solutions containing copper sulphate and cuprous chloride; and (6) it reduces $H_4[Si(Mo_2O_7)]$ in the presence of palladium chloride, according to Shepherd[4].

Carbon monoxide is the only substance known to have this combination of properties.

If the *p*H of the blood is changed before incubation, the formation of carbon monoxide is accelerated (Table 2). This effect is especially pronounced at *p*H 4–6 and *p*H 9–11. At more extreme *p*H's, however, the formation of carbon monoxide is inhibited.

Table 2. Increase in Concentration of Carboxy-hæmoglobin in Blood, hæmolysed by Addition of Distilled Water at Different *p*H Values after Incubation at 38° C. for 20 hr.*

Method	Species	Per cent carboxy-hæmoglobin before incubation	Per cent carboxy-hæmoglobin after incubation *p*H 4–6	*p*H 7·4	*p*H 9–11
Siösteen and Sjöstrand	Cow	0·69		1·35	2·60
	Cow		2·10	0·98	1·35
	Pig	0·84	2·20	1·10	1·70
	Pig	1·27	3·98	1·39	2·24
	Pig	1·00	3·79	2·20	3·95

* Changes of *p*H were obtained by using weak hydrochloric acid and sodium hydroxide solutions without the addition of buffers.

As may be seen from Table 3, the formation of carbon monoxide at *p*H 7·4 is greatly increased in the presence of 1/200 sodium azide, and the values are similar to those obtained after changing the *p*H of the blood. Thus, the comparative inhibition at *p*H 7·4 appears to be reversed by sodium azide.

Table 3. Increase in Concentration of Carboxy-hæmoglobin in Blood after Addition of Sodium Azide, 1 : 200, and Incubation at 38° C. for 20 hr.

Method	Species	No. of separate exp.	Per cent carboxy-hæmoglobin before incubation	Per cent carboxy-hæmoglobin after incubation without sod. azide	with sod. azide
Horvath and Roughton	Man	9	0·58	0·83	1·95
Siösteen and Sjostrand	Man	12	0·45	0·66	1·74
	Cow	2	0·85	1·20	5·20

The effect of different tensions of carbon monoxide on the formation of carbon monoxide in blood was investigated by adding carbon monoxide to the blood before incubation, to produce 5–60 per cent carboxy-hæmoglobin. In these experiments a significant decrease of the concentration of carboxyhæmoglobin was observed in nearly every case after incubation (Table 4). Table 5 shows, however, that in the presence of sodium azide there is an increase in carbon monoxide formation, even with increased tensions of carbon monoxide.

Table 4. Decrease in Concentration of Carboxy-hæmoglobin after Incubation at 38° C. for 20 hr. with Increased Carbon Monoxide Tension

Method	Species	No. of separate exp.	Per cent carboxy-hæmoglobin before incubation	Per cent carboxy-hæmoglobin after incubation
Horvath and Roughton	Man	11	12·05	10·91
Siösteen and Sjöstrand	Man	9	10·55	9·74
	Pig	4	39·2	35·0

Table 5. Change in Concentration of Carboxy-hæmoglobin in Blood after Incubation at 38° C. for 20 hr. with Increased Carbon Monoxide Tension, with and without Addition of Sodium Azide (1 : 200)

Method	Species	No. of separate exp.	Per cent carboxy-hæmoglobin before incubation	Per cent carboxy-hæmoglobin after incubation without sod. azide	Per cent carboxy-hæmoglobin after incubation with sod. azide
Horvath and Roughton	Man	8	12·50	11·46	13·84
Sjösteen and Sjostrand	Man	6	11·06	10·40	12·16

These observations seem to indicate that carbon monoxide may be both formed in and removed from the blood. If the blood is incubated at 38° C., an equilibrium seems to be reached between these antagonistic reactions. The rate of disposal of carbon monoxide is determined by its tension, and has its optimum value at approximately pH 7. In normal life the equilibrium may be affected by the expiration of carbon monoxide, if the concentration in the inspired air is lower than that of the alveolar air, as is usually the case with ordinary atmospheric air. It has also been shown that the reaction is shifted to give increased carbon monoxide formation during physical exertion and on breathing 10 per cent oxygen in nitrogen[5].

The results of these investigations appear to provide an explanation of the endogenous formation of carbon monoxide, and also of the observations made by Fenn and Cobb[6], Clark, Stannard and Fenn[7], and Clark[8], that carbon monoxide is oxidized in isolated muscle preparations and in the intact animal. They may also explain the well-known fact that the carbon monoxide capacity of blood is slightly greater than the oxygen capacity.

A more detailed account of these investigations will be published in *Acta Physiologica Scandinavica*.

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SOCIETY FOR APPLIED BACTERIOLOGY

ANNUAL GENERAL MEETING

THE annual general meeting and conference of the Society for Applied Bacteriology was held in Marischal College, Aberdeen, during July 3–6. Approximately sixty-five members and visitors attended one or more of the four paper-reading sessions. At the meeting the resignation of the secretary, D. A. McKenzie, was announced and G. Sykes, of the Microbiology Division of Messrs. Boots, Nottingham, was appointed to succeed him. During the conference visiting parties were received at the Rowett Research Institute, the Macaulay Research Institute and the Torry Fisheries Research Station. Seventeen original papers and four demonstrations were presented at the four paper-reading sessions.

Miss M. J. Masson (Rowett Research Institute) described the microscopical methods used in a study of the gut of the sheep. The need for the use of direct microscopy as a preliminary to, and check upon, pure cultural and biochemical work on microbial populations was emphasized. Qualitative and quantitative changes in the microscopical appearance of contents from nine regions of the gut of a sheep fed with hay and a concentrate mixture and from the rumen of sheep fed with different diets were detailed. The isolation of *Clostridium butyricum* and lactobacilli from the rumen of a sheep fed with large quantities of flaked maize and small quantities of hay, and a Gram-positive streptococcus which liquefied gelatin, clotted milk, and later digested the clot, grew on McConkey's medium and survived 60° C. for 30 min., from the rumen of a sheep fed up to 300 gm. daily of casein, was reported.

Two papers on "The Chemistry of the Nitrifying Bacteria" were presented by Dr. H. Lees and Dr. T. Hofmann (Biochemistry Department, Marischal College, Aberdeen). The free energy efficiency of *Nitrosomonas* is usually taken to be about 6 per cent, but Dr. Lees has found that in the early stages of growth the value is about 50 per cent (biochemically a far more reasonable figure). The value falls rapidly as nitrite accumulates until, at nitrite concentrations of 1,500 μgm. nitrogen/ml., it has reached about 6 per cent. The rapid fall in efficiency may well be due to an increased respiration-loss consequent upon the maintenance of a low intracellular nitrite concentration in a medium of increasing nitrite content. Experiments on enrichment cultures of *Nitrobacter* have shown that the organism is highly sensitive to chlorate and that chlorate inhibition is reversed by nitrate; this accords with the results of percolation studies on soil. Dr. Hofmann, using the paper chromatography method of Fowden, has found that the amino-acid content of the protein of nitrifying bacteria does not differ fundamentally from the proteins of other less-specialized organisms.

Dr. James Shewan and his colleagues of the Torry Research Station discussed some aspects of the bacteriology of marine fish. The taxonomy of the groups present in marine fish is one of great difficulty, and a comprehensive study of these groups is at present being carried out. It has been found, for example, that it is very necessary, in order to explain different rates of spoilage in the same fish caught at the same time and handled and stored under identical conditions, to know not only the number but also the types of bacteria present. The three main families of bacteria found are Achromobacteriaceæ, Pseudomonadaceæ and Micrococcaceæ. The important species in these groups also show certain common characteristics, namely, capacity for growth in low concentrates of organic nutrients, enhanced growth on solid surfaces (presumably due to increased concentrates of organic nutrients on the solid surfaces), fairly low optimum temperatures (20°–25° C.) and marked heat sensitivity; they are actively proteolytic and usually weakly saccharolytic. Some have rather unusual biochemical characteristics, for example, liquefaction of agar, digestion of chitin and reduction of trimethylamine oxide; a few are luminescent.

A symposium on the chemistry and bacteriology of silage was presented during the conference. Dr. A. J. G. Barnett (Marischal College, Aberdeen) reviewed some recent studies on the estimation of the lactic acid content of silage and directed attention to the fact that, while the lactic acid content of silage is directly related to pH, if the amount of lactic acid is re-calculated on the basis of the dry-matter content of the fresh silage, a similar curve results indicating that the lactic acid formed is proportional to the dry matter content of the initial crop. In further work, at present in progress, Dr. Barnett is studying the change of pH in relation to the lactic acid increase and the decline in sugar content.

Mrs. A. C. Stirling (College of Agriculture, Edinburgh) presented the results of preliminary experiments with grass silage made in laboratory containers under controlled conditions. Investigation of the bacterial content of such laboratory silage indicates that the fermentation proceeds more quickly at 30° C. than at 22° C. and that a temperature of 40° C. is selective of different types of organisms. Wilting of the grass delays bacterial action, whereas maceration gives a more rapid fermentation and a lower pH.

Miss R. E. A. Allen and Miss A. B. Dickinson (King's College, Newcastle upon Tyne) have investigated the variation in pH and total bacterial count (microscopical) in a pit of unmolassed grass silage. While they stress that it is not possible to draw final conclusions from the examination of a single pit, from their results it would seem that the variation of quality of silage in a pit, as measured by pH, is greater from top to bottom than from side to side. This agrees with the findings of Dudley and Townsend on the variation of crude protein and dry matter content through a cylindrical silo. Miss Allen's and Miss Dickinson's results were of interest in demonstrating the constancy of pH found in the middle layer of the pit.

Some preliminary results and suggestions on the role of plant cells in the ensilage problem were described by L. A. Mabbitt (Edinburgh). His paper dealt primarily with the problem of producing an apparatus which would be capable of doing all operations from sowing the seed to ensiling the fodder in the same sterile chamber. The illustration of Mr. Mabbitt's apparatus created considerable interest. Bacteriological examination of material obtained during 1950 showed that the 'silage' was sterile. Chemical analysis of the material showed that no alcohol, no volatile acid and no lactic acid were present. The amino-acid and volatile base content showed an increase. This work is also continuing.

The enumeration of lactobacilli on grass and silage has been studied by R. M. Keddie, Edinburgh. Mr. Keddie has found that addition of oleic acid and later 'Tween 80' stimulated the growth of lactobacilli. A medium containing 'Tween 80' and acetate in the form of an acetic acid/sodium acetate buffer was used at a final pH of 5·4. The medium gave good growth of lactobacilli apart from a group of homofermentative species. It is hoped from this preliminary work to develop a medium suitable for the enumeration of lactobacilli on grass and silage.

The methods hitherto used for the study of the anaerobic bacterial flora of silage have not been satisfactory. The development of an improved technique has been undertaken by R. F. Rosenberger (Edinburgh). Through the work of Barker in California the problem of the anaerobic fermentation of lactate has been largely solved, and, basing his work on Barker's conclusions, Mr. Rosenberger has been able to evolve a dilution method which appears to enumerate quantitatively the number of vegetative cells and spores of anaerobic lactate fermenters such as occur in normal silage. A similar method is being developed for the proteolytic anaerobes, based on the ability of these organisms to carry out an extensive protein breakdown in the absence of any other energy source, provided oxygen is excluded. With the introduction of semi-solid media and non-toxic reducing agents, thioglycollic acid and cysteine, a great advance has been made in anaerobic technique.

Dr. M. Ingram (Cambridge) recalled that experiments on whales have shown that the anaerobic bacteria (*Cl. welchii* type A) which occur naturally in whale flesh do not begin to develop actively until the muscles have passed through rigor mortis. Attempts to observe this effect on more normal meat (horse) have so far been unsuccessful, whether the flesh was incubated anaerobically with *Cl. welchii* as in the whale (artificial inoculation was necessary) or aerobically with species of *Pseudomonas*.

Some preliminary results on a small chlorinating plant suitable for farm water supplies were presented by Dr. L. F. L. Clegg (Wolverhampton) and W. A. Cuthbert (Leeds). The paper discussed the possibility and practicability of improving by chlorination those farm supplies used for dairy purposes which were either potentially dangerous or of such poor bacteriological quality as to be liable to affect the keeping quality of the milk produced. So as to overcome the difficulty of variation in the organic matter content, which in turn would cause a variation in the chlorine demand, super-chlorination followed by de-chlorination were employed. The principle of dosage was that of drawing in concentrated hypochlorite solution by a vacuum pump through a Venturi tube, followed by de-chlorination, on the same principle, with sodium thiosulphate. Incomplete sterilization was afforded with a dosage of 10 parts per million and a contact of 90 seconds, but satisfactory results were obtained by dosing at both 5 and 10 p.p.m. with a contact of 6¼ minutes. In order to reduce contamination from the sodium thiosulphate solution itself, it was found necessary to add a by-pass from the contact tank so as to leave a residual of 0·1–0·2 p.p.m. of available chlorine. Experiments are continuing using soil suspensions as contaminating material, and it is intended to study a prototype plant under farm conditions.

Two new experiments with the methylene blue test were described by H. Barkworth (Derby). In Mr. Barkworth's results, with replicate samples, the reduction time of methylene blue in milk diminishes with storage time, but this relationship ceases, or at least is seriously modified, when the reduction time has fallen to 30 min. These results cast suspicion on the value of any routine methylene blue test with an original reading of 30 min. or less, and since in the majority of cases tubes are read only at half-hourly intervals this means that any original reading less than one hour is of doubtful value.

Improvements in the ion-exchange method of preparing silica gel media (Taylor) was the subject of a communication from W. K. Smith (Butterwick Research Laboratories, Welwyn). This type of medium has a number of advantages and has created widespread interest. Mr. Smith discussed problems in the preparation of such media and described further applications.

The need for a rapid *in vivo* screening test for compounds of possible antituberculous activity has held the attention of workers in this field for some considerable time, and because of their small size, resulting in economy of drug and cost of maintenance, much work has been done on experimental tuberculosis in mice. Miss Betty Croshaw (Boot's, Nottingham) dealt with attempts to standardize the screening test in mice using intracerebral infection, all results being based on the extent of lung tuberculosis when the experiments were deliberately terminated four to six weeks after infection. Miss Croshaw's paper also dealt with the virulence of cultures according to the type of culture medium used and the advantage of objective interpretation of drug activity (that is, survival-time).

A note on the bacteriology of yoghurt was given by Miss E. R. Hiscox (Reading). It would appear that this fermented milk consists primarily of a mixture of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. In some types yeasts may also be present.

Miss C. M. Cousins (Milton-Deosan, London) described a preliminary screening test (bacteriological) for quaternary ammonium compounds and formulations. The test is based on a plate count method which determines the survival of a given test organism, *Bacterium coli*, in sterile homogenized whole milk, added with the bacterial suspension to the quaternary ammonium compound dilutions, for an exposure time of two minutes. The paper directed attention to the special cleaning of glassware that is necessary. The preparation and use of the quaternary ammonium compound inhibitor, lecithin in 'Lissapol N', was described, with details of the testing procedure. Examples quoted showed how this test indicates a difference in bactericidal efficiency between (*a*) two different quaternary ammonium compound solutions, and (*b*) the same quaternary ammonium compound included in two powder formulations of differing *p*H value.

GENES AND MUTATIONS

THE Symposia on Quantitative Biology held annually in the Biological Laboratory at Cold Spring Harbor, Long-Island, have become a major event in biology. Their purpose is to foster a closer relationship between biology and the other basic sciences, and they set out to achieve this not only by attempting a synthesis of existing experimental data concerning a particular subject, but also by applying new knowledge gained in other fields.

This year, the sixteenth of the series, the topic of discussion, selected by Dr. M. Demerec (Carnegie Institution), was "The Genes and Mutations". The same subject was discussed ten years ago, and the present meeting was intended to show the advances made in genetical research during the past decade. In 1941 the main subjects of discussion were the giant chromosomes of the salivary glands of *Drosophila*, the mechanism of chromosome coiling and spiralization, and the quantitative aspect of spontaneous and radiation-induced mutations. Only one contribution was concerned with the genetical usefulness of micro-organisms, viruses and bacteria. During the present Symposium the latter occupied a prominent position, and it was clearly demonstrated that the knowledge gained from studies of the genetical behaviour of bacteria, viruses and bacteriophage has deepened our understanding of the basic fundamentals of genetics themselves, and explained phenomena which baffled geneticists of ten years ago—as was so dramatically illustrated by T. M. Sonneborn (Indiana University) in the closing session.

A new theory of the gene, including its action in development and its relation to other genes, was brought to light by the work of B. McClintock (Carnegie Institution). She described very remarkable and complicated results on mutable genes in maize, which can be interpreted as due to transposition of minute pieces of chromatin from one position to another in the chromosome. The frequency of such transposition is itself under genic control, which findings emphasize the close integration or interrelationship of the gene complex. According to R. Goldschmidt (Stanford University, Cal.) the gene in the chromosome represents a "field of action" closely integrated into one system, in which gene mutation is a consequence of rearrangements on a submicroscopic scale. L. Stadler (University of Missouri) presented results on spontaneous gene mutation in maize, and E. R. Lewis (California Institute of Technology) on pseudoallelism in *Drosophila*. Both contributions have shown how it is possible by exact and extremely detailed genetical analysis to obtain insight into the complexity of genic activity. The same point was emphasized by S. G. Stephens (University of North Carolina) in describing the diversification of individual genetic loci in the diploid and amphidiploid forms of *Gossypium*.

Gene action and gene–enzyme relationship was discussed by D. M. Bonner (Yale University) and N. H. Horowitz (California Institute of Technology) in *Neurospora*. It was argued that there are genes which control only one step in the synthesis of enzymes, but an example in the synthesis of nicotinic acid was also presented to show that the blockage can be incomplete.

The genetical impact of chemical agents on genes and chromosomes was but little known in 1941. However, the present conference showed that the wealth of results obtained meantime in diverse organisms by the study of a great array of substances is not only impressive but also has widened our concept of mutagenesis itself and brought to light phenomena not observed previously. C. Auerbach (University of Edinburgh) pointed out the differences between chemically and X-ray induced mutations, by studying the mosaics in *Drosophila*, and emphasized the possibility of a delayed effect on the gene. Dr. Demerec described tests of various highly mutagenic compounds on the streptomycin-dependent mutant of *Escherichia coli*, which is a particularly suitable object for studies of the influence of environmental factors on gene-stability. On this aspect more evidence was presented by A. Hollaender (Oak Ridge National Laboratory, Tenn.) and collaborators, showing that lack of oxygen is one of the factors which greatly reduces the mutagenic effect of chemical agents and ionizing radiations. M. Westergaard (Institute of Genetics, Copenhagen) described his 'back-mutation' test in *Neurospora*, which will prove to be a very useful and rapid method for the detection of chemical mutagens, and made an attempt to interpret the chemical basis of induced mutagenesis. The aspect presented by Westergaard linked up closely with the contribution of N. H. Giles (Yale University), who described the various mechanisms which may be responsible for the spontaneous reversions of biochemical mutants in *Neurospora*.

The visible effects of various chemical agents on the chromosomes of *Allium* and *Vicia* were described by A. Levan (Institute of Genetics, Lund), who demonstrated that different chromosome regions may exhibit a different degree of reactivity to a drug, suggesting that further investigation by genetical and cytological means may disclose specific affinities between certain chemical compounds and chromosome regions or even genes.

The broader evolutionary significance of mutagenesis was discussed by A. Gustafsson (Forest Research Institute of Sweden, Stockholm), who illustrated, with examples on barley, how new mutants produced artificially can be superior to the original type under different environmental conditions. W. L. Russell (Oak Ridge National Laboratory, Tenn.), by using an ingenious method of analysis, was able to present data obtained from about 85,000 mice, which show that the X-ray induced mutation-rate is at least fifteen times higher in this mammal than in *Drosophila*. Because of the great likelihood that man belongs more to the former than to the latter type in respect of radiation sensitivity, Russell's data add to the problem of radiation hazards in man a very serious emphasis, which was stressed by Prof. H. J. Muller.

The genetic composition of a population is known to be under the influence of various factors, such as mutation, selection, rate of reproduction, etc. A. Novick and L. Szilard (University of Chicago) have described the 'chemostat', which makes the study of these factors possible in bacteria. It is an apparatus in which the medium is automatically replaced so that the various growth-limiting factors may be added at a slower or higher rate than the reproduction of the bacteria. These workers illustrated with experimental observations the usefulness of the chemostat in genetical investigation, the results obtained being similar to those of K. C. Atwood (Columbia University) and co-workers employing the more conventional method of genetical analysis.

The Symposium devoted one session to the cytoplasmic constituents of heredity. P. L'Héritier (University of Paris) has proved that the sensitivity of *Drosophila* to carbon dioxide is due to a cytoplasmic factor, and closely resembles a virus-caused infection. He was able to show that by injecting extract from carbon dioxide-sensitive flies into resistant *Drosophila*, the latter 'acquired' carbon dioxide sensitivity. When the 'virus' or 'genoid' invades the germ-plasm, then the carbon dioxide sensitivity becomes a heritable property. L'Héritier favours the view that the 'genoids' have an internal origin. A more complex system of cytoplasmic inheritance was presented by B. Ephrussi (University of Paris) in yeast. He finds that the formation of large and small colonies, which differ also in the presence or absence of cytochrome-oxidase, is due to a nuclear gene, inducing an instability in the cytoplasm. The latter can be influenced or affected by environmental factors, such as the presence of trypoflavin in the medium, when the incidence of small-colony formation increases enormously.

A large part of the Symposium was taken up with the genetics of bacteria and bacterial viruses. J. Lederberg (University of Wisconsin) and co-workers gave a detailed review of bacterial genetics, derived from experiments with *E. coli*, line K.12. Lederberg pointed out the complex system of linkage relationships of known genetic loci in this bacterium. The inherent difficulties of bacterial heredity were further stressed by E. M. Witkin (Carnegie Institution), who analysed the method of segregation and recombination in multinucleate bacterial cells. The cytology of bacteria was presented by K. A. Bisset (University of Birmingham) and E. D. DeLamater (University of Pennsylvania). Their papers brought out the basic disagreements in the interpretation of the cytological phenomena, and further emphasized the difficulties of bacterial genetics.

The transformation of various morphological and serological types of pneumococci by deoxyribosenucleic acid extracted from particular mutants was reviewed by H. Ephrussi-Taylor (Institute of Genetics of the C.N.R.S., Paris), who presented new results suggesting that the 'old' genetic determinant is not only altered but is completely replaced by the 'transforming principle'. R. D. Hotchkiss (Rockefeller Institute of Medical Research) has induced penicillin-resistant pneumococci which have yielded another 'transforming principle' (deoxyribosenucleic acid), and was also able to show that by combining this with the morphological 'transforming deoxyribosenucleic acid' they 'segregate' independently. Another interesting case of transformation has been found by N. Zinder (University of Wisconsin) in *Salmonella*, in which a 'stimulating' substance must be liberated first, in order to produce the transforming factor itself. It is claimed that the latter is associated with the microsomes of the cytoplasm.

The various properties of bacterial viruses and their behaviour in heredity were described by S. E. Luria (University of Illinois) and A. O. Hershey (Carnegie Institution). It has been shown that genetical analysis is still the most powerful method by which not only the characteristics but also the organization of the bacteriophage itself may be studied. At the same time it has been possible to demonstrate in these 'simple' forms many of the features of a complex genetic system, such as exists in higher organisms. However, they also show other phenomena, such as 'phenotypic mixing', which at present remain unexplained.

The Cold Spring Harbor Symposium was an outstanding success since it brought together into a coherent and closely integrated system a great deal of new and fundamental information, obtained from studies on the most diverse organisms. It has emphasized two facts: first, genetics is making use of many new organisms and techniques and is thus at present extending its boundaries extremely rapidly and to great profit; and secondly, and consequent upon the specialization which is necessarily occurring, it becomes increasingly desirable to hold meetings such as this, at which the new fields may be integrated.

SECOND INTERNATIONAL CONGRESS ON ASTRONAUTICS

THE second International Congress on Astronautics was held in London during September 3–8. It was attended by nearly fifty delegates representing societies and groups interested in astronautics from Argentina, Austria, France, Germany, Great Britain, Italy, Spain, Sweden, Switzerland and the United States. The first International Congress, held in Paris in September 1950, was purely exploratory in nature and was intended as a series of informal meetings to discuss the possibility of setting up an international federation. As a result of the deliberations of the first two days of the recent Congress, an International Astronautical Federation was founded, "to promote and stimulate the achievement of space-flight". Dr. Eugen Sänger was elected president, and the two vice-presidents are Dr. G. Loeser, of the Gesellschaft für Weltraumforschung, and Andrew G.

Haley, of the American Rocket Society. The headquarters are to be in Switzerland, and the Swiss group (there is as yet no legally constituted society) will handle all international matters, such as the collection, classification and storage of an astronautical library and archives. It is envisaged that the Federation's main tasks will be in the exchange of information between member societies and the organization of technical congresses. The next congress will be held in Germany in 1952.

The latter part of the London Congress was devoted to a symposium of papers on the general theme of orbital vehicles, their construction and uses. There was general agreement among the speakers that such vehicles are possible from an engineering point of view; the first instrument-carrying vehicles could be built within ten to fifteen years; but man-carrying artificial satellites appear to be much further in the future. In all, seventeen papers were read dealing with the engineering problems of raising and constructing such vehicles, return to earth by high-speed glider, travel between artificial satellite orbits, radar tracking of vehicles from the earth, danger from meteors and other relevant topics.

Mr. T. Nonweiler dealt with the problem of descent from a satellite orbit by glider. The most difficult matter is the temperature reached during the descent. In general, the rate of heat transfer to a body moving at very high speeds cannot be accurately calculated. However, Mr. Nonweiler presented an approximate general solution which he has developed and which is applicable at Mach numbers of 10 or more if the Reynolds number is between about 10^4 and 10^6. A return glider would, in fact, be operating within these limits during the greater part of its flight time. The effects of the air slip at the wing surface have also been examined; this has led to an estimate of the maximum rate of heat transfer to the surface. A limit to the skin temperature is also imposed by the conduction of heat along the surface: this has also been calculated. It was shown that the wing surface temperature will be a minimum if a thin, double-wedge wing-section is used, with a position of maximum thickness well aft and with both its inner and outer surfaces acting as good radiators of heat; the temperature will be highest near the leading-edge of the wing undersurface, and its value will vary approximately as the fourth root of the wing loading. If a maximum skin temperature of 1,300° C. be allowable, then it should be possible, for example, to construct an all-wing delta planform aircraft with an all-up weight of 20-tonnes capable of accommodating a payload of 5 tonnes.

In a paper entitled "Meteor Hazards to Space Stations", M. W. Ovenden extended both his own earlier work[1] and that of Grimminger[2]. Grimminger considered a space station of about 100 sq. m. exposed area and calculated the probable times between collisions with sporadic meteors of various magnitudes. The astronomical factors affecting the validity of Grimminger's analysis were examined. The existence of iron meteors was shown to require a reduction in the collision times by a factor of about 2. Radar observations provide direct evidence for the relationship between the assumed number of meteors to their magnitude down to magnitude 7, but extrapolation beyond this limit is uncertain because processes exist which might disturb the distribution. One such process is the sun's radiation pressure, which would repel all meteors smaller than magnitude 30 out of the solar system. Another process affecting much larger meteors is the Poynting–Robertson effect. This may increase Grimminger's times by a factor of about 3, although a much greater possible increase cannot be ruled out. The danger from meteor showers is comparable with that from sporadic meteors. The greatest uncertainty in the estimates of collision times is due to the imperfect knowledge of the mass of a meteor of given magnitude. Error here may require, at worst, a decrease in collision times by a factor of 50. The use of a very thin 'meteor bumper' around a space station, which would explode any incident meteors, was suggested for space stations intended for use for a period of more than about a year.

The greatest problem of interplanetary flight is that of propulsion, and in his paper "Interplanetary Travel between Satellite Orbits", Prof. Lyman Spitzer discussed a method of applying nuclear energy. It was suggested that an electrically accelerated ion beam could be used for achieving a gas ejection velocity of 100 km./sec. without the use of very high temperatures in the propellant gases. Such a unit could not be built with a large enough thrust/weight ratio to allow it to take off from the surface of a planet. It would be capable of travelling from a close-orbital station about the earth to a similar orbit about any other planet. The mass flow of the working fluid in an ion rocket would be low, and hence interplanetary vessels of a very low mass ratio could be built.

In "Biological Problems of the Earth Satellite Vehicle", Médecin-General P. Bergeret discussed the conditions under which the human body would have to function in an artificial satellite. One of the major unknowns is the effect of zero *g* or 'free fall' conditions. This condition can be obtained for periods up to 10 sec. in high-speed jet aircraft. Artificial gravity may be necessary and this can be obtained by rotating the vehicle.

J. HUMPHRIES

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STRESS ANALYSIS

THE fifth annual conference of the Stress Analysis Group of the Institute of Physics was held during April 4–6 in the Mechanical Engineering Laboratory of the University of Liverpool. Papers were read on relaxation methods, fatigue, applications of electric resistance strain-gauge methods, brittle lacquer methods, a pneumatic strain-gauge, applications and problems of the 'frozen stress' method of photoelasticity, and hydraulic methods of applying test loads.

The opening lecture of the conference was given by Prof. D. G. Christopherson on "Numerical Methods in Stress Analysis with Special Reference to the Relaxation Method". He outlined the development of the application of numerical methods to stress analysis problems, emphasizing the different approach of the mathematician and the engineer. The mathematician faced with an insoluble differential equation or an unreasonably large number of simultaneous linear equations seeks for more rapid means of obtaining an approximate solution. The engineer, on the other hand, concerned in the first place with problems of complicated structural frameworks, rejects the traditional apparatus of analysis and seeks for help in processes in which experience, intuition and imagination about the probable behaviour of the structure can play as large a part as mathematical ability. Prof. Christopherson referred to the moment-distribution method of Hardy Cross as one such method. Sir Richard Southwell's relaxation method was also first applied to problems of frameworks, and although the greatest successes of the relaxation method have been won in fields remote from structural engineering, the nomenclature of the method still shows its original applications.

Prof. Christopherson dealt with several types of problems of importance in stress analysis, demonstrating how they can be tackled, how the accuracy of a solution can be improved or at least reliably estimated, and how previous experience or intuitive knowledge of the type of stress distribution to be expected can all be made to give a more rapid convergence and therefore a quicker solution.

The two papers dealing with electric resistance strain-gauge work were by P. H. Wolfenden, on the use of these gauges for the measurement of transient forces in power looms, and by R. G. Boiten, on the determination of residual stresses, respectively. The latter dealt with the problems encountered when it is not possible to take the structure under investigation through a loading cycle while the gauges are in place. This arises mainly when determining stresses due to the self-weight of a structure such as a bridge, and when investigating locked-up stresses such as those due to welding. The method described by Mr. Boiten consists essentially of the measurement of the change of stress around a circular area 6 mm. in diameter. Three gauges are placed radially as close as possible to the area, which is then removed by drilling a hole of that diameter. From the change of stress observed the original locked-up stresses can be computed on the generally sound assumption that the stresses are reasonably uniform over the small circular area. Considerable care under what must often be field rather than laboratory conditions is required in the placing of the gauges and the hole.

Dr. D. G. Sopwith, in a lecture on "Fatigue", dealt with the subject of the failure of components or structures under repeated loads from the point of view of the designer or stress analyst rather than that of the metallurgist. He discussed the correlation of the safe stresses under fatigue conditions with other physical properties of the material and also the influence of factors such as temperature and corrosion on the behaviour of a specimen subject to repeated loading.

Dr. A. W. Hendry and J. K. Tattersall, and G. Robertson described work they have done using the 'frozen stress' method of photoelasticity, which makes use of a phenomenon observed in certain photoelastic model materials—namely, that a model subjected to load and taken through a heating and cooling cycle retains the relevant fringe pattern after the load has been removed and can even be sliced without the resulting slices losing their 'frozen' pattern. Dr. Hendry and Mr. Tattersall have used the method to analyse the stresses in a buttress dam of a hydroelectric power scheme in Scotland. They dealt separately with the stresses induced by the water pressure and those due to the weight of the dam. The former were tackled by ordinary 'frozen stress' methods using 'Catalin' as their model material. The latter posed a more serious problem since none of the usual photoelastic model materials capable of being sliced is sufficiently stress-optically sensitive to show fringes under its own weight. To simulate a gravitational field using a centrifuge necessitated the use of the longest convenient rotor arm so that the body force on the model should be reasonably uniform throughout the depth of the model. This made it impossible to spin the model in the oven as is usual; it would have involved the use of an impossibly large oven. To overcome this difficulty the model was heated in an oven and then transferred very rapidly in a heat-insulated box to the centrifuge, where it cooled slowly while being spun.

Mr. Robertson's work dealt with the stresses in pipe flanges. He used the comparatively new American material 'Fosterite', with which he could find no fault apart from its very high cost. He overcame one difficulty which is inherent in the analysis of three-dimensional problems by the 'frozen stress' method, this difficulty being that the slices cut from the three-dimensional models should be as thin as possible, as they are treated afterwards by the methods of two-dimensional photoelasticity. Very thin models, however, display very few fringes, since the fringe order at a point is proportional to the thickness of the model as well as the principal stress difference. Thin slices, therefore, require accurate measurements of fringe order by compensator methods. Having had to deal with a solid of revolution, Mr. Robertson was in a position to cut a large number of radial slices which by symmetry were identical. He made these slices thin enough to meet the requirement that the stresses should be reasonably constant through the thickness of the slice, but obtained satisfactory fringe photographs by using a pile of half a dozen or more slices superimposed on each other. The fringe photographs obtained in this way were strikingly well defined.

H. de Leiris discussed the development of brittle lacquer methods and of a pneumatic strain-gauge of very short gauge-length. He compared the fusion technique of applying strain-sensitive lacquers with the dissolving technique exemplified by such commercially available lacquers as 'Stresscoat' and 'Strainlac'. He discussed the relative merits of using different criteria such as the appearance of the first crack, the crack density or the lengths of the cracks when interpreting crack patterns. He dismissed the first two criteria as unsatisfactory, being dependent on variations in the thickness of the lacquer and other fortuitous circumstances. He was in favour of the method by which a family of curves, one for each increment of load, is obtained by drawing a line through the extremities of all the cracks. This method has the merit of dealing with a large number of cracks each time, thereby eliminating the effect of some of the random variations. M. de Leiris emphasized the important part played by the contraction stresses in the lacquer which are present before any load has been applied to the specimen. The load is, in fact, only the proverbial last straw which makes the lacquer crack. He therefore found it difficult to envisage any mechanism of failure which did not in some way require a tensile stress to open the crack. No simple law of cracking has as yet been suggested. There is, all the same, no doubt that the brittle lacquer method used as an auxiliary to more accurate methods of analysis fulfils an important function. In the second part of his paper M. de Leiris described a pneumatic gauge operating on the 'Solex' principle. This instrument has a gauge-length of 2 mm. with a magnification of 200,000; a stress of 1 kgm./sq. mm. in steel is indicated by a change of level of 20 mm. on a manometer.

E. K. Frankl

LETTERS TO THE EDITORS

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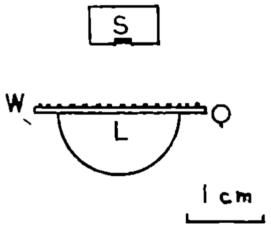
Chemical Effects in Liquids due to α-Particle Irradiation

A considerable amount of research has been carried out on the chemical effects which are produced by alpha-particles in liquids. So far, no satisfactory theory has been proposed to account for the fundamental processes involved in these reactions. From early studies, extended by recent work in this Department, of the ionization currents which can be collected from liquids, it is clear that the vast majority of ions recombine almost immediately. Jaffé[1] has shown in his 'column theory of ionization' that in liquids the half-life for recombination is 10^{-7} sec., due to diffusion alone. It has been pointed out by Kramers[2] that, due to the intense electrostatic fields which must exist in such columns of ionization, the half-life should be substantially reduced. It therefore appears impossible to explain the main features of the chemical experiments simply in terms of the production of ions, especially in view of the independence of chemical yield upon concentration of the reactants.

It has already been reported that quanta are emitted from thin films subjected to α-particle bombardment[3], and we considered that the chemical effects might be due, at least partly, to quantum emission associated with the intense ionization. As in the experiments with thin films, this radiation would be readily absorbed by the parent material, possibly producing free radicals within the solvent. While the radiation length is small compared with the bulk of the liquid, it is large compared with the estimated diameter of the ion columns. In this manner, the production of free radicals can be distributed over a comparatively large volume, hence increasing the probability of producing chemical effects remote from the ionic column and independently of ionic recombination. Such a basic process would provide a mechanism for the independence of concentration of reactants and the chemical yield. Experiments were therefore conducted with the view of testing such a theory.



The experiments took the form of irradiating a thin film of water with α-particles. A sample of a suitable aqueous solution was exposed to the quanta which might be liberated from the thin film. The diagram shows the experimental arrangement. The source *S*, about 20 millicuries of polonium, was placed about 0·5 cm. above a quartz slide 1 mm. thick. A film of water, of a thickness less than the equivalent range of the α-particle, was maintained on the upper surface of the slide. A reaction vessel, *L*, containing about 1·5 c.c. of solution, was placed immediately below the slide. The solutes investigated were ferrous ammonium sulphate, chloracetic acid and sodium iodide; in each case the solvent was water. Colorimetric methods were used for determining the yields of ferric, chlorine and iodine ions respectively. The water films were subjected to α-particle irradiation for periods of up to eleven days. Control experiments were performed to determine the amount of chemical change due to other conditions and due to the irradiation of the quartz by α-particles. Such control effects were in general negligible. Experiments were also carried out in which similar solutions were irradiated directly by α-particles.

A comparison of the results showed that chemical effects, between a twentieth and a twenty-fifth of the yield obtainable from direct bombardment, were found when the thin water films were irradiated. Recent improvements of the measurements reported previously[3] have provided an estimate of the absorption length of the quanta in the thin films. It appears that the ratio of the numbers of quanta emerging from the thin films in the above chemical experiments to the total number of quanta produced by the α-irradiation is of the same order of magnitude as the above ratio of the two chemical yields. These results suggest that the bulk of the chemical effect produced by α-particles in liquids can be explained by secondary effects of quantum emission arising from the primary ionization.

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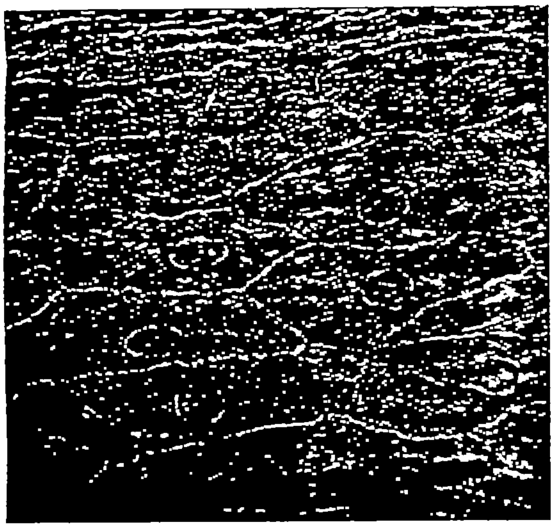
Surface Cells of Feather Barbs

From Strong's[1] drawings it is evident that those cells of the cortex of the feather barb which lie nearest to the surface are flattened. No author, however, has directed attention to the fact that these cells differ in structural detail from the rest of the cortical elements. The surface cells of the feather barbs appear to form a pattern similar to some of the cuticular scale patterns seen on animal hairs. It was found that this pattern could be shown by making casts of the barbs in the same way as casts of animal fibres are made.

These casts were made in polyvinyl acetate; a thin layer of a 20 per cent solution of polyvinyl acetate in benzene was spread on a microscope slide and heated to drive off the benzene. Feather barbs were then placed on the plastic layer and another slide placed on top; these slides were then placed on an electric hot plate and pressure applied (the load applied was approximately 6 lb. over the whole slide). A small piece of polyvinyl acetate was placed on another slide adjacent to the first slide and used as a temperature guide; when it had softened the current was switched off, the slides were allowed to cool while still under pressure, and the barbs afterwards removed from the slides and the casts exam-



Cast near base of barb of Guinea fowl. × 400

ined. Where the surface cells appeared to be thicker, additional weights were added to give a load of approximately 10 lb.

The first casts made were of barbs without barbules; but later it was found that the presence of barbules made very little difference to the casts. Barbs from the feathers of Guinea fowl, 'Silky' fowl and *Chlorophanes spiza* (Cœrebidæ) were examined in this way. The patterns formed by all these show a network of polygons arranged with their long axes parallel to the length of the barb. Thus the surface cells are of a different shape from those within the cortex, which are long and similar in shape to the cortical cells in mammalian hair.

In some instances, for example, the reverse side of the barb of the Guinea fowl, the following details can be seen in the cast: (1) an oval area corresponding to the original position of the nucleus in each cell; (2) coarse striations; and (3) fibrillary structures. The close moulding of the thin 'surface cells' to the cortex proper may be the reason why the coarse fibrillary striations, arranged in parallel in the cortex proper, are visible in the cast. The patterns formed by the fibrillary structures within the surface cells are not always clearly visible in the casts of all feather barbs; but in the cast of the reverse surface of the barb of Guinea fowl the pattern formed by these structures can be seen superimposed upon that formed by the parallel fibrillary striations of the cortex proper. This pattern gives the effect of a delicate cross-hatching with a distinctly longitudinal trend within the network formed by the boundaries of the surface cells (see photograph).

Further evidence of cell boundaries is seen in transverse sections of the feather barb of the Guinea fowl. Indentations can be seen in the surface margin of the reverse side of the barb when thin (one micron) unstained sections are viewed by phase-contrast using 1/12 in. oil-immersion objective.

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Sedimentation in the Tropical Indian Ocean

As a result of recent investigations[1] into the distribution of the Radiolaria in the sediments collected by the Swedish Deep-Sea Expedition in the Western Pacific Ocean, two conclusions of outstanding importance can be drawn: first, that several species of Radiolaria which are widely distributed in the tropical oceans of the present day do not extend farther back in time than the very latest Tertiary or early Quaternary; secondly, that erosion and re-distribution of older sediments on the deep-sea floor often result in the mixing of the tests of Tertiary Radiolaria with Recent ones in that region.

With the object of determining whether either of these effects could be found in the sediment cores collected by the Expedition in the tropical Indian Ocean, a preliminary examination was made of the Radiolaria from samples taken at 1-metre intervals in the following cores:

Core No.	Position		Depth
	Lat.	Long.	
125	S. 10° 07′	E. 106° 56′	6,875 m.
127	S. 11° 07′	E. 103° 39′	5,650 m.
128	S. 11° 28′	E. 102° 24′	5,170 m.
137	N. 01° 56′	E. 88° 12′	4,300 m.
141	N. 02° 18′	E. 76° 02′	3,765 m.
142	N. 00° 35′	E. 75° 14′	4,050 m.
143	S. 00° 31′	E. 74° 33′	3,314 m.
145	S. 01° 20′	E. 68° 20′	3,620 m.
147	S. 01° 19′	E. 66° 16′	4,380 m.
149	S. 01° 22′	E. 62° 38′	4.760 m.
154	S. 00° 23′	E. 54° 30′	4,860 m.
155	N. 04° 28′	E. 52° 48′	5,117 m.

This examination showed that all the characteristic present-day tropical species occurred in all cores at all levels—even those species which are known to have short time-ranges do not disappear at the bottoms of the cores. No Tertiary Radiolaria were found in any of the samples examined.

From these results it can be concluded that, along the course of the Swedish Deep-Sea Expedition in the Indian Ocean, there is no locality where Tertiary sediments have been laid bare by bottom currents which have eroded them and re-distributed their components. This is in strong contrast to the results from the Western Pacific Ocean, where such effects of current erosion seem to be widespread.

The reason for this difference in the results from the two oceans probably lies in their different geological histories. The floor of the Indian Ocean has been a region of comparative tectonic quiet since the Eocene. Thus there have been no major changes in the topography of the sea-floor which would result in widespread re-distribution of sediments. The Western Pacific, on the other hand, was a region of considerable diastrophic activity at the close of the Tertiary, and therefore late Tertiary sediments in that area must often have been brought into the sphere of action of bottom currents.

Even though there is no evidence of recent erosion of Tertiary sediments in the tropical Indian Ocean, it is not impossible that Quaternary sediments are being moved, to a certain extent, by bottom currents. Nevertheless, the magnitude of this process must be much less than in the Western Pacific.

For the facilities for carrying out this investigation, I am indebted to Dr. B. Kullenberg, of this Institute.

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Cone Electroretinography by Flicker

It is generally assumed that the *b*-wave of the human retinal action potential is due to the stimulation of the rods. With an intensity of 2,000 lux, the *b*-waves fuse at a frequency of about 20 flashes per second. At lower intensities the fusion frequency in our experiments decreased. A linear relation was found between fusion frequency and the logarithm of stimulus intensity. However, the subjective fusion frequency, determined by cone activity, is known to reach values around 50–60 flashes per second. These high values are never obtained with the *b*-waves of the electroretinogram as index. This is but one of several reasons for assuming the *b*-waves to express rod activity.

According to Karpe and Tansley[1], the threshold of the scotopic *b*-wave of the electroretinogram is higher than the sensory threshold. In agreement with expectations from the general theory of the electroretinogram[2], Adrian[3] found the photopic electroretinogram to be characterized by larger initial negative *a*-waves. It was therefore held that flicker at very high light-intensity might give evidence for cone activity by changing into (negative) *a*-wave flicker from the low-frequency (positive) *b*-wave flicker. This proved to be the case. When we increased the light-intensity until the *b*-waves were preceded by well-developed *a*-waves, the *b*-waves decreased (Figs. *A*–*C*) and the *a*-waves increased (*B*–*C*) as flicker frequency rose (see legend of diagram). The *b*-waves disappeared at a flash frequency of about 20 per sec. The negative *a*-waves appeared to have maximum amplitude at about 25–35 flashes per sec. It seems very likely that their quick return after each flash is due to a true off-effect. This off-effect becomes more pronounced if the *PII* component of Granit's analysis has been removed. Onset of fusion of fast flicker was accompanied by decrease of amplitude. It depended upon stimulus intensity in the same way as the *b*-flicker at lower intensities. Fusion coincided with sensory fusion. The highest fusion frequency observed was at about 55 flashes per second. A reduction of light-intensity to one-tenth reduced the fusion frequency to 35.

From the results obtained by Granit[2], it appears likely that the decrease of the subnormal *b*-waves with increasing frequency of stimulation by intermittent light is caused by an accumulation or increase of post-excitatory inhibition. The amplitude of the rapid potential changes, *a*-wave and off-effect, goes on increasing even after the fusion frequency of the rods has been exceeded. Actually the human retina, which to the ordinary range of stimulus intensities behaves like an *E*-retina, turns into an *I*-retina at higher intensities. Similar transitions are known for other eyes (for example, frog[2]), and the suppression of the *I*-properties at lower intensities has been ascribed to a general inhibition exerted by the rods on the cones.

Enroth[4] has recently shown that the limiting conditions for fusion in individual retinal elements of the cat's eye can be strictly determined. Fusion in, for example, an off-response results if the difference between the latencies of the off-response and the pre-excitatory inhibition is equal to the length of half a flicker period. We assume that the fusion of the rapid potentials in the human retina follows a similar pattern.

These observations are of some general interest because they seem to offer means of studying objectively the photopic function of the human retina.

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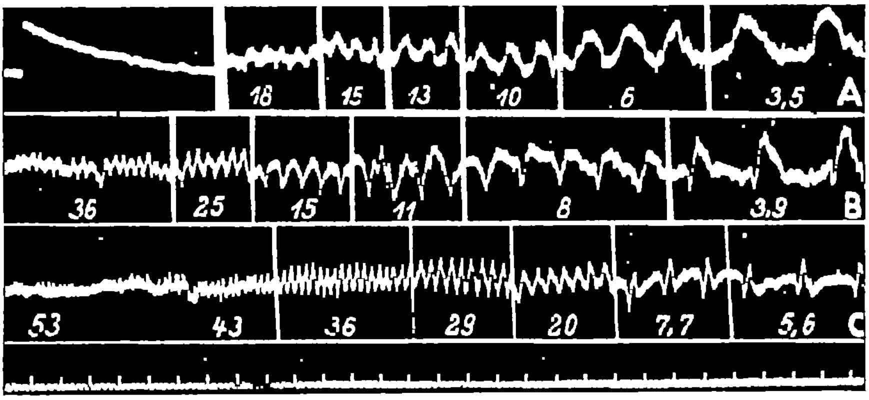

Flicker electroretinogram at different intensities and frequencies of stimulation. The numbers in each row give the frequencies. Upper row, (*A*): intensity approximately 2,000 lux. Fusion of the sub-normal *b*-waves occurs at 18 stimuli per second. Middle row, (*B*): intensity approximately 2,000 lux; the *b*-waves are preceded by negative *a*-waves, the amplitude of which increases with increasing frequency. Simultaneously the *b*-waves decrease in amplitude. Fusion frequency is 36 stimuli per second. Lower row, (*C*): intensity approximately 24,000 lux. After passing the fusion frequency of the *b*-waves, the *a*-potentials display a further increase in amplitude the maximum of which is reached at about 25–35 stimuli per second. Fusion at 53 stimuli per second. Calibration, upper left-hand corner, 0·1 mV.; time marker, 1/10 sec.

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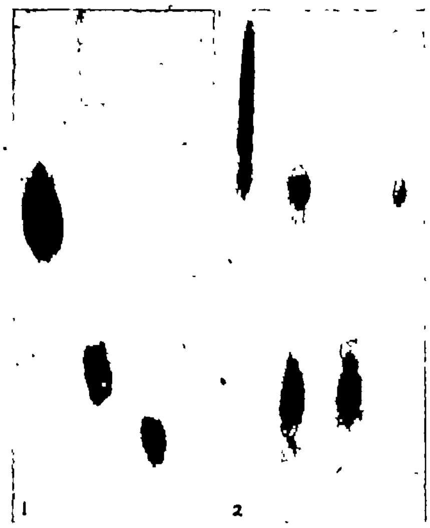
Paper Chromatography of the Pyrogallol Tannins

By one-dimensional paper partition chromatography, some of the phenolic substances allied to the pyrogallol tannins have been separated. When using the well-known solvent phases such as butanol/acetic acid and phenol, previous workers[1] have found that the simpler phenols tend to give long diffuse trails. The preparation of the more complex phenols, such as are found among the pyrogallol tannins, is complicated by their ready oxidation in the presence of bases. Tailing of the spots in neutral and acidic solvents is influenced by the acidity of the mobile phase (cf. organic acids[2]). Addition of strong organic acid to the eluting solvent causes separation into well-defined spots. Unfortunately, formic acid greatly increases the rate of run of the tannin, the spots coming too close to the solvent front for clear definition. Two new solvents have now been found which separate many mixtures of complex phenols into well-defined spots : (1) phenol/acetic acid/water, prepared by adding 30 ml. glacial acetic acid to approximately 500 ml. liquid phenol and just saturating



(1) Phenol/trichloracetic acid/water. Left to right: digalloyl glucose, gallic acid, split acid.

(2) Phenol/acetic acid/water. Left to right: gallotannic acid, synthetic pentagalloyl glucose, synthetic pentagalloyl glucose after passage through column of 'Amberlite *IR4b*', gallic acid

with water at room temperature; (2) phenol-trichloracetic acid/water, prepared by adding 35 gm. trichloracetic acid to approximately 500 ml. liquid phenol and just saturating with water at room temperature.

Spots containing approximately 20 μgm. of each substance are eluted down Whatman No. 4 paper and the chromatograms are dried thoroughly and sprayed with ammoniacal silver nitrate solution (0·1 *N*), when the separate substances appear as black spots in the cold. The R_F values of the different tannins vary considerably with temperature, and for identification purposes it is more reliable to run control spots than to use the mathematical technique.

Employing this method, it has been possible to separate widely different types of compounds, such as chebulinic acid[3] and its hydrolysis products, digalloyl glucose, split acid and gallic acid (Fig. 1). The method has been used to check the purity of synthetic and naturally-occurring amorphous pyrogallol tannins. Thus synthetic amorphous pentagalloyl glucose, prepared via the acetyl derivative, contains at least four compounds (Fig. 2) and is not, as assumed, a single substance. Similarly gallotannic acid, when free from gallic acid, contains more than one compound, none of which is present in impure synthetic pentagalloyl glucose. Hydrolysis of gallotannic acid and similar complex materials by acid, or water in sealed tubes at 100° C., gives pyrogallol as well as gallic acid, indicating that some decomposition occurs.

The pyrogallol tannins of *Terminalia chebula* (Myrobalans) have been separated using the two solvents. A more detailed account of this work will be reported later.

I am indebted to the Council of the British Leather Manufacturers' Research Association for a grant and permission to publish this note.

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[1] Evans *et al.*, *Nature*, 164, 674 (1949).

[2] Lugg and Overall, *Nature*, 160, 87 (1947).

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Paper Partition Chromatography of Some Organic Bases by the Method of N-Methylation

The precipitate formed between organic basic substances and Dragendorff's reagent is influenced by the valency of the basic nitrogen atom and by hydrophilic groups, such as carboxyl, hydroxyl, etc.[1]. Difficulties in the use of this reagent can often be overcome by a preliminary N-methylation.

The procedure recommended is as follows. Place a small quantity of an aqueous or methanolic solution of the basic substance not reacting readily with Dragendorff's reagent, such as ephedrine, the sulpha drugs, marfanil, benzedrine, etc., on a paper strip and develop it for about twenty hours in butanol acidified with acetic acid (butanol : water : acetic acid = 5 : 4 : 1) by the ordinary procedure of paper partition chromatography (ascending method). After drying, a 10 per cent aqueous solution of potassium carbonate is sprayed on the paper strip and the drying repeated. The paper strip is then immersed in dimethyl sulphate, pressed between layers of filter papers using a rubber roller in order to remove excess reagent, and warmed to 90° for ten minutes in an air bath to complete the N-methylation process.

On spraying with Dragendorff's reagent (diluted five times with 70 per cent acetic acid), a red or reddish-orange colour is revealed at the positions occupied by the basic substances with quaternary nitrogen atoms. The method is also applicable to the extracts of crude drugs.

Examples of R_F values of basic substances obtained by this method are as follows:

(±)-Ephedrine hydrochloride	0·78	Nicotinic acid	0·75
(−)-Ephedrine hydrochloride	0·82	Pyridoxine	0·61
(+)-Ephedrine hydrochloride	0·79	Sulphapyridine	0·82
Marfanil	0·43	Theobromine	0·56

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[1] See *J. Pharm. Soc. Japan*, 70, 721 (1950); *Jap. J. Pharm. Chem.*, 22, 468 (1950); cf. also Sakaguchi, T., *J. Pharm. Soc. Japan*, 65 (1945).

Detection of Enzymes by the Agar-Plate Method and its Application to Paper Chromatography

In a communication under the above title, Giri[1] describes the use of a starch agar gel for the location of amylases on the paper chromatogram. The technique seems to be essentially the same as that used in this Department, and previously described in *Nature*[2].

The following comments may be made on the technique. Giri[1] obtains marked movement of certain amylases with 50 per cent acetone, whereas, in this laboratory, 50 per cent acetone produces little, although 40 and 30 per cent acetone show marked movement; this may be due to the higher ambient room temperature in Giri's experiments. Most enzymes examined show a marked tailing effect even with low concentrations, which is not apparent unless the time of incubation on the gel is prolonged (18–24 hr.). With the exception of polygalacturonase and pectin-esterase, it has not been possible to separate enzymes, as each is resolved into two or more components and the components from different enzymes frequently overlap. The exact status of these components is as yet undetermined; for example, the number of components and the resulting pattern of the gel-developed chromatogram vary with amylases from different sources. In general, solvent – water mixtures are preferable to aqueous salt solutions as developing agents.

Mitchell, Gordon and Haskins[3] found that both adenosine-deaminase and amylase could be resolved into components on a pile of filter paper disks with ammonium sulphate solutions as developing agents.

It is probable that the chromatographic technique is comparable to electrophoresis in that it separates enzyme proteins due to differences in physical properties rather than differences in enzymic behaviour, for example, kinetics. The R_F-value has been of little use in this technique, as it is markedly affected by slight changes in the conditions of development.

Full experimental details are being submitted for publication elsewhere.

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Chromatographic Evidence for the Tetraphosphate Ion

A KNOWLEDGE of the structure of phosphorus pentoxide, P_4O_{10}, enables predictions to be made concerning the mechanism of its hydration to orthophosphoric acid and particularly about the structures of the phosphoric acids formed intermediately[1]. In order of their formation, these would be expected to be $H_2P_4O_{11}$, $H_4P_4O_{12}$ (tetrametaphosphoric acid), $H_6P_4O_{13}$ (tetraphosphoric acid) and eventually mixtures of $H_5P_3O_{10}$, $H_4P_2O_7$ and H_3PO_4. Salts of tetrametaphosphoric acid have already been isolated and identified by X-ray and other methods from the alkaline hydrolysate of P_4O_{10}, and we have explored the use of paper chromatography as a means of separating the tetraphosphate ion. Aqueous solutions which would be expected to contain the latter were made by controlled alkaline hydrolysis of sodium tetrametaphosphate, using conditions analogous to those giving sodium triphosphate from sodium trimetaphosphate and similar to those described by Thilo and Rätz[2].

Chromatographic evidence for the existence of the tetraphosphate ion was obtained at Cambridge by one of the authors in association with Dr. C. S. Hanes using the techniques developed by Hanes and Isherwood[3] in their study of phosphoric esters. This chromatic evidence has been confirmed in detail by further work at Toronto.

In both laboratories the sodium tetrametaphosphate hydrolysate was prepared by heating 1 gm. of the tetrahydrate for 2 hr. at 70° C. with just sufficient alkali to break the ring. This was chromatographed alongside pure specimens of the orthophosphate, pyrophosphate, triphosphate, trimetaphosphate and tetrametaphosphate kindly supplied by Dr. B. Raistrick.

A number of solvent mixtures were used, of which *n*-propanol, water, 0·88 sp. gr. ammonium hydroxide (60, 20, 20 by volume respectively) is a good example. A strong spot which by colorimetric analysis accounted for 60 per cent of the hydrolysate appeared in a position where the tetraphosphate ion might logically be expected, and could not be ascribed to any of the other anions conceivably present.

During the course of this work, it was noted that a separation of orthophosphate, pyrophosphate and triphosphate anions could be obtained. Furthermore, it was observed that a sample of commercial sodium triphosphate, which by usual methods of analysis had a pyrophosphate content of 3–10 per cent, gave on chromatographic analysis two spots, the fainter one occupying the pyrophosphate position. It would seem, therefore, that a chromatographic separation of the phosphate anions should lead to an improved method for their quantitative analysis.

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Vapour Pressure of Isotopic Carbon Tetrachlorides

A THEORY of the vapour pressure relationship for isotopic molecules has been given by Topley and Eyring[1]. It is, however, difficult to see *a priori* how to apply the theory in calculating vapour pressures for a particular case, in view of our lack of knowledge of the liquid state. The isotopic molecules of carbon tetrachloride would be expected to be very favourable cases for showing differences of vapour pressures if they exist. Grimm[2] carried out a multiple fractionation with a single small packed column and calculated that neighbouring isotopic molecules on the mass scale had boiling points not differing by more than 0·001° C. We have calculated from Grimm's results that his total fractionation was equivalent to 75 theoretical plates.

Modern packed columns have much higher efficiency and can be operated automatically. We have made use of three packed columns constructed by Dr. Newell Cook of the Chemistry Department of this College in an attempt to fractionate the isotopic molecules of carbon tetrachloride.

These columns have probable theoretical plate ratings of 100, 200 and 400 plates respectively, and are completely automatic in operation. We have operated the columns in such a manner that the first distillate was charged into the second column, etc. The reflux ratio used was 1,000 : 1. The last column was brought to equilibrium, and the specific gravity of the equilibrium mixture relative to the original charge of the first column determined. Since the first column was continued in operation after it had furnished its charge to the second column, a cut was taken near the end of the distillation and this sample compared with the top of the third column.

The specific gravity was determined by the buoyancy balance method described by Lewis and MacDonald[3], which had a sensitivity at least as great as 1·8 in the fifth decimal place. We were not able to detect the slightest difference in the density of the various samples.

Carbon tetrachloride is particularly favourable for such a fractionation experiment, since one can be sure of its purity to a degree unable to affect the density to the above precision by examining the infra-red spectrum in a liquid cell 1 cm. or greater in thickness.

Since the experiment gave completely negative results, it is only possible to calculate the maximum possible difference in the vapour pressures from the sensitivity of the apparatus. If we make a few reasonable assumptions, this is easily accomplished.

If A is the fractional part of chlorine of mass 35 and B the fractional part of chlorine-37, that is, $A + B = 1$, statistically the population of the five types of isotopic molecules will be given by the expansion of $(A + B)^4$. Each term of this expansion is identically equal to the mole fraction M_i of the particular molecule A_nB_m, where n and m represent the number of chlorine atoms of the mass in question.

We shall assume that the difference in vapour pressures of progressively heavier isotopic molecules varies linearly with increased mass. We shall make a further but somewhat doubtful assumption to simplify the calculations, that free statistical exchange of isotopic chlorine atoms is possible. This assumption in any event will not greatly affect the result. We can now write the following relationships:

$$M_1 + M_2 + M_3 + M_4 + M_5 = 1; \qquad (1)$$

$$M_1^* + M_2^* + M_3^* + M_4^* + M_5^* = 1; \qquad (2)$$

where the M's refer to the mole fractions of the various isotopic molecules and * quantities refer to enriched samples. If p is the vapour pressure of the most volatile molecule, namely, $C^{35}Cl_4$, the relative volatilities will be

$$1, \frac{p-\delta}{p}, \frac{p-2\delta}{p}, \frac{p-3\delta}{p}, \frac{p-4\delta}{p}. \qquad (3)$$

δ is obviously the difference in vapour pressure between neighbouring isotopic molecules on the mass scale. The composition of the distillate will be given by:

$$M_1 + M_2\left[\frac{p-\delta}{p}\right]^n + M_3\left[\frac{p-2\delta}{p}\right]^n + M_4\left[\frac{p-3\delta}{p}\right]^n + M_5\left[\frac{p-4\delta}{p}\right]^n = S, \qquad (4)$$

where

$$M_1^* = \frac{M_1}{S}, \; M_2^* = \frac{M_2}{S}\left[\frac{p-\delta}{p}\right]^n, \ldots \; M_5^* = \frac{M_5}{S}\left[\frac{p-4\delta}{p}\right]^n,$$

and n is the number of theoretical plates.

From the minimum detectable density change, it is possible to calculate the minimum detectable change of molecular weight, and thus to calculate the quantities M_1^* from the new values for A^* and B^* inserted into $(A^* + B^*)^4$. Solution of equation (4) is now easily possible and yields a value of δ of $1\cdot4 \times 10^{-3}$ mm. of mercury for a value of n of 700 theoretical plates and a change of specific gravity of 1·8 in the fifth decimal place.

From this result it follows that neighbouring isotopic molecules do not differ in boiling point by more than 6×10^{-5} degrees centigrade. It is conceivable that the vapour pressure differences of these isotopic molecules could be greater than we have calculated. Cohen[4] has shown that when fractionation processes are carried out with materials of very close boiling points, the equilibrium times become extremely long and minor disturbances have a large effect on the efficiency of the column. The net effect is, of course, a marked reduction of the effective number of plates in the column.

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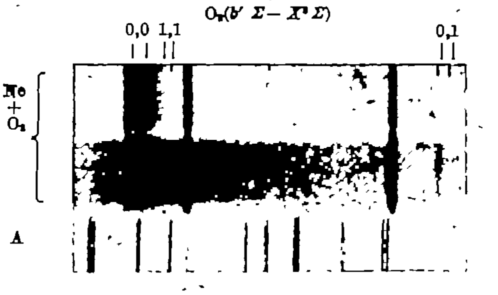
Atmospheric Oxygen Bands in Emission from Neon–Oxygen Mixtures, and in Night Sky and Auroral Luminescences

IN a recent paper, Meinel[1] suggested that the radiations at 8628 A. and 8659 A. in the night sky luminescence might be identified as the R and P branches of the (0,1) band of the atmospheric oxygen system, $b^1\Sigma^+_g - X^3\Sigma^-_g$. Other bands of this system might also be present, and the absence of the most intense band, the (0,0) band, was accounted for by the reabsorption in the lower atmosphere.

This oxygen band system, best studied in absorption, has in the past few years been observed in emission by several investigators[2-4]. In spite of this, wave-length data of band heads and approximate origins are somewhat scarce and relative intensities are not given at all. More information about them is therefore needed.

In the emission from discharges through pure oxygen and neon–oxygen mixtures, I have observed three bands of the system. The (0,0) band at 7592·5, 7622·5 A. (R head and approximate beginning of the P branch, as measured from my plates) was by far the most intense. Exposure times of less than 5 sec. were sufficient to produce a suitable photographic density of the band (on unsensitized Eastman *I N* plates with a *B* II spectrograph from the Société Générale d'Optique). The two other bands observed were the (1,1) band at 7680 (partly masked), 7710·5 A. and the (0,1) band at 8604·2, 8649·8 A. with intensities of about 0·5 and 2 per cent respectively of that of the (0,0) band.

The discharges were successfully run both by ordinary high tension (50 c./s.) between cold electrodes in the discharge tube and by high-frequency tension (2 Mc./s.) between external electrodes. (In the latter case the emission had a silver-white appearance due to a strong and very even continuum extending throughout the whole region investigated, 3200–



0·02 per cent oxygen in neon. Total pressure, 700 mm. mercury. High-frequency excitation

9700 A.) Variation of total pressure and oxygen concentration did not appreciably influence the relative intensities of the bands, whereas the absolute intensities varied considerably.

This variability of the band intensities gives some information on the collision deactivation probability of the metastable $O_2(b^1\Sigma)$ state. A method similar to that used in the investigation of the metastable $O\,I(^1S)$ state[5] was adopted. Preliminary results seem to indicate that the sensitivity against non-radiative deactivation of the lowest two vibrational levels in the $O_2(b^1\Sigma)$ state is slightly less than that of the $O\,I(^1S)$ state.

The mean life-times of the molecular[6] and atomic metastable states here mentioned are of the same order of magnitude. The collision-deactivation of the two states under similar conditions should therefore, according to the preliminary result, also be of about equal magnitude. Bearing in mind that in the upper-atmosphere oxygen atoms, excited to the $2s^2 2p^4$ ^1S state, are left undisturbed long enough to be deactivated by radiation, there is reason to believe that this should also apply to the $O_2(b^1\Sigma)$ state, provided oxygen molecules exist there. Evidence of this, however, has recently been supplied by the discovery of O_2^+ bands in the auroral spectrum[7]. Meinel's identification of atmospheric oxygen bands in the night sky luminescence seems, therefore, highly probable.

The similar behaviour of the two metastable states also indicates that the atmospheric oxygen bands might be present in the auroral spectrum with appreciable intensity. There is some experimental evidence in favour of this. On the infra-red auroral spectrogram obtained by Meinel[8], an unidentified radiation with short wave-length limit just above 8600 A. fits very well with the *R* head of the (0,1) band. The *P* branch is partly overlapped by the N_2 1*P*(2,1). The sharp short wave-length side of the N_2 1*P*(2,0) band may be due to overlapping of the *R* branch of the molecular oxygen atmospheric (1,1) band. But here the absorption of the (0,0) band of the same system sets in, which may result in a similar effect.

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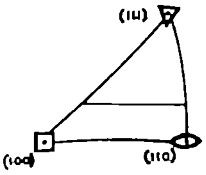
Effect of Orientation on the Metallic Reflexion of Polarized Light

E. C. W. Perryman and Miss J. M. Lack[1] have attributed the optical anisotropy of etched monel, which is face-centred cubic and should be optically isotropic, to the presence of a surface structure. They find, however, that optically anisotropic cadmium does not possess a similar structure.

By studying the reflexion of polarized light under crossed nicols from grains of known orientation, we have obtained information concerning the nature of three different types of anisotropic reflexion. These are exemplified by reflexions from surfaces of etched monel metal, isotropic aluminium the surface of which has been etched to develop cubic etch pits, and unetched anisotropic beryllium. A Bausch and Lomb elliptical vibration compensator[2] was used under a rotating stage to measure the change of phase and the rotation of the reflected polarized light.

It is well known that plane-polarized light is not affected by reflexion from an inclined polished plane if the plane of vibration is parallel or perpendicular to the axis of tilt. If these conditions are not met, the reflected light is no longer plane-polarized and can be observed under crossed nicols. Thus, when a scratch is parallel or at right angles to the plane of vibration, the scratch extinguishes the light. At intermediate positions, the scratch appears bright. The inclined faces of cubic etch pits on the surface of aluminium furnish a means of studying this 'scratch effect'. When the three sides of the pits are approximately parallel and perpendicular to the plane of vibration of the incident light, the grain will show extinction. This has been experimentally verified for all orientations below the solid line of the diagram. However, since the etch pits are not all true planar surfaces, the amount of rotation and phase change created is not constant and cannot be determined experimentally.



Large-grain aluminium specimens were etched to develop cubic etch pits. Those with orientations below the solid line showed extinction when the plane of the cube pole closest to the horizontal agreed with or was perpendicular to the plane of vibration of the light

Grain growth studies of monel[3] have shown that a crystallographically straight interface, or the straight part of a jagged interface, is evidence of the presence of a spinel twin relationship. When traces of the four {111} planes of a grain have been plotted, the orientation can be uniquely determined. By this means, the orientations of most of the grains in several fields (× 250) were determined. By repolishing and re-etching, it was found that whereas the maximum intensity from an individual orientation might vary, the position of extinction with respect to the plane of vibration of the light remained the same, that is, extinction was reproducible.

A study of the interference figure and a correlation of the orientation with measurable rotations and phase changes[4] indicated that the anisotropy was due to the presence of a uniaxial crystal on the surface of the metal, the c-axis and therefore the extinction position of which always lay within 1·5° of the plane containing a cube pole of the monel. The inclination of the c-axis to the specimen surface within this plane was also that of the cube pole, that is, minimum intensity of reflexion when the c-axis is vertical and maximum when it is horizontal. By polishing electrolytically, and using the etching solution as the electrolyte, the thickness of this film, as well as the measurable rotation and phase change, can be increased appreciably without removing the orientation relationship. A chemical spot test showed the increased presence of a chromate. The anisotropy of etched monel is therefore attributed to a layer of hexagonal copper chromate. We feel that the fact that the minute etch pits and troughs, observed on the surface of monel by Perryman and Lack, can be compensated for as to phase change and rotation, must mean that their faces are crystallographically quite planar.

Single-grain specimens of hexagonal beryllium, which is optically active after mechanical or electrolytic polishing, show a reproducibility of extinction position[3]. In this case, there is extinction within a range of ± 2° when the intersection of the basal plane with the surface of the specimen is parallel or perpendicular to the plane of vibration of the incident light, regardless of the method of polishing. As the specimen is rotated through 360° from the extinction position, two symmetrical sets of unequal peaks are observed. The intensities of any two successive peaks are at a maximum when the basal plane is perpendicular to the surface, and a minimum when it is parallel. The graph of the measured angle of rotation of the plane of polarization versus the angle of inclination of the basal plane is linear and when extrapolated becomes 0 at 0° inclination; that is, there is no rotation when the basal plane is parallel to the surface.

The measurable anisotropy varies with temperature and on exposure to oxygen. This effect is attributed to the time-dependent development of a 'chemi-sorbed' layer at the beryllium – beryllium oxide interface[4].

Metallographically, it is of interest to note that the extinction position, in all cases studied, is reproducible and bears a definite relationship to the orientation of the grain under observation. When several orientations are prepared in a similar manner, as in a polycrystalline aggregate, the relative maximum intensities of the grains are a function of the orientation.

This work was carried out at the M.I.T. Metallurgical Project under Contract No. AT—(30–1)—981 with the U.S. Atomic Energy Commission and the U.S. National Bureau of Standards.

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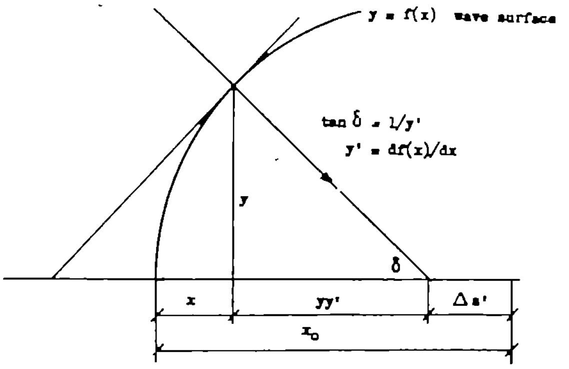
A Formula for determining the Wave-Surface if the Spherical Aberrations are Known

If the spherical aberrations of a cylindrical symmetrical optical system are known in the form of a series:

$$\Delta S' = a \tan^2\delta + b \tan^4\delta + c \tan^6\delta + \ldots, \quad (1)$$

it is possible to deduce the equation of the orthotomic wave-surfaces to the rays defined by (1), as has been shown by Picht[1]. Picht gives a recursion formula proceeding from the higher terms to the lower, which is very inconvenient if the constants $a, b, c, \ldots$ increase rapidly, as is ordinarily the case. It is possible, however, to obtain a recursion formula proceeding from the lower terms to the higher, which has been found very useful for practical purposes while analysing the concentration of light near the geometrical focus[2] by the Debye–Picht method.



From the accompanying diagram we obtain the relation

$$x_0 = x + yy' + \Delta S', \quad (2)$$

which gives the differential equation of the wave surfaces:

$$yy' + \frac{a}{y'^{2}} + \frac{b}{y'^{4}} + \frac{c}{y'^{6}} + \ldots x - x_0 = 0. \quad (3)$$

This can easily be solved by a Legendre transformation, and by introducing the unknown variable in the transformed equation in the form of a series of the powers of the parameter $\tan^2\delta$ and determining the constants by putting the sum of them for each power equal to zero. In this way we get the meridional co-ordinates of the wave surfaces:

$$x = -A \tan^2\delta - 3B \tan^4\delta - 5C \tan^6\delta \ldots \quad (4)$$

$$y = -2A \tan\delta - 4B \tan^3\delta - 6C \tan^5\delta \ldots \quad (5)$$

with the recursion for the constants:

$$A = -\frac{x_0}{2};\ B = \frac{a-A}{4};\ C = \frac{b-3B}{6};\ D = \frac{c-5C}{8}. \quad (6)$$

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[1] Picht, J., "Optische Abbildung", 164 (Braunschweig, 1931).

[2] A paper dealing with this subject is to appear in *RAD Jugoslavenske Akademije, Zagreb.*

Compressibilities of Cubic Crystalline Powders: a New Method of Measurement

By suitable averaging, the following relations may be derived for polycrystalline aggregates consisting of randomly oriented and ideally closely packed particles of any substance crystallizing in the cubic system:

$$C'_{11} = \frac{3}{5}C_{11} + \frac{2}{5}(C_{12} + 2C_{44});$$

$$C'_{44} = \frac{3}{5}C_{44} + \frac{1}{5}(C_{11} - C_{12}).$$

C'_{11} and C'_{44} are the thickness and shear elastic constants of a plate of the aggregate and C_{11}, C_{12} and C_{44} are the elastic constants of the corresponding single crystal. If the crystal is such that the Cauchy relation $C_{12} = C_{44}$ holds good, the above equations become dependent on one another and reduce to $C'_{11} = 3C'_{44} = \frac{3}{5}(C_{11} + 2C_{12})$. If $C_{12} \neq C_{44}$, they remain independent but may be combined to give $3C'_{11} - 4C'_{44} = C_{11} + 2C_{12}$. Thus, the measurement of C'_{11} and C'_{44} will enable us not only to state whether the Cauchy relation holds good for the crystal under investigation, but also to evaluate the bulk modulus K, which is $\frac{1}{3}(C_{11} + 2C_{12})$.

C'_{11} and C'_{44} can be conveniently measured by the ultrasonic wedge method, developed and described by us in earlier publications[1]. Results obtained for a few test cases, using cubic crystal powders, compressed into plates of suitable dimensions, are given in the accompanying table in units of 10^{11} dynes per cm.^{2}.

Substance	C'_{11}	C'_{44}	$K = \frac{5}{9}C'_{11}$	K (direct measurement)
KCl	3·16	1·07	1·76	1·77
KBr	2·71	0·91	1·51	1·50
KI	2·19	0·76	1·22	1·17
NaCl	4·37	1·47	2·43	2·40

C'_{11} in all cases is three times C'_{44}. This is in conformity with the known fact that the Cauchy relation holds in all these crystals. Moreover, K obtained from C'_{11} (column 4) agrees well with the value available in the literature for each case (column 5).

It is proposed to extend this method to as many aggregates as possible, and the results will be published elsewhere.

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Reaction between Glucose and the Terminal Amino Group of Lysine

Patton and Chism[1] have recently used paper chromatography followed by examination of the unheated papers under an ultra-violet lamp for demonstrating a series of fluorescent products in boiled glucose–glycine solutions. We have been using a similar technique in an investigation of the reaction between glucose and α-N-acetyl-L-lysine at 37° C. and have found it particularly effective when combined with a study of the effect of water content on the course of the reaction.

Freeze-dried mixtures of the two substances (1½ moles glucose/amino group, *p*H on re-solution 6·5) were shown to react with progressively increasing complexity as the relative humidity increased, until at about 60 per cent relative humidity all the changes characteristic of the Maillard reaction in true solution[2] were occurring. The reaction products were examined by descending paper chromatography with 80 per cent aqueous propanol as solvent.

At 20 per cent relative humidity a simple one-to-one glucose–amino combination took place and gave rise to a spot at R_F 0·1 (*A*) which had all the properties described by Gottschalk and Partridge[3]. Glucose and α-N-acetyl-L-lysine were clearly separated at R_F 0·3 and 0·2. At 30 per cent relative humidity there appeared, in a characteristic band on the rear edge of the first spot, a second compound (*B*) which gave a bright purple fluorescence under an ultra-violet lamp and on elution showed a pronounced absorption peak at 2880 A. Reduction of ammoniacal silver nitrate and ferricyanide at *p*H 5 occurred in the area *AB*. At 40 per cent relative humidity a series of non-reducing pale-blue-fluorescent compounds (*C*) appeared at R_F's 0·05, 0·03 and 0·01, while brown products (*D*), which had now begun to accompany the reaction, remained stationary. Compounds *C* and *D* could be reproduced by storing the isolated amino–glucose complex *A* at 40 per cent relative humidity, and this, combined with a progressive movement towards the visible region of a poorly defined peak in their absorption spectra (reaching 3280 A. in the brown compounds), suggests that they are successive degradation products of the complex.

At 60 per cent relative humidity the pattern of the fluorescent compounds, though similar, was more complex and has not yet been examined in detail. It is interesting to note, however, that several of the complex effects, including browning, fall in *p*H and loss of glucose in excess of the one-to-one relationship, reached a maximum at this humidity, whereas the maximum rate of loss of amino groups occurs at 40 per cent relative humidity. A similar behaviour has already been observed in the protein–sugar reaction[4].

The precise chemical nature of compounds *A* and *B* still remains to be determined. Both appear to be primary products of a one-to-one reaction, but neither liberates glucose on acid hydrolysis nor undergoes reduction by hydrogen and palladium black at room temperature and pressure. There is therefore as yet no direct evidence for an N-glycoside or *iso*glucosamine structure of the type well known in the aromatic series. Compound *A* appears to be one of the main intermediaries in the browning sequence; but sufficient browning to account for that of the intact systems could only be achieved by storage of *A* with all the slower-moving compounds (except *D*). This mixture browned two or three times as rapidly as *A* alone. At least one of these other compounds is therefore also involved, possibly in a catalytic role, since only *A* browns when a developed paper chromatogram is heated.

These experiments, and others with a preparation of polylysine of molecular weight 10–15,000, were carried out with the object of assessing the extent of the contribution of the terminal amino groups of lysine to the effects already observed with intact proteins[4,5]. Similar effects were observed in all three systems[6], confirming the view that the free amino groups of the protein are of great importance in the protein – sugar reaction. Even insolubility, preceded by an increase of molecular weight, occurred in the polylysine experiments, showing that cross-linking can apparently occur without the participation of other amino-acid residues.

This work was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research. A full account will be published elsewhere.

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Amino-acids of Silk Sericin

The silk thread extruded by the lava of the silk moth of commerce (*Bombyx mori*) consists of two parts: a central core of two filaments of the protein fibre 'fibroin', surrounded and cemented together by a layer of protein material called 'sericin'.

Analyses of the amino-acids of sericin are widely scattered through the literature[1-4], and are in no case claimed to be complete. By the methods of paper-partition chromatography we have examined the amino-acid constitution of sericin, and demonstrated the presence of fifteen amino-acids. Of these, valine had not previously been reported, and the evidence for a number of others, especially lysine, proline, glycine and phenyl alanine, was very slight.

The sericin was divided into three fractions, depending on their solubility in hot water, or in dilute acid or alkali. This separation follows the general lines described by various earlier workers[4-8]. The outer, most soluble fraction, sericin *A*, had a total nitrogen content of 17·2 per cent; paper chromatography of the hydrochloric acid hydrolysate of this fraction showed it to contain the following amino-acids: serine, threonine, glycine and aspartic acid in high concentration; glutamic acid, arginine, alanine, leucine, *iso*leucine, valine and tyrosine in moderate concentration; and lysine and phenyl alanine in relatively low concentration.

The second fraction, sericin *B*, had a nitrogen content of 16·8 per cent. On acid hydrolysis it yielded the amino-acids of sericin *A* in similar proportions, and in addition some tryptophane.

The third, inner layer of sericin, sericin *C*, adjacent to the fibroin, was insoluble in hot water, but could be removed from fibroin by treatment with hot dilute acid or alkali. Its nitrogen content was 16·6 per cent and on hydrolysis it yielded proline in addition to the amino-acids of sericin *B*. This inner layer also contained sulphur, present as inorganic sulphide. No sulphur-containing amino-acids could be detected.

There was some evidence for the presence of traces of a third basic amino-acid residue in each of the three sericin fractions. This was not histidine, for although histidine has been reported as present in sericin by other workers we could not detect it in any of the hydrolysates by the sensitive Pauly reaction[9]. The spot we obtained may have been due to hydroxylysine; but our evidence regarding this amino-acid was by no means conclusive.

The distribution of the amino-acids in sericin is being investigated by Sanger's technique[10] and by other methods.

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Preparation of the Specific Purified Antigen of Canine Hepatitis Virus and Antiserum for Serological Studies

The natural history of mammalian hepatitides viruses supports the concept of a widespread unapparent infection[1,2] which makes it extremely difficult to study the problem by experimental inoculations without a reliable serological test. This communication describes a simple method for the purification and concentration (if necessary) of the antigen, as well as the preparation of the active antiserum for serological studies. Four strains of the virus have been used in these experiments: two English strains, one from Australia and one from Sweden.

Preparation of antigen. Methanol cooled to –30° C. was cautiously added to a final concentration of 30 per cent to a cooled fine 10 per cent suspension of a virus-rich tissue in distilled water or to undiluted body fluid (such as serum, peritoneal fluid, etc.), while it was kept in an ice box. The resultant turbid fluid was held at 0° C. for 2–3 hr. and then centrifuged at 4,000 r.p.m. until all the suspended particles were thrown down. The supernatant fluid was removed and the sediment was taken up in a volume of 0·85 per cent saline at pH 6·8–7·0 equal (or less, if desired) to that of the original liquid, and after stirring thoroughly it was allowed to stand for 24 hr. at 0° C. Any undissolved material was then removed by centrifugation and the final water-clear supernatant was used as the antigen. Ethanol or butanol can be used instead of methanol, but the resultant antigens appeared to be less active.

Preparation of antiserum. Dogs were hyperimmunized with a fine 10 per cent suspension (in 0·85 per cent saline) of the virus-rich liver. The intravenous or subcutaneous inoculations of the material used were carried out by giving increasing amounts (1 to 11 ml.) of the suspension over a period of three weeks. In the intraperitoneal method three injections were given (5 ml. each) at weekly intervals.

Complement-fixation test. The test mixtures: serum (or dilution) 0·1 ml., antigen (or dilution) 0·1 ml., and complement dilution 0·5 ml. 0·85 per cent saline was always added to make the total volume 1·5 ml. Each reaction mixture was given primary incubation either in a water-bath at 37° C. for 30 min., or in a refrigerator at 3° C. for 16–18 hr., followed by 1 hr. at room temperature. Then 0·5 ml. of hæmolytic system (5 M.H.D. of hæmolytic amboceptor in a volume of 3 per cent sheep red cells suspended in 0·85 per cent saline) was added. This was followed by a final incubation in a water-bath at 37° C. for 30 min. The amount of hæmolysis was estimated in six grades. Before conducting the main test, complement was always titrated in amounts varying by 0·25 M.H.D.

Ring precipitin test. This was carried out by carefully stratifying 0·04 ml. of the viral antigen on 0·04 ml. of test serum in a small test-tube (3 mm. × 25 mm.). The reaction was allowed to stand 2 hr. at 37° C. Definite ring-like precipitate formed at the junction of the two fluids in positive cases.

Quantitative flocculation test. Dilutions of sera and antigen were prepared separately. Each dilution of test serum was set up in as many test-tubes (0·5 ml. in each) as the number of antigen dilutions required to be tested. Then 0·5 ml. of antigen dilution was added into each tube, thus doubling dilutions of both components. Readings were made after the reaction was allowed to stand 18 hr. at 37° C. A definite turbidity noticeable by the naked eye in the daylight appeared in positive tests.

Some properties of the antigen. It can be derived from various virus-rich dog tissues and body fluids, although the lungs and spleen contain less of the antigenic material. It is stable on storage at + 3° and – 30° C., as well as to heating at 56° C. for 30 min. and 1 hr. The supernatant fluid after high-speed centrifugation at 15,000 r.p.m. is antigenically active. Solubility of the active material in organic solvents (benzene, chloroform, petroleum ether, ethyl ether, amyl and butyl acetate) is negligible. The antigen on being inoculated into dogs can induce the specific and sometimes fatal disease. Precipitins and complement-fixing antibodies can disappear completely from the circulating blood after one year and in some cases even earlier. At the same time these dogs appeared to be actively immune to subsequent challenge with the virus.

I am grateful to Dr. H. P. Chu for his kindness in carrying out the high-speed centrifugation, and to Mr. W. G. Orbell for technical assistance. The details of this work will be published elsewhere.

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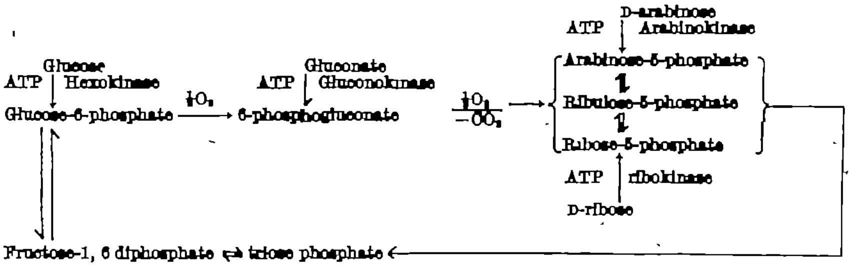
Utilization of Gluconate and Glucose in Growing and Virus-infected *Escherichia coli*

We have described various enzymes in *E. coli* participating in an oxidative pathway of glucose-6-phosphate degradation via 6-phosphogluconate to pentose-5-phosphate and then to triose phosphate. Recently, we have found the specific adaptive transphosphorylases, gluconokinase[1], D-arabinokinase[2], and ribokinase[3] in *E. coli* which permit the insertion of the homologous substrates into this pathway. The Embden–Meyerhof pathway of anaerobic triose formation also exists in these bacteria. These relationships are presented in the accompanying chart.



Alternate pathways for triose phosphate formation

The reaction of glucose-6-phosphate to 6-phosphogluconate has been considered to be essentially irreversible. If this were true, the metabolism of gluconate, for example, could only proceed via the oxidative pathway. To test this, we have measured the liberation of carbon dioxide from the C_1 of gluconate, labelled specifically in that position with carbon-14. *E. coli*, strain *B*, were grown aerobically in Warburg vessels in a mineral medium with gluconate as the sole carbon source. The carbon dioxide was trapped in sodium hydroxide and recovered quantitatively as barium carbonate in the presence of 150 micromoles of diluting sodium carbonate. The radioactivity of the barium carbonate was measured.

During growth on gluconate, the average production of carbon dioxide was 2·3 moles per mole of gluconate. The average recovery of C_1 in carbon dioxide was 88 per cent, recoveries ranging between 84 and 95 per cent. When gluconate was oxidized without growth by pre-adapted bacteria in a 0·05 *M* phosphate buffer at *p*H 7·0, carbon dioxide production was 3·5 moles per mole of gluconate and C_1 recovery was 100 per cent.

Pre-adapted bacteria were infected with about five bacteriophage $T\,2r^{+}$ particles per cell in the presence of labelled gluconate, and C_1 yields were compared with those from uninfected bacteria. Although infected bacteria stopped multiplying, their respiratory quotient and rate of production of carbon dioxide were identical with those of uninfected bacteria. The C_1 recoveries from the two systems were essentially identical and almost quantitative. We conclude from these experiments that the path of gluconate metabolism in growing and virus-infected *E. coli* is almost completely, if not completely, through pentose phosphate, with attendant C_1 liberation as carbon dioxide. Furthermore, the glucose-6-phosphate oxidation to 6-phosphogluconate is essentially irreversible in these bacteria.

The same technique was applied in analysing the routes of glucose utilization by these bacteria. When glucose is converted to triose phosphate via the Embden–Meyerhof scheme, the carboxyl of pyruvate derived from it would contain C_3 or C_4 of the original glucose. Carbon dioxide from this pyruvate might arise from a variety of pathways, two extreme cases being (1) the complete combustion of pyruvate in the tricarboxylic acid cycle, or (2) the preferential liberation of carbon dioxide from the carboxyl. No mechanism is known at present which would give rise preferentially to carbon dioxide from pyruvate —CH_3, which would contain the original C_1 of glucose. In the first case, we would obtain the maximal C_1 liberation as carbon dioxide and the recovery of C_1 in the carbon dioxide would be proportional to the yield of carbon dioxide from glucose.

When C_1-labelled glucose is oxidized by the bacteria in a 0·05 *M* phosphate buffer (*p*H 7·0) free of a nitrogen source, 3·2 moles of carbon dioxide were liberated per mole of glucose. This carbon dioxide contained 54 per cent of the total C_1. Since the specific activity per mgm. carbon of this carbon dioxide was that of the entire glucose, these oxidizing cells gave no indication of a preferential liberation of carbon dioxide from C_1 or of a use of the oxidative pathway.

Under conditions of growth, in which 1·4 moles of carbon dioxide were liberated per mole of glucose, a maximal value of 23 per cent (1·4/6 × 100) could be expected from the combustion of a portion of the pyruvate formed anaerobically. However, an average of 37 per cent (34–39) of the C_1 was recovered in the carbon dioxide in eight experiments. This is significantly in excess of the maximal value of 23 per cent, and the minimal value for glucose degradation by the oxidative pathway would then be 37 — 23, or 14 per cent. The maximal value would be the C_1 recovery or 37 per cent. In either case, the oxidative pathway could be supplying all the ribose requirements of the organism.

C_1 RECOVERY IN CARBON DIOXIDE PRODUCED DURING GLUCOSE UTILIZATION BY *E. coli*

Physiological condition	$\frac{\text{Moles } CO_2}{\text{Mol. glucose}}$	$BaCO_3$ (counts/min./mgm. C)	Recovery of C_1 in CO_2 (per cent)*	Theoretical C_1 recovery (per cent)	Excess (per cent)
Oxidation, no growth	3·22	212	54·4	53·7	0·7
Growth	1·32	156	37·7	22·0	15·7
T2 synthesis	1·38	121	29·1	23·0	6·1

* Calculation after correction for dilution.

When these cells were infected with five bacteriophage $T2r^+$ particles per cell, they stopped growing and proceeded to the synthesis of virus components almost exclusively[3]. Although their respiratory quotient and rate of oxygen consumption were unchanged under conditions of virus infection, the excess of C_1 in the carbon dioxide was markedly decreased. A typical experiment is presented in the accompanying table. This may be interpreted as a shunt in glucose utilization from the oxidative pathway to the anaerobic pathway and occurred under conditions in which ribose nucleic acid synthesis was eliminated and deoxyribose nucleic acid synthesis was stimulated.

We have also observed that gluconate may be used readily for growth, when far more ribose nucleic acid is produced than deoxyribose nucleic acid, but is a poor substrate for virus synthesis when an increased demand for deoxyribose nucleic acid appears. These results suggest that, in glucose utilization by *E. coli*, ribose is derived mainly from the oxidative pathway, and deoxyribose may come from constituents generated most readily from the anaerobic pathway.

This work was supported by a grant from the Commonwealth Fund. I am indebted to Dr. S. Gurin of the University of Pennsylvania for C_1-labelled gluconate, and to Dr. H. S. Isbell of the National Bureau of Standards for C_1-labelled glucose.

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Cytology of the Ecotypes of Diœcious *Melandrium dioicum* (L. emend.) Coss. & Germ.

IN 1942, a tetraploid ($2n = 48$) plant of the diœcious *Melandrium dioicum* complex was discovered by D. Löve[1] in a Swedish population. She diagnosed it as "*M. crassifolium* Fries"[2], which Turesson[3] has considered to be a coastal ecotype of *M. dioicum*. From herbarium studies of the morphology of adult plants, she further concluded that "*M. crassifolium*" and *M. rubrum* subsp. *lapponicum* Simm.[4] are synonymous and, as the latter has been regarded by Turesson[3] as forming part of the sub-alpine ecotype of *M. dioicum*, this means that there is no outstanding morphological difference between the 'coastal' and 'sub-alpine' ecotypes of this species. From a comparison of pollen-sizes in her tetraploid and these ecotypes, she concluded that both the coastal and sub-alpine races are tetraploid.

This is important, because it had already been established (in 1940) by Warmke and Blakeslee[5] that a tetraploid race, once formed, could spread without loss of diœcism even though such a race had not then been discovered. Nevertheless, Baker[6–8] has shown that a number of plants representing the coastal ecotype in the Shetland Isles are diploid ($2n = 24$) without any tetraploids being found, despite the fact that this race shows many morphological features normally associated with polyploidy (and even found in artificial polyploids in this genus[5,9]), such as increased flower-, capsule- and seed-size along with thicker and hairier leaves and stems. It was pointed out[6,8] that further evidence that all coastal and sub-alpine plants are not tetraploid had been provided by the determination of diploidy in sub-alpine material collected by Dr. J. Clausen at Abisko (in Swedish Lappland) and examined by Warmke and Blakeslee[5].

Recently, we have been able to study material collected by one of us (H. G. B.) in 1950 at Krossbu (alt. 1,340 m.) and Finse (alt. 1,500 m.), in Norway, the latter station being the type locality of Turesson's alpine ecotype of this species[3]. In addition to this sub-alpine and alpine Norwegian material, plants collected by Miss E. A. Baker, at a height of approximately 1,500 m. on the Weissenstein in Switzerland, have been grown and examined. All these thick-leaved plants (of both 'sexes') gave a diploid count with the usual complements of sex-chromosomes and autosomes. Their crossing reactions with each other and with British material are being examined; but all indications, so far, are that they do truly represent ecotypes of the single species *M. dioicum*. Therefore, it appears that Löve's tetraploid plant is not characteristic of the coastal and montane races of this species (which have remained at the diploid level), but is an aberrant. It would have been most interesting if the fate of this plant, representing a potential new race, could have been followed in Nature.

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Unusual Features of the Root System of the Oil Palm in West Africa

On the deep acid sands of West Africa the roots of the oil palm (*Elæis guineensis*) may be divided into primary, secondary, tertiary and quaternary.

The primary roots emerge radially from the trunk-base and proceed for long distances without change in diameter. In palms over two years old this diameter is very constant (about 5 mm.). No roots have been found emerging at less than 15° from the soil surface. After proceeding downwards to a depth proportional to the angle they make with the soil surface, these primary roots tend to level out and travel horizontally for considerable distances (specimens from a 12-ft. palm have been traced for more than 40 ft. without coming to the end). They are completely unbranched and, in this soil, which is very free from obstructions, travel almost straight, occasionally tending to rise slightly. All primary roots found have been at a depth of more than 18 in.

The secondary roots emerge from the primary root within 45° of the vertical diameter, the sides of the primary roots being almost entirely clear. Of these secondary roots approximately 70 per cent grow vertically upwards and the remaining 30 per cent vertically downwards. The roots that grow upwards continue until they reach the soil surface, those growing downwards being of variable length.

The tertiary roots, which are probably the main absorbing roots, emerge at right angles from the secondary roots and travel in a horizontal plane. Their length is normally limited to about 10 cm., and the majority of them occur in the upper 10 cm. of the soil, where their length is also greatest. They do not occur in quite the same way on secondary roots growing downwards, as the tertiary roots tend also to continue downwards, producing an effect more like an unequal dichotomy.

The quaternary roots are very short (normally less than 5 mm.) and emerge at right angles to the tertiary roots.

Two other features of interest were noted: (1) The root system undergoes constant renovation, new primary roots emerging from the trunk base and old roots dying back from the tips. (2) New roots tend to grow along old dead roots. Whether the reason for this is nutrition or ease of spread remains to be proved by future experiments.

The importance of this type of root system to plantation practice is manifold. Thus mineral fertilizers do not need to be buried to become available to the plant, and, in fact, are likely to be more quickly and certainly absorbed if applied to the surface of the soil. Again, mechanical cultivation between the rows with implements such as disk harrows will do very little damage to roots, as the numbers of roots other than tertiary ones that will be cut will be very small.

My thanks are due to Messrs. Pamol, Limited, under whose auspices this work was done, for permission to publish this note.

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Effect of Nitrogen-fixing Blue-Green Algæ on the Growth of Rice Plants

The fixation of atmospheric nitrogen by blue-green algæ has been reported by Pringsheim, Molisch, Drewes, Allison and Morris, De, Stokes, Bortels, Fogg, Burris and Wilson, Shioiri and Nishigaki *et al.*[1]; but no experiments on the effect of these algæ on the growth of rice plants have been performed.

About ten years ago one of us[2] began collecting blue-green algæ from the rice fields in various Far Eastern and South Sea regions. In the 643 samples collected, only thirteen blue-green species proved to be able to fix atmospheric nitrogen. These thirteen algæ grow abundantly in the tropical and semi-tropical regions of Java, Sumatra, Borneo, the Philippine Islands, Malaya, Indo-China, Siam, Burma, Hainan, Formosa and South China; but they are scanty in Japan, North China, Manchuria, Korea and Sakhalin. They belong to the genera *Tolypothrix*, *Nostoc*, *Schizothrix*, *Calothrix*, *Anabænopsis* and *Plectonema*. *Tolypothrix tenuis* (from Borneo), *Calothrix brevissima* (from Palau Islands), *Anabænopsis* sp. (from Sumatra) and *Nostoc* sp. (from Java) were the only ones of which bacteria-free cultures were obtained in a nitrogen-free medium (0·3 gm. K_2HPO_4, 0·2 gm. $MgSO_4 . 7H_2O$, 0·05 gm. $CaCl_2$, a trace of $FeCl_3$, 2 gm. glucose, and 1,000 c.c. distilled water). The total nitrogen fixed in 2 months was 9·6 mgm. in *Tolypothrix tenuis*, 5·2 mgm. in *Calothrix brevissima*, 3·4 mgm. in *Anabænopsis* sp. and 3·1 mgm. in *Nostoc* sp., estimated by the micro-Kjeldahl method.

With the help of such pure cultures the effect of these algæ on the growth of rice plants was examined

Table 1

Experiment	Length of leaves (cm.)			
	Tolypothrix tenuis	*Calothrix brevissima*	*Anabænopsis* sp.	Control
1	75·5	78·5	70·5	72 5
2	78 5	84·0	76·0	68·5
3	80·5	80·5	75·5	72·5
4	84 0	80·5	78 0	74·0
5	89·5	82·0	78 0	76 0
6	80·0	85·0	80 5	71 0
Mean	81·33	81·75	76·42	72·42
Variance	19·72	4·90	9 61	5·43
Standard deviation	4·44	2·21	3·10	2·33

in water-, as well as in pot-cultures[3,4], and in paddy-field experiments[5]. In the water-cultures with *Tolypothrix tenuis* the lengths of the leaves increased on an average by 17 per cent and the number of ears by 30 per cent. In pot-cultures with three of the blue-green algæ the effect on the lengths of the leaves is shown in Table 1.

As will be seen, the presence of *Tolypothrix* had a positive effect on the growth of the plants, the amount of nitrogen absorbed by them being 7·5 lb. per acre in excess of the control and the total nitrogen fixed at about 20 lb. per acre, while *Anabænopsis* produced no appreciable effect. In the paddy-field experiment *Tolypothrix tenuis* positively affected the growth of the plants, increasing the rice yield both in well-drained, as well as in badly-drained, paddy fields (Table 2).

Table 2

	Rice harvest (bushels per acre)		Percentage increase
Well-drained paddy field	non-inoculated	44·9	15
	Tolypothrix-inoculated	51 8	
Badly-drained paddy field	non-inoculated	30·3	25
	Tolypothrix-inoculated	37·8	

Full details will be published elsewhere.

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[1] Shioiri, M., Hatumi, Y., and Nishigaki, S., *J. Sci. Soil and Manure* (Japan), 18, 69 (1944).

[2] Watanabe, A., paper read at the tenth general meeting of the Bot. Soc. of Japan (Tokyo, 1942).

[3] Watanabe, A., Miscellaneous Reports of Research Inst. for Nat. Resources (Tokyo), Nos. 17–18, 61 (1950) (in Japanese).

[4] Nishigaki, S., paper read at the twenty-first general meeting of the Society of Soil and Manure, Japan (1950).

[5] Konishi, C., paper read at the twenty-second general meeting of the Society of Soil and Manure, Japan (1951).

Micro-electrode for Electro-physiological Work

THE micro-electrode described by R. A. Weale[1] necessitates the use of an electronic device, just for breaking the circuit, when the chain of silver crystals has reached the tip of the capillary tube. Furthermore, the micro-electrode proper has three disadvantages: (1) contact is easily disrupted in the capillary part; (2) resistance is comparatively high; (3) the electrolyte remains between the crystals. These disadvantages are a consequence of the 'feathery' or 'larchlike' character of the chain of silver crystals, which do not adhere sufficiently to one another.

We have prepared micro-electrodes in the following way. A capillary tube is drawn out by a method described by P. de Fonbrune[2]. The following stages are exactly in accordance with the method of Weale, except that we use silver nitrate instead of water in the tube. Then a plating bath is made of a drop of saturated silver nitrate on a tissue-culture slide (hollow ground). The bath is put on the table of the microscope, the tip of the capillary brought into the drop and observed with a high-power objective. The plating circuit is closed by bringing the silver wire anode into the drop as well. With a plating current of 1 V., very slow growth of relatively large silver crystals starts. As soon as the rate of growth exceeds the limit of being just perceptible, the plating voltage is reduced with an adjustable resistance. After about fifteen minutes, a few tenths of one volt will be sufficient to maintain the slow growth. Quicker growth suddenly produces the feathery chain. The indispensable watching of the growth of the crystals is fairly trying, as they take about 45 minutes to reach the tip. When the chain is finished, we break the circuit, an electronic device thus being dispensed with.

The result is a micro-electrode which is massively filled with silver. Consequently (1) contact is secured by the crystals adhering closely; (2) the resistance averages one ohm; and (3) no electrolyte remains between the crystals.

This method holds good for electrodes not smaller than 5 μ. Smaller tubes fill spontaneously with silver crystals. This curious phenomenon unfortunately produces crystal chains of the feathery type. We have not yet succeeded in solving this problem.

J. WORST

Mozartstraat 1,
Arnhem.
June 9.

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[1] Weale, R. A., *Nature*, 167, 529 (1951).

[2] de Fonbrune, P., "Technique de Micromanipulation" (Masson et Cie., Paris).

Bacterial Flagella

IN a recent communication in *Nature*[1], Weibull tends to regard my theory of bacterial motility as incorrect and as based on misinterpretation of observations made with dark-field microscopy. He confuses the issue, as so many do, by assuming that 'flagella' in different groups of bacteria mean the same thing, whereas in reality they often are structures *sui generis* in the various groups and may have very little or even nothing in common[2-4].

Weibull states that motile bacteria always have flagella; this is incorrect. He refers to Kauffmann's statement that *H*-serum immobilizes motile bacteria immediately, because it 'paralyses' their flagella. But my *observations* have shown that *H*-serum produces a precipitate on bodies and flagella which, after a determined struggle on the part of the bacteria, becomes so thick that motility gets less and less[6,7]. This purely mechanical progressive inhibition can be watched in a cinemicrographic film I made[8]. Weibull also mentions Ørskow's observation that *Proteus* bacteria on agar, covered with ink, can give the impression that their bodies lie still while their flagella whirl ink particles about. Flagella, however, were not actually seen, and it must be difficult to make sure that the bodies really are motionless; in any event, my contention that normally the body wags the flagella does not imply that nothing else can ever move them. Kingma Boltjes's work, also quoted by Weibull in support of his criticism, is invalidated by confusing the flagella of the large spirillums with those of typhoid and *Proteus* bacteria.

They are in entirely different categories, as I have shown[2-4,6]. One should not (and here I also think of electron microscopists) apply conclusions drawn from observations on spirillums and vibrios to the flagella of typhoid, *Proteus* and *subtilis* bacteria. In this letter I shall try to confine myself to a discussion of the latter bacteria. Weibull also mentions Fleming's experiments on penicillin-poisoned *Proteus* bacteria. I have repeated these experiments and made a film of them and find them inconclusive. I think these grotesque movements are more readily explained by bodily contortions. If flagella could perform in this way, they would require an elaborate system of co-ordination, something like a central nervous system.

Weibull agrees with Reichert's interpretation of the mechanical function of flagella. I have often pointed out[2-4,6,7,10-12] that Reichert never saw normal flagella functioning, at least not in typhoid and *Proteus* and suchlike bacteria. He himself states that he could only make their flagella visible with his darkground technique by suspending them in a colloidal solution. He imagined that the colloid just retarded motion and had an effect on refraction; but in reality, as I have repeatedly shown, it became adsorbed on the bodies and flagella, just like *H*-serum. What Reichert studied were live artefacts. Weibull's own *Proteus* flagella, coming from an agar medium and therefore growing in a colloidal medium, during growth are also covered with a sheath of agar. Weibull evidently does not know of and underrates *sunlight* darkground microscopy. It is only with sunlight darkground microscopy that I succeeded in making *naked* flagella and tails properly visible in broth or water[3,11-14]. By this technique, one can see the naked thin tail split into numbers of very thin flagella; this is entirely different from the picture on which Reichert and Weibull have worked.

With this sunlight darkground method[15] I have made further observations on the function of normal, that is, not artificially thickened, tails and their constituent flagella. There is the sudden reverse, the semi-somersault, the possibility of shaking off flagella by mechanical means after which swimming goes on undisturbed, the curious fact that the same bacterium will produce magnificent tails in one broth and none in another while motility is identical in both, and the definite spiral movement and shape of bacterial bodies (sometimes hidden by their high speed and then made visible by slow-motion filming). These studies, extending over twenty years, make it impossible for me to regard flagella as motor organs[2-16].

As a result of X-ray diffraction analysis of his flagella from *Proteus* and *subtilis* bacteria, Weibull places their proteins in the fibrous protein group, which comprises keratin and myosin. Chemical analysis gave him a low cystine and a high lysine content. This would fit in much better with myosin than with keratin. But chemical analysis of flagella from typhoid bacteria undertaken in my Department showed high cystine and low lysine content[17]. This would place flagella in the keratin group. I find it difficult not to consider that perhaps we are all analysing our respective nutrient media and not so much the flagella.

Weibull says the source of energy of flagella is obscure. This is not the only obscurity. Supporters of the motor theory of bacterial flagella do not commit themselves readily as to the origin of flagella. If they start in the protoplasm they must pierce the cell wall. In the case of peritrichous bacteria such as *Proteus*, this would mean dozens of holes. When are the new holes made, before or after cell division? After piercing the wall, the flagella must bend at right angles, run along the cell wall in close apposition, and at the end of the bacterium they must twist round one another to form a tail, which performs spiral movement. The mechanical implications of such an arrangement are extraordinary, and sudden reverses and semi-somersaults must cause awkward complications. If, on the other hand, the flagella arise outside the cell wall and yet are active motor organs, it follows that bacteria must have live active protoplasm both outside and inside the cell wall. These two masses of protoplasm evidently cannot directly communicate with one another and this creates an entirely novel situation in biology. The mechanical implications here are too formidable. My theory at least does away with difficulties of this kind. I do not claim that it is the last word on bacterial motility.

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[1] Weibull, C., *Nature*, 167, 511 (1951).
[2] Pijper, A., *J. Path. Bact.*, 58, 325 (1946).
[3] Pijper, A., *J. Bact.*, 57, 110 (1949).
[4] Pijper, A., and Nunn, A. J., *J. Roy. Micr. Soc.*, 69, 138 (1949).
[5] Pijper, A., in "The Nature of the Bacterial Surface" (Blackwell, Oxford, 1949).
[6] Pijper, A., *Schw. Z. Pathol. u. Bakt.*, 12, 681 (1949).
[7] Pijper, A., *J. Path. Bact.*, 47, 1 (1938).
[8] Pijper, A., *J. Bact.*, 42, 395 (1941).
[9] Pijper, A., *Science*, 109, 379 (1949).
[10] Pijper, A., *Z. Bakt.*, *I*, *Orig.*, 118, 113 (1930).
[11] Pijper, A., *Z. Bakt.*, *I*, *Orig.*, 123, 195 (1931–32).
[12] Pijper, A., *J. Biol. Phot. Assoc.*, 8, 158 (1940).
[13] Pijper, A., a motion picture of bacterial shape and motility (Pretoria, Wallachs, 1947).
[14] Pijper, A., *Nature*, 161, 200 (1948).
[15] Pijper, A., *S. Afr. J. Sci.*, 46, 296 (1950).
[16] Pijper, A., *J. Bact.*, 53, 257 (1947).
[17] Unpublished observations.

As any reader of Pijper's many works on bacterial flagella will soon discover, his opinions on this subject have changed considerably during the years. In the work from 1947, cited by me, bacterial flagella are described as "lifeless mucous twirls" or "polysaccharide twirls".

That the flagella of *Proteus vulgaris* are not mucous twirls or polysaccharide twirls is clear from chemical analyses and from X-ray investigations. It should suffice to mention their nitrogen content (16 per cent), and the near absence of carbohydrate (less than 0·2 per cent). From this it follows also that the *Proteus flagella*, prepared by me, are obviously not covered by a sheath of agar, as Pijper says.

As to the question of their role as motor organs, an excellent review of the different opinions on this matter is found in ref. 3. I am still convinced that the experiments of Ørskow, Kauffmann, Kingma Boltjes, Fleming, and others, carried out by independent methods, show that they are active motor organs.

CLAES WEIBULL

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[1] Weibull, C., *Biochim. Biophys. Acta*, 3, 379 (1949).
[2] Astbury, W. T., and Weibull, C., *Nature*, 163, 280 (1949).
[3] "The Nature of the Bacterial Surface" (Blackwell, Oxford, 1949).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, October 29

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Social Implications of Television" (to be opened by Mr. F. H. Townsend).

Tuesday, October 30

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. Kathleen Lonsdale, F.R.S.: "Patterns".*

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Miss Audrey I. Richards: "Tribal Admixture in Uganda".

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. O. Hassel: "Some Fundamental Problems in Structural Organic Chemistry and their Significance to the Chemistry of Substances containing Six-Membered Rings".* (Further Lecture on October 31.)

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. R. A. Peters, F.R.S.: "The Scientific Basis of Medicine, 7, Biochemical Function of Vitamin B_1".* (Further Lectures on November 2, 5, 7, 14, 16, 20, 23, 27 and 29, December 4, 6 and 11.)

Society of Instrument Technology (at the Royal Society of Tropical Medicine and Hygiene, Manson House, Portland Place, London, W.1), at 6.30 p.m.—Mr. H. B. Moss: "Development of Materials for Instrument Manufacture".

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Dr. W. F. Hilton: "Supersonic Propellers".

Wednesday, October 31

Royal Statistical Society, Research Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. P. Armitage: "The Statistical Theory of Bacterial Mutation".

Manchester Literary and Philosophical Society, Social Philosophy Section (at the Portico Library, Mosley Street, Manchester), at 5.30 p.m.—Mr. David K. Baxandall: "The Function of a City Art Gallery".

Physical Society, Colour Group (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 5.30 p.m.—Mr. P. Warburton: "The Appearance of Colours in Pattern Design".

Thursday, November 1

Physical Society, Optical Group (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Scientific Papers.

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "The Physics of the Deformation of Metals". (Further Lectures on November 8, 15 and 22.)

Plastics Institute, North-Western Section (in the Great Hall, College of Technology, Manchester), at 6.30 p.m.—Prof. W. T. Astbury, F.R.S.: "Fibres and Chain-Molecules, Old and New". (Members of the Society of Dyers and Colourists are invited.)

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, November 2

Physical Society, Acoustics Group (in the small Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Discussion on "The Calibration of Transducers by the Reciprocity Method" (to be opened by Mr. B. G. Butcher).

Royal Institute of Philosophy (at University Hall, 14 Gordon Square, London, W.C.1), at 5.15 p.m.—Prof. C. D. Broad: "Philosophy".* (Further Lecture on November 9.)

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. D. Keilin, F.R.S.: "The Scientific Basis of Medicine, 8, Metal Catalysis and Intracellular Respiration".* (Further Lectures on November 5, 7, 14, 16, 20, 23, 27 and 29, December 4, 6 and 11.)

Institution of Works Managers (at the Waldorf Hotel, Aldwych, London, W.C.2), at 7 p.m.—Annual General Meeting.

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir John Cockcroft, F.R.S.: "Experiments with High Energy Nucleons and Quanta".

Friday, November 2—Saturday, November 3

Institute of Physics, X-Ray Analysis Group (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2).—Conference on "The Structures of Silicate Minerals".

Saturday, November 3

Association of Scientific Workers, Agricultural Committee (at the Society for Visiting Scientists, 5 Old Burlington Street, London, W.1), at 3 p.m.—Sir William Slater: "The Training and Supply of Biologists".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Research Lecturer in Applied Physiology and Applied Psychology in the Nuffield Department of Industrial Health—The Registrar, King's College, Newcastle-upon-Tyne (October 31).

Principal (a good honours degree and teaching experience essential) of the Southend Municipal College—The Acting Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea (November 1).

Chemist to carry out research on building materials at the laboratory in Wimbledon—The Director of Research, Railway Executive, Research Department, London Road, Derby (November 3).

Chemists at the Central Laboratory, Chiswick: (Ref. F/EV.186a) with experience or interest in general analytical work (excluding metallurgical analysis), (Ref. F/EV.186b) with experience or interest in technology of liquid fuels and lubricating oils—The Staff Officer, London Transport Executive, 55 Broadway, London, S.W.1, quoting the appropriate Ref. No. (November 3).

Demonstrator in Anatomy—The Registrar, King's College, Newcastle-upon-Tyne (November 3).

Generation Engineer (Construction), in the Eastern Division based at Divisional Headquarters in London—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting AE/212 (November 3).

Head of the Department of Electrical Engineering—The Registrar, Nottingham and District Technical College, Nottingham (November 3).

Junior Research Fellowships in Organic Chemistry—The Clerk to the Governors, Birkbeck College, Breams Buildings, London, W.C.1 (November 3).

Lecturer in Applied Mathematics—The Registrar, The University, Sheffield (November 3).

Lecturer in the Department of Electrical Engineering, Oldham Municipal Technical College—The Director of Education, Education Offices, Oldham (November 3).

Lecturer (with an engineering degree and suitable industrial experience) in the Department of Mechanical Engineering, capable of teaching Thermodynamics and Hydraulics to students studying for the Higher National Certificate and Final B.Sc. (Engineering)—The Principal, Acton Technical College, High Street, Acton, London, W.3 (November 3).

Lecturer in Geology—The Secretary, The University, Edinburgh (November 3).

Lecturer in Metallurgy at the Technical College of Monmouthshire—The Director of Education, County Hall, Newport, Mon. (November 3).

Lecturers (science graduates) in the Department of Education—The Secretary, International Wool Secretariat, Dorland House, 18–20 Regent Street, London, S.W.1, endorsed 'Confidential' (November 3).

Mining Engineer to take charge of the sinking, surface workings and development of a large colliery in the South-Western Division—The Divisional Establishment Officer, National Coal Board, South-Western Division, Cambrian Buildings, Mount Stuart Square, Cardiff (November 3).

Scientist (mycologist or botanist, with good honours degree or equivalent qualification, and experienced in microscopical examination of timbers) in connexion with the study of the degradation and methods of preservation of structural timbers, especially in cooling towers—The Secretary's Office (Establishments), Applications Section, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting AE/210 (November 3).

Lecturer in the Department of Veterinary Pathology—The Registrar, The University, Liverpool (November 5).

Plant Pathologist—The Registrar, Wye College, Wye, Ashford, Kent (November 5).

Principal Scientific Officer (Sociologist) in the User Requirements Division of the Building Research Station (at present stationed in South Kensington), to undertake research into the relationship between design of buildings of all types and the requirements of their occupants—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4084/51 (November 8).

Principal Scientific Officers in the Royal Naval Scientific Service: (*a*) at the Underwater Countermeasures and Weapons Establishment, Havant—Physicist with considerable experience in the development of electronic amplifiers and similar devices together with a wide experience of magnetic and electromagnetic apparatus and a thorough knowledge of eddy current phenomena in various conducting media, to lead a group of scientists engaged on the development of electric and electromagnetic devices; (*b*) at the Naval Construction Research Establishment, Rosyth—Physicist able to take charge of a division carrying out applied research in connexion with underwater explosives, gun and rocket blast and the effect of these on ships' structures; (*c*) at the Naval Construction Research Establishment, Rosyth—Engineer familiar with modern techniques of load strain measurements and with a sound knowledge of the design and theory of structures to undertake both small- and large-scale investigations and experiments involving the mechanical testing of structural assemblies in steel—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4080/51 (November 8).

Head of the Department of Science (Grade I), Reading Technical College—The Clerk to the Governors, Education Office, Blagrave Street, Reading, Berks (November 10).

Assistant Lecturer in Chemistry—The Registrar, Trinity College, Dublin (November 10).

Senior Lecturer and a Lecturer in the Postgraduate School of Mining—The Registrar, The University, Sheffield (November 10).

Senior Scientific Officer (with an honours degree in organic chemistry and some research experience, preferably of synthetic work) in the Biochemistry Department—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (November 12).

SCIENTIST I (with a good honours degree in chemistry, and have studied physics, engineering or fuel technology to degree standard, with considerable experience of research in heavy industry) to lead a team on pilot plant and associated research on carbonization, at the Central Research Laboratories, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/382 (November 14).

PROFESSOR OF PHILOSOPHY, and a LECTURER (Grade I) or SENIOR LECTURER IN MATHEMATICS, at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 15).

VETERINARY SURGEONS in the Field and Research branches of the Department of Veterinary Service, Southern Rhodesia—The Secretary, Southern Rhodesia Government, 429 Strand, London, W C.2 (November 15)

LECTURER IN PATHOLOGY and an ASSISTANT LECTURER IN PHYSIOLOGY, at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (November 17).

RESEARCH OFFICER (with University degree with honours in science or applied science, with physics or physical chemistry as major subject, or equivalent qualifications) IN THE DIVISION OF INDUSTRIAL CHEMISTRY, Fishermen's Bend, Melbourne, to undertake investigations on the reactions and equilibria in gasworks and/or metallurgical refractories—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No 3580 (November 17).

SENIOR STATISTICIAN at the Waite Agricultural Research Institute of the University of Adelaide, to assist in the design and interpretation of the experimental programme of the Institute, and to give introductory lectures in statistical methods in the Faculty of Agricultural Science—The Registrar, The University, Adelaide, Australia (November 30).

AERONAUTICAL AND MECHANICAL ENGINEERS (Ref. Est. 5c/48) at the Ministry of Supply in London and elsewhere, for the planning and progressing or control of production or inspection of air and marine craft and ancillaries and of related machine tools, gauges and armament, AUTOMOBILE AND MECHANICAL ENGINEERS (Ref. Est 5c/49) in London and elsewhere, for the planning and progressing or control or inspection of wheeled and tracked vehicles and components, MECHANICAL ENGINEERS (Ref. Est.5c/52) in London and elsewhere, for the design and development or standardization or planning and progressing or control of production or inspection of air and marine craft and installations, wheeled and tracked vehicles, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting O 536/51AA and the appropriate Ref No.

ASSISTANT BIOCHEMIST (B Sc. graduate in chemistry, hons. degree desirable) IN THE DEPARTMENT OF CLINICAL PATHOLOGY—The Secretary, United Manchester Hospitals, Royal Infirmary, Manchester 13.

ASSISTANT TEACHER (with graduate or equivalent qualification) OF CHEMISTRY AND PHYSICS and related subjects, in the Department of Science, Sheffield College of Commerce and Technology—The Director of Education, Education Office, Sheffield 1

CHEMISTS AND METALLURGISTS (Experimental Officer grade) at a Ministry of Supply research establishment in Berkshire · METALLURGIST (Ref. F.591/51A) with research experience in electrodeposition or in the investigation of the properties of metallic films and coatings, PHYSICAL CHEMIST or PHYSICIST (Ref. F.592/51A) with interest and preferably experience in work on ceramic materials—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

CHEMISTS (Senior Scientific Officer grade) (with a first- or second-class honours degree in chemistry or equivalent qualification, preferably with explosives or propellent experience) at Ministry of Supply London headquarters, for work concerned with guided weapons—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C 2, quoting F.723/51A.

ELECTRICAL ENGINEER (young university graduate, with research outlook) to join a team working on aircraft de-icing—The Employment Officer, National Research Council, Sussex Street, Ottawa, Ont., Canada.

ENGINEER at a Ministry of Supply establishment at Bickley, Kent, to be responsible for inspection of radio fuses and some development work—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.435/51A.

ENGINEER at a Ministry of Supply establishment in Hants, to run a 10,000 kW gas turbine power station and control a substation with 40 M V A , 33 kV grid intake and associated factory H.T. distribution—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D 465/51A.

EXPERIMENTAL OFFICERS in various Royal Ordnance Factories. (a) in Somerset (SENIOR EXPERIMENTAL OFFICER, EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS, Ref. F.724/51A) for work connected with the manufacture of explosives and acids and routine analysis of a more intricate nature, (b) in Ayrshire (ASSISTANT EXPERIMENTAL OFFICER, Ref. F 725/51A) for chemical analysis and experimental work, supervision of chemical testing of high explosives and related substances, (c) in Lancashire (EXPERIMENTAL OFFICER, Ref. F 726/51A) for laboratory work, (d) in the London area (ASSISTANT EXPERIMENTAL OFFICER, Ref F.727/51A) for chemical analysis of ferrous and non-ferrous metals and alloys and works control of ferrous and non-ferrous metallurgical processes—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting the appropriate Ref No.

EXPERIMENTAL OFFICERS or ASSISTANT EXPERIMENTAL OFFICERS, in the Ship Division of the National Physical Laboratory (Department of Scientific and Industrial Research), Teddington, for experimental work in the Ship Tanks—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.613/51A.

FISHERIES OFFICER (with a University degree in natural science, preferably zoology, and a real interest in natural history) in the Agricultural Department, Tanganyika, to investigate the potentialities of marine fishing along the coast of Tanganyika, and types and habits of fish in these waters, etc.—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27404/10/51.

GRADUATES IN PHYSICS OR MATHEMATICS (with first- or second-class honours) as METEOROLOGISTS in Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. No. 27118/4/51.

HEAD OF THE DEPARTMENT OF ENGINEERING AND MINING, Wakefield Technical College—The Director of Education, 27 King Street, Wakefield.

IRRIGATION ENGINEER IN THE DEPARTMENT OF WORKS AND HYDRAULICS, Trinidad—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W.1, quoting Ref. No 27322/228.

JUNIOR INVESTIGATOR (with B Sc., or equivalent, in metallurgy) for work on the welding of alloy steels—The Secretary, British Welding Association, 29 Park Crescent, London, W.1

LECTURER (Grade I) IN COTTON SPINNING—The Principal, Technical College, Paisley

MICROBIOLOGIST or BIOCHEMIST (postgraduate, preferably with several years research experience) to take part in research work, mainly on the mode of action of antibacterial agents—The Secretary, Wright-Fleming Institute, St. Mary's Hospital Medical School, Paddington, London, W.2.

OBSERVER (based in Trinidad) to take charge of seismological recording stations to be set up in Windward and Leeward Islands—The Under-Secretary of State, Research Department, Sanctuary Buildings, Great Smith Street, London, S W 1.

PHYSICAL CHEMIST (degree in chemistry essential, and some research experience in electrochemistry or corrosion an advantage) for research in the Electrochemistry Section of the Laboratories at Sketty Hall, Swansea—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1

PLANNING ENGINEER to undertake the detailed construction planning of sections of large factories and to follow up construction and installation progress—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

PRINCIPAL SCIENTIFIC OFFICER (with a good honours degree and some research experience) IN THE ENGINEERING DIVISION, to undertake investigation of problems associated with the mechanical harvesting, handling and processing of underwater seaweed—The Secretary, Institute of Seaweed Research, Inveresk, Midlothian.

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics· a wide general physics background is essential) at the Ministry of Supply London headquarters, for the co-ordination of physical research for guided weapons and evaluation of progress in new techniques for potential application to weapon projects—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting A.293/51A.

RESEARCH ASSISTANT for dissection studies on cereals—The Director of Research, Research Association of British Flour Millers, Cereals Research Station, Old London Road, St. Albans, Herts.

RESEARCH ASSISTANT to carry out experimental work on the effect of adsorption on the strength of solids, under the supervision of Dr S. J. Gregg—The Registrar, University College, Exeter.

RESEARCH ASSISTANT (Scientific Officer grade, with appropriate honours degree, or equivalent), to take part in studies mostly concerned with use of chicks in nutritional research—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks, quoting 51/5.

RESEARCH OFFICER (with degree in physics, or equivalent) for work on full- or semi-scale plant, eventually to supervise technical investigations on dust and pulverizing, and a RESEARCH OFFICER (with degree in physics, or equivalent, and experience in the finer techniques of physical measurement and of electronics desirable)—The Assistant Secretary, Ref. A.4, British Coal Utilisation Research Association, Randalls Road, Leatherhead, Surrey.

RESEARCH SUPERINTENDENT—The Secretary, Linoleum Research Council, Roxburghe House, 273 Regent Street, London, W.1.

SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER at the Royal Aircraft Establishment, Farnborough, for the design and development of small clockwork mechanisms and associated small electro-mechanical devices—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C 2, quoting C.405/51A.

SENIOR LECTURER IN AIRCRAFT DESIGN—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks, endorsed 'Senior Lecturer in Aircraft Design'.

SENIOR LECTURER IN PHYSIOLOGY in the Department of Pharmacy, Bradford Technical College—The Director of Education, Town Hall, Bradford.

SENIOR SCIENTIFIC OFFICER (Ref. E 503/51A) for engineering development and research covering a wide range of structures and mechanisms, a SENIOR EXPERIMENTAL OFFICER (Ref. E.504/51A) for work on the design of steel and alloy structures, including the mechanical testing of metals and some metallurgical examinations, and an EXPERIMENTAL OFFICER (Ref. E.505/51A) for engineering development and research, at a Ministry of Supply establishment in the South of England dealing with the design and development of military bridging and associated equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C 2, quoting the appropriate Ref No.

UNIVERSITY GRADUATES IN MATHEMATICS, PHYSICS, ENGINEERING, or GEOGRAPHY (including Geodesy) as SURVEYORS, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting Ref. No 27076/21/51.

UNIVERSITY GRADUATES IN PHYSICS, MATHEMATICS and ENGINEERING, for Permanent Commissions or for Short-Service Commissions in the Education Branch of the Royal Air Force—The Air Ministry (A.R.1), Kingsway, London, W.C.2.

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LEADERSHIP, EDUCATION AND TECHNOLOGY

IN his lecture on August 20 on higher technical and scientific man-power in Great Britain in the series of centenary lectures on the worker in industry, arranged by the Ministry of Labour and National Service, Lord Hankey remarked that in his wide experience in peace and war the qualities of 'leadership' and 'character' are harder to find and are even more important than technical capacity. Similarly, his earlier Romanes Lecture on "The Science and Art of Government" emphasized that since government is primarily concerned with human beings, human relations and human personality are dominating considerations. Whatever measures are taken to introduce the humanities to the curriculum for students of science and technology, whether at the undergraduate stage or before entry to the university, Lord Hankey's suggestion for broadening the outlook and experience of those destined for positions of high administrative responsibility in the world of science and technology presupposes that the universities and technological institutions in which they were originally trained do, in fact, receive in the first instance a fitting proportion of the ablest minds in each generation.

In an article on "Research in the Universities" published much about the same time (*Universities Quarterly*, August), Prof. A. R. Ubbelohde expressed a similar view: except where their professional qualifications make it absolutely essential, scientific workers in Britain do not occupy public positions in proportion to their native talents. It is true that some, quite apart from any administrative qualities they may or may not possess, are indisposed to deal with administrative duties: they would endorse whole-heartedly Sir Cyril Hinshelwood's forthright declaration that the man of science is in peril of being overwhelmed by the mass of administrative work. That danger exists, and some pruning of the proliferation of committees and other administrative work within and without the academic world may well be required. There will remain, however, an irreducible minimum of administrative responsibilities, and if these are not discharged by the scientific men themselves, they must be carried out by those who can at least understand the outlook and the method of science as well as its findings. Otherwise, as Prof. Ubbelohde rightly insists, in this technological civilization very wasteful and damaging situations can arise.

During the past twenty years, the annual Walker Trust Lectures at the University of St. Andrews on leadership have dealt with various aspects of leadership—its nature, the way it is exercised in different walks of life, and above all its functioning in a democratic society. In one of the earliest of these Lectures*, Dr. J. R. Mott referred to the way in which his travels throughout the world had made him conscious of a demand the world over that the universities should equip and send forth into all walks of life more young men and women for the leadership of the constructive forces of the world; and in the latest of these Lectures (see p. 769), dealing with the universities and cultural leadership, Sir Walter Moberly urges that to educate for leadership is still a primary duty of universities, and to get such an education should be one of the chief motives which bring students to them.

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* Walker Trust Lectures on Leadership, delivered before the University of St. Andrews, 1930–49. Pp. viii+286. (London: Oxford University Press, 1950.) 15s. net.

Under the influence of the German ideal of the university as an institution for extending the realm of knowledge, attention has been concentrated in the modern universities of Britain on research rather than on education, and sometimes, indeed, the latter has not been clearly differentiated from instruction. Outside the ancient universities, the idea that universities are institutions for educating men and women whose abilities suggest that they may hold high positions in life was not readily accepted. Even to-day, when both ancient and modern universities are fully alive to the importance of both research and educational duties and of the interrelation of these two functions, the idea of education for leadership is unpopular in the presence of the strong equalitarian views prevalent in our society. Confused thinking on this issue has discouraged discussion of the idea of education for leadership; attention has been forced upon the subject by outspoken comments at discussions on higher technological education and at conferences organized by the universities themselves and industrial bodies such as the Federation of British Industries.

In these circumstances, Dr. Eric James's "Education and Leadership" makes a timely appearance*. It is a brief but brilliant analysis of the problem of leadership in a democratic society, and the difficulties which attend attempts at selection. Dr. James discusses in some detail the education of the brilliant individual, and in particular he deals with the contribution of the boarding school. In these chapters he raises debatable issues, but they are large issues and deserve the attention not of the educationist alone but also of the industrialist, the man of science, the politician and all who are concerned with the continuance of democratic institutions in the Welfare State.

Dr. James's first chapter, in which he discusses at length various aspects of leadership in a democratic society—the reasons for the distrust of democratic communities of the idea of an élite and the whole conception of leadership, the factors which have made leadership so important in the complex and technical situations of modern civilization and the conditions which must be satisfied for leadership to be acceptable in our society—is a fine and challenging piece of work. It is worthy of setting beside any of the lectures included in the recently published volume of Walker Trust Lectures, not excepting even those by John Buchan, Lord Moynihan, Dr. Hensley Henson, Lord Montgomery, Earl Wavell, or Sir Richard Livingstone.

High intelligence, in Dr. James's view, is the key to the type of leadership which is competent to meet the highly complex and technical situations that confront us to-day. He does not minimize the value of character: on the contrary, he recognizes a purely materialistic view of life as more serious than the dangers of new weapons of destruction. The removal by science and technology of many material obstacles to right living imposes great demands upon spiritual leadership, because the attitude of most men to fundamental questions of moral and æsthetic judgment must depend to a very considerable degree upon the values accepted and proclaimed by a minority of exceptional individuals.

Dr. James is fully aware of the difficult problems which here confront us in our dependence for advance upon the individual, or the creative minority, at a time when authority is rejected and the validity of individual judgment accepted. He does not, however, discuss further their implications, and the way in which the dependence of effective leadership in a democratic community upon persuasion as well as upon a belief in equality of opportunity and wide diffusion has made training for leadership even more imperative. The responsible leadership which such factors, as well as the rapid development of science and technology, demand cannot be achieved, even with high intelligence, without training. These must be acquired, through common living as well as through education, mental habits of freedom, equitableness, calmness and moderation, and the power to understand men and to lead them.

In this chapter Dr. James directs attention to the social problems that are involved, once it is accepted that leadership in any field calls for recruitment of those with high intelligence. Some of our fundamental assumptions and practices will require discarding as the educational ladder is perfected and the risk of talent being unrecognized disappears. However repugnant a democratic community may feel towards the idea of special schools for leadershi it must recognize, as Dr. James insists, that if societ is forced to place authority and responsibility in th hands of certain individuals, education has no mor urgent task than to see that those individuals are so far as is possible, adequately prepared for thei tasks.

The concern over higher technological educatio indicates that this point is appreciated in one secto of the field; but there is plenty of evidence to sho that its general implications are by no means commonly accepted. There is a real danger that equalit in education may come to mean—and not merely i the comprehensive secondary school—the limitin of opportunity for those abler children on whom th nation greatly depends. It is easy to point to instance of defective leadership in almost every sector of th national life: able leadership in the industrial o technical field can scarcely exert its full influenc unless it is matched by equally wise leadership in th trade unions and in the political field. Not the leas important feature which makes Dr. James's book 'tract for the times' is its analysis of the difficultie which in our present system attend the education of the most gifted individuals, and of the implications for to-day of the Platonic conception of education.

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* Education and Leadership. By Eric James. Pp. 112. (London: George G. Harrap and Co., Ltd., 1951.) 6s. net.

Dr. James is not afraid of raising debatable issues, but he shows convincingly exactly why it is important that those who are destined to become leaders in government, in science and in industry must be exposed to the influence of first-rate minds and given the opportunity of growing in an environment designed to meet their needs. We can, he remarks, legitimately demand from our leaders that they shall have devoted at least some thought to certain perennial and fundamental problems of individual and social life. Ideally, they should have arrived at a coherent philosophy and a basis of principle in the light of which they will make their judgments. Some studies are manifestly more likely than others to force young men and women to grapple with these general questions of politics and æsthetics, of morals and metaphysics, and to encourage them to submit their standards of value to constant scrutiny. In the nature of things, the young scientific worker or technologist will learn more of what is in the minds of men, the thoughts that have always excited and the enduring traditions, from history, philosophy and literature, than he can from his own subject, no matter how fine that may be as an intellectual discipline.

It can scarcely be altogether fortuitous, Dr. James points out, that the course of study most conspicuously successful in producing the highest kind of leadership is also that in which the student is bound to concern himself with the greatest questions of human conduct and social obligation. He does not deny that there are many scientific men who are at least as wise in their political and moral judgments as their colleagues who have studied the humanities. Nevertheless, it is much easier for an individual in some schools and all universities to study chemistry, for example, and never have to ask himself what he means by justice, or what are the limits of his obligation to the State, than if he had studied history or philosophy. If such an individual comes to occupy a position of authority he is to this extent less well equipped, and for that reason it may be questioned whether the policy of higher technical education which was outlined in the White Paper of September 20 will do anything to supply higher technologists of the quality really required. Still more important is the question whether a policy of entrusting such education to the technical colleges will ensure that t is carried out by teachers of sufficiently high standing. On the importance of that factor, not only Dr. James but also the majority of participants n the debate on higher technological education have nsisted; and it is notable, as the recent discussion in Edinburgh showed, that even those who are most anxious to see the task entrusted to the technical colleges are doubtful whether, in fact, without a transformation of the whole structure of the technical colleges, rendering them independent of the local authorities, it will be possible to provide those conditions of academic freedom as well as of remuneration which will attract teaching staff of the requisite calibre.

Higher technological education is only one of the problems which this book illumines, and like the Walker Trust Lectures on leadership it contains much wisdom to guide us in shaping our future policy, both there and in the expansion of the universities. Vocational education is inescapable, and its extension at the universities may be unavoidable. We may be called upon to determine more carefully the nature of good vocational education, but that the universities will continue to be places of vocational education and that young men and women should seek earnestly to prepare themselves within a university for vocations to which they wish to devote their lives is, as Prof. G. B. Jeffrey emphasized in his Eddington Memorial Lecture, wholly admirable.

Nevertheless, neither the universities nor the colleges of technology can accede to all the demands now being made upon them for the provision of new forms of training without their structure and character being profoundly changed. The universities must discover some principle of decision, rooted in their own tradition, on which they can give an answer to these demands. Prof. Jeffrey suggested that this might be found by appealing to the characteristics which in his view should be the mark of a university: a temple of knowledge, one and indivisible; inspired by a social purpose, and a place in which young people are prepared in body, mind and spirit for service in other spheres. To justify vocational training in a university, a profession must therefore show that the field of knowledge requisite for its exercise is a part of the integrated body of knowledge for which the university is trustee; that this general body of knowledge would be manifestly incomplete if it failed to have regard to these professional studies; and that these professional studies could not be adequately pursued except in living contact with the greater body of knowledge. A profession that can meet this test is rightly described as a learned profession, and can further make some contribution towards giving a student a worthy conception of the great body of knowledge of which the university is itself a symbol.

That, after all, is one central point. We may presuppose that through a wise and rigorous selection the universities receive a fitting proportion of the ablest intellects of each generation. We must recognize, too, that the engineer or physicist trained in a university is marked out as a potential leader, at least in his chosen profession, and for that leadership he needs education. Part of that education must be social, and for that duty to be discharged the universities must find new forms, appropriate to our time, of giving social expression to the unity of knowledge in the fellowship of learned men. But the need still remains for liberalizing vocational education, and for ensuring that in every scientific and technological course appropriate place is found for the humane studies, with the insight they afford into the minds of men.

STRUCTURAL INORGANIC CHEMISTRY

Structural Inorganic Chemistry

By A. F. Wells. Second edition. Pp. xi+727. (Oxford: Clarendon Press; London: Oxford University Press, 1950.) 35s. net.

Anorganische Strukturchemie

By Prof. W. Hückel. Pp. xv+1033. (Stuttgart: Ferdinand Enke, 1948.) 71.20 DM. (£5 10s. 0d).

Structural Chemistry of Inorganic Compounds

By Prof. Walter Huckel. Translated by Dr. L. H. Long. Vol. 1. Pp. xiii+437. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1950.) 70s.

In his foreword to "Anorganische Strukturchemie" Prof. W. Huckel states that "this work attempts to furnish inorganic chemistry with that which organic chemistry has long possessed as a basis for its systematization, namely, a structural and constitutional theory in one embracing representation", while in "Structural Inorganic Chemistry" Dr. A. F. Wells has a less ambitious aim based on his conviction that the structural side of inorganic chemistry cannot be put on a sound basis until the results of X-ray crystallography and other techniques of investigating structure have been incorporated into chemistry as an integral part of that subject. With these aims the two books inevitably cover a good deal of common ground, but they differ considerably as a result of the authors' different outlooks, and this not only in content but also in the nature of the approach. In particular, whereas in general Dr. Wells is content to let the facts speak for themselves and is careful to make quite clear what are facts and what is speculation, Prof. Hückel frequently adopts the style of the advocate, and in some cases belabours those whose views do not please him with what seems to me to be unnecessary vehemence; moreover, in reading some of Prof. Huckel's discussions, a student would find it very difficult to decide whether the examples given were based on experimental facts or merely inferences from theory.

The second edition of Dr. Wells's book follows the same general plan as the first edition, but in addition to being expanded by about 25 per cent it has been considerably improved in various respects. Part 1, consisting of six chapters dealing with such matters as covalent bonds and their properties, the crystalline state, and the experimental methods of structural chemistry, has been somewhat reduced in length, chiefly by omitting a chapter on the structure of the atom and shortening one on states of aggregation. By passing quickly over subjects on which there is already an extensive and easily accessible literature, the author has thus been able to give a much more satisfactory treatment of a number of topics to which he scarcely did justice in the first edition; for example, a student reading the second edition can now obtain an understanding of some of the contributions of thermodynamics to structural chemistry, and when he encounters a new concept he will now find either an explanation in the text or a good reference to its more extended treatment elsewhere.

Part 2 contains a systematic description of the structures of most of the important classes of inorganic compounds. The additions to our knowledge in this field since the first edition appeared have been very great, and the formula index of the book now contains nearly twice as many entries as before. The text of Part 2 has, however, increased by less than 50 per cent, and Dr. Wells has very successfully incorporated the new matter without loss of clarity in the general treatment; a valuable feature of the book is that bond-lengths and other data are presented critically so that, for example, the student can see clearly to what extent a particular structural theory is supported by the experimental facts.

The production of the book is of the high standard expected of the Clarendon Press, and I have not noticed any misprints. The price has increased only in proportion to the size and still remains remarkably low, particularly having regard to the wealth of excellent illustrations which the book contains. The provision of numerous references to the original literature in the form of footnotes is a considerable improvement, and the two indexes (formula and subject) are adequate, although those who, like myself, take a minor delight in the eponymic nomenclature of inorganic chemistry will note with regret that old friends such as Fremy's and Reiset's salts are not allowed to appear in the subject index but must take their places with the common herd in the formula index.

In retrospect I feel that in devoting a large part of my review of the first edition of Dr. Wells's book (see *Nature*, 157, 386; 1946) to remarks on some of its shortcomings, I did less than justice to its positive merits; in acknowledging this, it is a pleasure to express the opinion that the second edition retains all the merits of the first and scarcely any features which could be described as defects even by the most exacting critic.

A great many people would wish Prof. Hückel success in his attempt to provide a single all-embracing structural and constitutional theory for inorganic chemistry, not least those numerous students who go up to universities with a disinclination for inorganic chemistry because "it isn't systematic like organic chemistry", and it is therefore of some interest to inquire whether Prof. Hückel's book is likely to appeal to such students. It should perhaps first be asked whether it is intended to do so, and the answer to this is not easy to find. The author explains that he wrote various parts of the book at different times as monographs, in part at least to familiarize himself with the topics concerned, and this, together with his obvious conviction of the value of his method of approach for the development of the subject, suggests that the book is addressed to mature workers in chemistry. In assembling the parts into the finished book, however, additional matter seems to have been added to make the work suitable as a text-book. The result is a most interesting and unconventional book, but not in my opinion a successful one; indeed, to embark on a task such as Prof. Huckel has attempted requires a belief in an inherent simplicity in Nature which, if it exists, is at present obscured by too many hard facts.

Prof. Hückel takes the view that while the Periodic System probably gives as good a basis as any for the classification of inorganic substances for elementary study, classification based on bond types is better for the advanced worker; and he believes further that the Werner co-ordination theory, which is valid for a high proportion of inorganic compounds, should be given much more prominence in this classification. This view underlies the plan of the book and the development of most of the themes in it, and, while the resulting treatment has much to commend it (and indeed in many respects is not so novel as Prof. Huckel seems to think), it is pursued too exclusively, so that the book as a whole is unbalanced. Thus while the author concedes that kinetic and thermodynamic studies have much to contribute to inorganic chemistry, he devotes relatively little space to such matters (entropy is not mentioned), and when he warms to his theme he is apt to deny virtue to anything but stereochemistry. Apart from the lack of balance in treating existing knowledge, such an attitude may have the unfortunate consequence of persuading its holder that the main object of future work is to provide confirmation for a theory.

The work is divided into three books: (1) stoichiometry and systematization, (2) atomic structure and chemical bonding, and (3) structure and constitution. Book 1 opens with a good historical survey and then discusses the basis of systematization—the co-ordination theory, valency and bond types, and Werner's work. It concludes with a chapter of about 140 pages on complex compounds in which the author illustrates the application of the co-ordination theory to double salts, salt hydrates, inner-complex compounds, multinuclear compounds, polyacids, etc. Book 2 deals with the Periodic System, atomic structure, methods of investigating bonding, and the nature of the chemical bond. This section is very unbalanced and very uneven in quality; for example, in the chapter on methods fifteen pages are devoted to molecular volumes and only two to electron diffraction, and the account of several of the methods is neither sufficiently clear to be suitable for a student nor critical enough to be useful to an advanced worker. Book 3 contains chapters on inorganic molecules and volatility, crystal chemistry, silicates and glasses, metals and alloys, and chemical reactions. These chapters contain a wealth of material and make very interesting reading, but they contain more errors than one would expect, some merely irritating and others definitely misleading.

A student taking up this work will find much that is interesting, although not much that he cannot find elsewhere; he will almost certainly not feel that the new approach offered him is appreciably more systematic than that which he has known previously—the canvas is too vast and the book attempts too much. Some advanced readers may find the treatment attractive, but it does not make the book particularly easy to use as a work of reference, even with the help of the excellent indexes; the style is frequently turgid and too often inclined to be polemical (of five references to a well-known pre-war text-book, four are made in order to criticize).

The first volume of Dr. L. H. Long's "Structural Chemistry of Inorganic Compounds" contains Books 1 and 2 of Prof. Huckel's work, and it is unfortunately necessary to say that it is a very bad translation. A rather large number of misprints mar an otherwise beautifully produced book; but, in addition, many errors have been introduced by the translator (as, for example, "more frequently" for "vielmehr", making nonsense of the sentence in which it appears). Dr. Long explains in his foreword that the unusual complexity of the original language has given him difficulties; but a translator can scarcely be regarded as discharging his task adequately when he gives an almost word-for-word translation of a difficult German sentence to produce such a monstrosity as "The force of affinity was supposed to exhibit itself between dissimilar particles as, for example, the reaction between acid and base teaches". Still less can he be excused for mis-translating the German into such sentences as "This fact is expressed here by the nature of the opposing forces in the representation selected for the maintenance of stable structural arrangements through the equilibrium of forces". These examples are among the worst I have encountered; but on nearly every page there is some clumsy construction, error of translation or misprint, with an occasional grammatical error or spelling mistake, so that the book makes very irritating reading.

E. G. Cox

MAN IN BRITAIN THROUGHOUT THE AGES

A Natural History of Man in Britain

Conceived as a Study of Changing Relations between Men and Environments. By H. J. Fleure. (New Naturalist Series.) Pp. xviii+350+64 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1951.) 21s. net.

It need scarcely be said that anything Prof. H. J. Fleure writes is worth reading. The book is clearly not intended for the specialist, as its range both in time and subject-matter is enormous; but it will doubtless appeal to schools and the general public interested in the study of man throughout the ages in the British environment.

More than half the available space is taken up with a history of England from the Stone Ages until modern times, and, as this half consists of only 181 pages, even Prof. Fleure's excellent summary can but be in the nature of a sketch. On the other hand, the next chapter, which deals with people and their racial make-up, is a first-class piece of original work, the result of long years of research undertaken with the help of the Leverhulme Trust. A chapter on clothes throughout the ages, and others on dwellings, villages and towns follow. The one on dwellings, especially, contains much general information on early types of habitation. There follows a chapter on the church and the castle, concerned not only with architecture but also with religious and lay organizations throughout the period. The book concludes with a brief account of the changes in means of transport and the alterations and rises in population in the countryside and towns. As has been said, whatever Prof. Fleure writes is interesting; but it is rather sad that only in Chapter 9 does opportunity occur for him to give an account of his original researches in a subject of which he is an acknowledged master.

There are numerous excellent photographic illustrations, thirty-eight of them in colour. Frankly, the latter are the less satisfactory. The colours are not too good, and the subjects in many cases irrelevant. It is difficult to see why a colour plate should have been devoted to a Highlander teaching a boy to play the pipes; nor can one be very excited about a small farm-house near Snowdon merely because it is entitled, "House of a man who married a fairy"—neither have much relevance to the text. The half-tone illustrations are better chosen and well reproduced and include some really lovely photographs. The line-drawings of such objects as stone implements are entirely inadequate. This is to be regretted, as one such sketch figures the chalk idol found many years ago by Mr. Leslie Armstrong at Grimes Graves and which I fancy has never up to now been illustrated. One gets the unfortunate impression that the illustrations have been included rather to catch the eye of a would-be purchaser than to illustrate the text. The book is very readable, and one can be full of admiration for Prof. Fleure, who certainly set himself a difficult task.

M. C. Burkitt

THEORIES OF THE VISUAL THRESHOLD

Les théories photochimiques classiques et quantiques de la vision et l'inhibition nerveuse en vision liminaire.

Par Ernest Baumgardt. Pp. 61. (Paris : Éditions de la *Revue d'Optique théorique et instrumentale*, 1950.) 300 francs.

Since the pioneer work of Hecht, Shlaer and Pirenne on the significant part played by the quantum nature of light in the perception of threshold light stimuli, a number of workers, including the author of this little book, have applied themselves enthusiastically to the full exploitation of the idea. M. Ernest Baumgardt belongs to those who believe that *two* or more light quanta must be absorbed within a certain small time-interval and within a certain retinal area if perception of the stimulus is to ensue. The experimental results which it is sought to explain on this hypothesis consist of measurements of the absolute threshold as a function of the exposure time and the area of the test stimulus. The second half of the book is, in fact, devoted to new measurements of this kind by the author, dealing in the main with the effect of stimulus area for both foveal and extra-foveal vision and employing blue- and deep-red stimuli to separate the rod and cone responses.

So far as the variation of threshold with exposure time is concerned, the central hypothesis is not entirely adequate, the deviations being in the direction one might expect if the minimum number of quantum absorptions for perception exceeded two. The author is able to show, however, that a possible explanation is obtained on the following lines. The neurone receiving the pulses from the receptors which have absorbed light quanta is assumed to be thrown into a state of facilitation following the absorption of the first light quant. This lasts for a critical time τ, and if within this time a second quant is absorbed the neurone discharges and perception ensues. But if the second absorption is delayed beyond the time τ, the neurone passes into a refractory state and, even though a third quant may be absorbed within a time τ after the second, there is no discharge and no perception. For extrafoveal vision the effect of area on the threshold is found to accord well with the central hypothesis, the critical area corresponding to about 45′ diameter for rod vision and 8′ diameter for cone vision. For foveal vision the situation is complicated by the inhomogeneity of the receptor network. It is remarkable—and this criticism applies not only to the present work—that investigators of areal summation rarely make any attempt to explore the uniformity of the threshold over the retinal region under study by point-to-point observations with a small test stimulus.

Some interesting comments are made by M. Baumgardt on the notion that as the level of adaptation of the retina is raised the progressive modification of visual functions such as differential sensitivity is associated with a steady reduction in the concentration of photosensitive substance (visual purple for rod vision) in the end-organs. He vehemently rejects this view, at least for levels up to about one lumen per square metre. While we may not be prepared to go all the way with him, his arguments seem worthy of careful consideration. Unfortunately the style in which the book is written is a little repelling : it tends to oscillate between the dogmatic and the obscure. This is a pity, as M. Baumgardt's views should prove stimulating to all workers in the subject.

W. S. Stiles

FUNCTION THEORY

Leçons sur la théorie des fonctions

Par Émile Borel. (Collection de monographies sur la théorie des fonctions.) Quatrième édition. Pp. xiii+296. (Paris : Libr. Gauthier-Villars, 1950.) 1200 francs.

Leçons sur les nombres transfinis

Par Prof. Waclaw Sierpiński. (Collection de monographies sur la théorie des fonctions.) Nouveau tirage. Pp. 240. (Paris : Libr. Gauthier-Villars, 1950.) n.p.

The great collection of monographs on the theory of functions, directed by Émile Borel, was inaugurated in 1898 by his own "Théorie des fonctions", of which the present work is a fourth edition. Although the substance of the book has not changed much, and is therefore more than fifty years old, it is still perhaps the most inspiring introduction for the young student to the concepts of aggregates, measure and modern theories of integration, concepts the development of which can be traced back to the stimulus of Cantor's work on "Mengenlehre". The new edition contains some additional matter in notes and in a new appendix, all tending to emphasize Borel's own philosophical position with respect to current controversies on the foundations of mathematics.

Borel has always held the view that definitions which are not constructive, numbers which cannot be calculated, descriptions which do not define, are insecure pillars in a mathematical edifice, though his scepticism is not carried to the extreme position occupied by Brouwer and his school. If, as he says, the result is that the pupils of his pupils regard him as a reactionary, it is because his own work and teaching have been extraordinarily stimulating.

The reprint of Prof. W. Sierpiński's tract on transfinite numbers in the Borel collection is welcome. The author was the acknowledged master of the virile Polish school of real-variable theory, and his account of the transfinite cardinals and ordinals is clear, precise and succinct. While Sierpiński's main logical position is almost flatly opposed to Borel's, the series of Borel monographs would have been sadly incomplete without some account of Cantor's fundamental work on transfinite numbers, and no one was better fitted than Sierpiński to write such an account. Since the techniques employed are in themselves not of great complication, the book can be read and enjoyed, without much previous acquaintance with the topic, by anyone with a taste for fantastic logical adventures of a severely abstract type.

ALCHEMY AND ALCHEMISTS*

By Prof. JOHN READ, F.R.S.

The Nature of Alchemy

MOST people who think about alchemy in the present age (and there are not many who do) regard it as the pretended art of transmuting base metals, such as lead, into the noble ones, silver and gold. Liebig held the view that alchemy was never anything else but chemistry; from this point of view one may look upon alchemy as the chemistry of the Middle Ages. In its widest and truest significance, however, alchemy was a grandiose philosophical system which aimed at penetrating the mysteries of creation and of life; it sought to place the microcosm of man in adjustment with the macrocosm of the universe; the transmutation of one form of inanimate matter into another was merely an incidental alchemical goal.

The more one studies alchemy, the more complex it appears. It was, indeed, a vast network of rudimentary chemistry, interwoven with philosophy, astrology, mysticism, theosophy, magic, and many other strands. The associations of alchemy with religion and with psychology still offer wide fields of study; in recent years C. G. Jung, in particular, has expressed the opinion that alchemy is no less important to psychology than to chemistry.

Alchemy endured for more than a millennium, that is to say, from at least early Christian times until the end of the seventeenth century. But alchemy has long been outmoded, and so there is little realization at the present day of the extent to which alchemical conceptions and imagery permeated the thought and art of the Middle Ages.

Sketched in broad outline, the fundamental ideas of alchemy were, first, that all forms of matter are one in origin; secondly, that these forms are produced by evolutionary processes; thirdly, that matter has a common soul which alone is permanent: the body, or outward form, being merely a mode of manifestation of the soul, is transitory and may be transmuted. Here are views which in their essentials bear a remarkable resemblance to those of modern physical science. Indeed, in this twentieth century "modern alchemy", as Lord Rutherford called it, has shown the possibility of bringing about many transmutations of elements.

Alchemical reasoning was mainly deductive and based on two *a priori* assumptions: first, the unity of matter; secondly, the existence of a potent transmuting agent, known as the Philosopher's Stone. From the postulate of the unity of matter it followed that this medicine of the metals became also the medicine of man. In this guise the Philosopher's Stone was known as the *Elixir Vitæ*, or Elixir of Life.

From this summary it should be clear that alchemy was much more than an experimental science. It was a philosophical system. In their true significance, the efforts made by the adepts to transmute metals were attempts to prove the truth of the broad philosophical system of alchemy by means of material experiments.

Origin of Alchemy

The universal patron adopted by the alchemists from early times and throughout the Middle Ages was Hermes Trismegistos, or Hermes the Thrice-Great. In this Greek equivalent of the Egyptian Thoth, the deified intellect, the alchemical fraternity recognized the father of the Hermetic Art and the author of the Emerald Table. The thirteen precepts of this Table formed the articles of association of the so-called "Sons of Hermes": it laid down in cryptic language the guiding principles of their creed.

Thoth, as depicted in ancient Egyptian temples, was sometimes shown with the *crux ansata* (the symbol of life) in the right hand, and a staff in the left. Linked with the staff were a serpent, a scorpion, a hawk's head, a circle, and an asp. Each of these representations had its particular symbolical meaning. Such symbolism was later characteristic of alchemy; and even modern chemistry, the daughter of alchemy, is to a large extent a science of symbols.

The origin of alchemy has often been ascribed to Egypt, otherwise known as Khem, the Biblical Land of Ham. Sometimes it has been supposed that alchemy arose farther to the east, in Chaldea, or even in China. The Chaldeans, as exponents of astrology, associated the sun, moon and planets with specific metals, and also with human organs and destinies. Still farther east, in ancient China, alchemical ideas may be traced as early as the fifth century B.C. in the comprehensive religious and philosophical system known as Taoism. Much later, in the first century A.D., Wei Po-Yang, "the father of Chinese alchemy", wrote the first treatise in Chinese dealing with alchemy, in which he described the preparation of the "pill of immortality", otherwise the *Elixir Vitæ*.

The ultimate origin of alchemy is thus a vexed question. There is little doubt, however, that alchemical knowledge and ideas were gathered from the ancient civilizations of Egypt, Babylonia, India, and China, and brought to a focus in Greece. From Greece this corpus of alchemy was transmitted to Islam, mainly through Syria and Persia. Eventually the accumulated knowledge of the Muslim alchemists, drawn from these various sources and augmented in its passage through Islam, was brought into Western Europe, chiefly through Spain.

Alchemical Theory

Alchemy, like modern science, had its guiding theoretical principles. The fundamental theory of alchemy was that of the Four Qualities and Four Elements, often represented in a diagram formed of an outer and an inner square (see p. 760).

The corners of the outer square carry the names of the four elements: fire, earth, water and air. The corners of the inner square, situated at the mid-points of the sides of the outer square, are allocated to the four fundamental qualities: the hot, the dry, the cold, and the wet. The diagram shows that fire is hot and dry; earth, dry and cold; water, cold and wet; air, wet and hot. These four elements may

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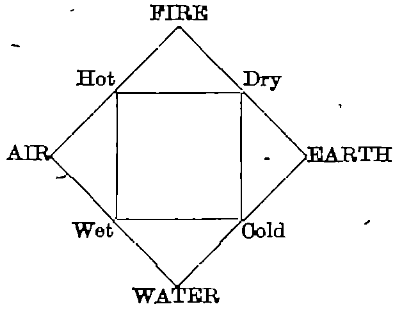
* Substance of a discourse delivered on August 10 to the British Association for the Advancement of Science meeting at Edinburgh.



The four qualities and the four elements

also be looked upon as representing energy (fire) and the solid, liquid and gaseous states of aggregation of matter (earth, water, air).

This theory, usually ascribed to Aristotle, may be traced in Egypt and India as far back as 1500 B.C. It is the oldest theory of physical science, and it was very widely held, in one form or another, over a long period. It bears out the statement that "there is a great oneness in the human mind in the matter of broad principle in crude cosmical ideas".

According to the theory, water—one of the four elements of the material world—is an embodiment of cold and wet qualities. When the cold quality is replaced by the hot one, the element water is changed into the element air, embodying the wet and hot qualities. The idea of transmutation is thus implicit in the theory. Nowadays, of course, this process is viewed simply as a change of liquid water through the agency of heat into the gaseous form of the same substance, and there is no question of transmutation.

In essence, this ancient theory is based upon a primitive mode of thinking sometimes known as the Doctrine of the Two Contraries. This is dependent upon the recognition of a distinction between opposites, such as cold and hot, dry and wet. An apposition of outstanding importance in alchemy was that of the two opposed, or contrary, elements—fire and water. These two opposites came to light in a new guise in the sulphur–mercury theory of the metals, which seems to have been propounded by the Muslim alchemists in the ninth century A.D.

The principle here known as "sulphur" was essentially an embodiment of combustibility, and "mercury" denoted the mineral spirit of metals and also liquidity or fusibility. It was held that when these two natural principles, engendered in the bowels of the earth, came together in a state of purity the result was gold; if they were slightly impure they gave silver; if they were markedly impure they furnished only the baser metals. Beyond this, it was supposed that in states of superfine purity they could give rise to something so much purer than ordinary gold that a small amount of this product (the Philosopher's Stone) would be able to transmute a very large quantity of a base metal into gold of ordinary purity.

The chief experimental task of the alchemical adept was to imitate, and even surpass, Nature in accomplishing such changes.

In the cryptic expression and symbolic representation of alchemy, sophic sulphur and sophic mercury (as the two principles were often called) assumed many forms. For example, they were known as Osiris and Isis, sun and moon, Sol and Luna, brother and sister, masculine and feminine, active and passive, giver and receiver, fixed and volatile, wingless lion and winged lioness, and so forth.

It was supposed by the esoteric alchemists, or adepts, that the pure "seeds" of gold and silver (or quicksilver) could be extracted from these metals in the form of sophic sulphur and sophic mercury. These "seeds" could then be combined, often in a liquid menstruum, to yield the Philosopher's Stone. The succession of processes here concerned was known as the Great Work, leading to the preparation of the Philosopher's Stone, or Grand Magisterium. The Stone, resulting from the union of masculine and feminine principles, was often symbolized as an infant.

According to these views, in order to prepare the Philosopher's Stone an initial quantity of gold was necessary. The Stone (often described as a red powder) could then be used to convert base metals into more gold, so that the original gold was "multiplied", as the alchemists used to say. One of their favourite metals for "multiplication" was mercury, and this choice has been curiously vindicated by modern observations that gold can indeed be produced by transmutation from mercury, although only in excessively minute amounts and at great cost.

In modern parlance it would be correct to call the Philosopher's Stone a catalyst. Here again the alchemists are vindicated; for what more potent catalyst could be imagined than the neutrons which start and maintain the explosive disintegration of uranium-235 into other elements? "Every thing possible to be believ'd," wrote the English poet and mystic, William Blake, "is an image of truth. . . . What is now proved was once only imagin'd."

Alchemical literature abounds in cryptic descriptions and pictorial representations of the blending of sophic sulphur and sophic mercury in the synthesis of the Stone. For example, a wingless lion and winged lioness are shown in playful conflict, with a watery background (representing the liquid menstruum, or Hermetic Stream); an alchemist is depicted in the act of balancing equal weights of fire and water; the Hermetic Androgyne—half man, half woman—stands above a dragon, signifying the menstruum.

Incidents from the Bible and from classical mythology were also freely adapted to alchemical ends. Thus, in an illustrated manuscript in the St. Andrews collection, the birth of Eve from Adam's rib, with the Serpent as onlooker, is depicted to symbolise the same fundamental idea as the Hermetic Androgyne. As an example of another kind, taken from a different source, Apollo and Artemis, with the terrorizing serpent of Juno, are selected from classical mythology in order to furnish a further pictorial illustration of the same conception. Some alchemists went so far as to insist that the whole corpus of classical mythology was nothing more than a complex medium designed expressly to record alchemical truths in concealed allegories and "abstract riddles of our Stone", as Ben Jonson phrased it in his play, "The Alchemist" (1612).

Alchemical Symbolism

Pictorial symbolism is an ingredient of the first importance in alchemy. Many of the designs were characterized by colour schemes suggestive of heraldry. Among medieval examples, the so-called "figures of Abraham the Jew", dating from the early years of the fifteenth century, were held in great reverence by alchemists of succeeding ages. These figures were ascribed to Nicolas Flamel, a Parisian alchemist of great repute; they took the form of a series of elaborate frescoes, decorating the arcade of the churchyard of the Innocents in Paris. The designs, executed in colour, were capable of a dual alchemical and religious interpretation. The Biblical story of the massacre of the innocents by King Herod formed a central feature of the series. Herod was pictured as "a King with a great Fauchion". Mothers were shown in the act of weeping "at the feet of the unpittiful Souldiers; the bloud of which Infants was put in a great vessel, wherein the Sun and Moon came to bathe themselves". In other words, infants' blood was merely a cryptic representation of the liquid menstruum which was supposed to aid in the conjunction of sophic sulphur and sophic mercury.

As another example, an illustration entitled the "First Key of Basil Valentine" (c. 1600) shows a king and queen as the central feature. Below the king a wolf leaps over a heated crucible, and near the queen an old man with a wooden leg manipulates a scythe around a cupel. An accompanying "explanation" directs the operator: "Take a fierce grey Wolf. Cast to him the body of the King, and when he has devoured it, burn him entirely to ashes in a great fire. By this process the King will be liberated; and when it has been performed thrice the Lion has overcome the Wolf, who will find nothing more to devour in him. Thus our body has been made fit for the first stage of our Work."

The alchemical wolf, *lupus metallorum*, was "antimony" (stibnite, or native antimony sulphide), used in the heated crucible as an agent for purifying gold, since it "devoured" traces of metallic impurities. The wooden-legged ancient signified Saturn, that is to say, either the slow-moving planet of that name or the dull, heavy metal, lead. The scythe, like other sharp implements, symbolized fire. This part of the design therefore represents the cupellation of argentiferous lead, furnishing pure silver. In brief, the First Key of Basilius shows how to begin the preparation of sophic sulphur and sophic mercury, in readiness for the next operation of the Great Work.

Probably the finest artistic examples of the avowed symbolism of alchemy are the beautiful copper-engravings of Johannes Theodorus de Bry and his associates; these occur notably in various alchemical works of Count Michael Maier, such as "Atalanta Fugiens" and "Symbola Aureæ Mensæ", published at Oppenheim and Frankfurt during 1617–18. These plates are boldly engraved: textures are conveyed by different systems of shading; human figures are drawn forcefully and correctly; the compositions have an effect of brilliance and solidity, enhanced by strong modelling and shadows.

Apart from such *ad hoc* pictorial representations of alchemical tenets, a strong alchemical influence pervaded much of the art of the Middle Ages. It found expression repeatedly in the painting, decorative architecture, sculpture and coloured glass of this era. Alchemical ideas and symbolism may be traced in detail, for example, in the work of such artists as Durer, Cranach, Giorgione and Campagnola. It may even be claimed that every detail in Durer's masterpiece of engraving, "Melencolia" (1514), is capable of an alchemical interpretation: the doctrine of melancholy is inseparably bound up with the Saturn mysticism which permeates alchemy[1].

Decline of Alchemy

The outstanding practical aim of alchemy until the sixteenth century was the transmutation of base metals into gold, whether from purely philosophical or mercenary motives. Early in the sixteenth century Paracelsus endeavoured to give a new direction to operative alchemy by insisting that its main goal should be the healing of disease rather than the making of gold. He envisaged alchemy as a handmaid of medicine, to be applied in the preparation of chemical remedies of mineral origin. He sought to liberate medicine from the obsession of the ancient Galenic order, and in this sense he takes rank beside such contemporaries as Luther, Copernicus and Columbus as an emancipator of mankind from the trammels of authority. The ensuing period of iatro-chemistry or medico-chemistry, lasting until the eighteenth century, witnessed a slow decline of the old alchemy.

Paracelsus was essentially a reformer and propagandist of the Renaissance. His chief contribution to alchemy was his modification of the sulphur–mercury theory by the introduction of a third principle which he named salt. In his system of the *tria prima*, or three hypostatical principles, sulphur, mercury and salt stood materially for inflammability, metallicity and uninflammability (fixidity) and mystically for the soul, spirit and body of man. The second half of the seventeenth century found both the old alchemy and iatro-chemistry on the wane. Despite their excesses, both the alchemists and the iatro-chemists had done a great deal to accumulate chemical knowledge and to prepare the way for the incipient science of chemistry which was to arise in the second half of the eighteenth century.

It is sometimes held that the publication of "The Sceptical Chymist" by Robert Boyle in 1661 heralded the end of alchemy. It is true that Boyle dismissed to his own satisfaction in this famous book the systems of the four elements and the *tria prima* and put forward the modern idea of an element; but the emergence of modern chemistry had to wait for more than another century. "During this Indian summer of alchemy the stage was held by the Theory of Phlogiston, while the four elements and the three hypostatical principles hovered behind the scenes like ghosts reluctant to be laid. Phlogiston, an imagined inflammable principle present in all combustible bodies, was essentially a revival of sophic sulphur, claiming noble descent from the Sun god of the primitive religions. Phlogiston melted finally 'into air, into thin air' with the discovery, in the second half of the eighteenth century, of the chemical composition of the ancient 'elements' air and water and of the true nature of combustion. These discoveries ushered in the era of modern chemistry."[2]

Types of Alchemists

The term 'alchemist' has been used throughout the ages to denote men, of many kinds, with a real or professed knowledge of alchemy. These ranged from impostors and charlatans having no claim to the title, through puffers (*souffleurs*), goldmakers, skilled practicants, and scholastic philosophers, to adepts and religious mystics.

Simon Forman (d. 1611), the original of Ben Jonson's alchemist, Subtle, was a typical charlatan, gaining a livelihood by imposture and having a mere smattering of alchemical knowledge. The puffers—so called from their unintelligent addiction to the bellows—were uninformed "labourers in the fire", exoteric exponents of alchemy who were animated solely by avarice: their number was legion. Some of the goldmakers were indistinguishable from the puffers; but others, possessing a definite grasp of the principles of alchemy, occupied a higher position in the alchemical hierarchy. Goldmakers were often attached to courts and subsidized by princely patrons. One of the most picturesque of this kind was Damian, alchemist to James IV of Scotland, and Abbot of Tungland in Galloway. Damian, who is said to have been a Lombard, varied his alchemical experiments in Stirling Castle by undertaking one of the earliest experiments in artificial flight, with the aid of a pair of wings made of feathers. He took off in September 1507 from the lofty battlements of Stirling Castle; but, according to a contemporary account, "shortlie he fell to the ground and brak [broke] his thee bane [thigh bone]". In the true alchemical manner he attributed this result to the substitution, in his wings, of eagle's feathers by hen's feathers, "which yearned and coveted the mydding [dunghill] and not the skyis [skies]".

Scotland figures a good deal in the history of alchemy. Also in Scotland there are some outstanding collections of alchemical literature, particularly the Ferguson and James Young Collections in Glasgow, and others in St. Andrews, Edinburgh and Aberdeen. A century after Damian's exploit, Scotland produced a mysterious itinerant goldmaker in the person of Alexander Seton, otherwise known as "The Cosmopolite". He has also been called "the chief martyr of alchemy"; for his dramatic career is said to have ended in tragedy at Cracow in 1604, as a result of his experiences in the torture-chamber of the Elector of Saxony at Dresden[3].

The numerous paintings of alchemists and alchemical interiors, notably by Brueghel, Stradanus, Teniers, Steen, Wijck and other artists of the Low Countries, are mainly concerned with alchemists of the kinds that have been mentioned[4]. Such genre representations of these painters and of artists in Italy, Spain, Germany and other countries, are of great interest and value to historical science.

Alchemists of a severely practical type, who were interested chiefly in chemical phenomena and in the discovery and application of new substances and processes, are typified by such men as Brunschwick, Agricola, Libavius and Glauber; the scholastic philosophers by Roger Bacon and Albertus Magnus; and the religious mystics, who viewed alchemy as "the Divine Art", by Ripley and Khunrath.

Alchemical Music

Among the mystical alchemists, Count Michael Maier calls for special mention. He was physician, private secretary, and alchemist to the Emperor Rudolph II (the so-called "German Hermes") at Prague, early in the seventeenth century. A man of many accomplishments, Maier was also a philosopher, mystic, classical scholar and musician. He was a voluminous writer of great credulity, and he carried to extremes the alchemical interpretation of Egyptian and classical mythology. This subject forms the chief theme of his "Atalanta Fugiens" (1618), a quaint and fascinating work handsomely embellished with fifty copper-engravings by de Bry and his school. Each engraving is provided with a cryptic title and a Latin epigram written in elegiac couplets. Each epigram is set to music, in the form of so-called "fugues", which are in reality canons in two parts against a repeated *canto fermo*. In allusion to the classical legend, these three parts are termed, "Atalanta, or the fleeing voice", "Hippomenes, or the pursuing voice", and "The apple in the path, or the delaying voice".

Presumably, in view of the alchemical belief in the beneficent influence of music, the final processes of the Great Work, carried out in the sealed Vessel of Hermes and directed by prayer as well as by chemical and astrological influences, were sometimes undertaken to the accompaniment of musical chants or incantations. To the religious mystics among the alchemists these processes would partake of the nature of a religious ritual, and it would be natural for them to introduce music from one of these closely related activities to the other. It must be emphasized also that alchemical theories and ideas came largely from ancient Greece, and that the alchemists followed Pythagoras and Plato in ascribing a particular importance to number and harmony in the interpretation of Nature and the universe.

In 1935, some of these alchemical canons[5] were sung in public for the first time by members of the St. Andrews University choir, at the Royal Institution in London. Fuga XVIII may be mentioned as typical. The Latin epigram begins:

> *Si quod agens fuerit natura, mittit in orbem*
> *Vires atque suas multiplicare cupit . . .*

"Whatever active principle there is in nature, it sends out its force in all directions and loves to multiply the same." It is of interest that some manuscript notes of "Atalanta Fugiens" made by Sir Isaac Newton, and now in the St. Andrews collection, bear a special mark of emphasis beside this particular epigram.

REFERENCES

The numbered references given above may be found in various works by the writer of the present script, as follows:

[1] For a detailed alchemical interpretation of Dürer's "Melencolia" see "The Alchemist in Life, Literature and Art", 57–62 (London and Edinburgh, 1947).

[2] *Op. cit.*, pp. 8–9.

[3] A detailed account of Seton, and of his rescuer and successor, Sendivogius, is given in "Humour and Humanism in Chemistry", 37–65 (London, 1947). The same work also deals fully with James IV and Damian (pp. 16–36).

[4] Alchemical paintings by artists of the Low Countries and others are reproduced in the work mentioned under (1) above.

[5] Some of Maier's alchemical music is reproduced in "Prelude to Chemistry" (London, 1936; 2nd edit., 1939; and New York, 1937).

A METHOD OF MAKING VISIBLE THE DISTRIBUTION OF ACTIVITY IN A SOURCE OF IONIZING RADIATION

By PROF. W. V. MAYNEORD, R. C. TURNER, S. P. NEWBERY and H. J. HODT

Physics Department, Royal Cancer Hospital, London

FROM the medical point of view, probably the most important physical question in relation to the use of radioactive isotopes is finding their distribution in the body. If we are interested in diagnostic applications, then clearly this is the main problem which faces us. What we want to know is where the material goes, how quickly it gets there, and generally what is its natural history. If we are interested in the therapeutic use of radioactive isotopes, then the problem has a double significance inasmuch as the spatial distribution of the material is also the basis of the radiation dosimetry. The only method of defining uniquely the distribution of the material is to use measuring or detecting systems with strongly marked directional properties. The usual procedure of taking an insufficiently protected Geiger counter with a wide aperture is quite inadequate for deducing the precise distribution of radioactive material.

In a recent publication, Mayneord and Belcher[1] have described how a scintillation counter may be used in the examination of various simple sources, and have verified the theory that such a directional system measures approximately the 'thickness' of radioactive material. In many instances we do not require, however, an accurate determination of the distribution of radioactive material, but we do require to know its approximate position and extent. It would, in these instances, be a great convenience if, instead of having to make multiple observations with a Geiger counter, draw 'equinumeral surfaces' and so deduce radiation distribution, we could obtain a visual image of the distribution of material. With such ideas in mind about six months ago, we started to construct apparatus in an attempt to form such visual images.

Apparatus

Imagine a detector in a well-canalized system receiving radiation from only a small angular region, and moving in front of a source so as to scan it. Then the instantaneous counting-rate at any moment will be proportional *inter alia* to the radioactive material 'seen' at that moment. If now we produce on a screen a brightness proportional to that instantaneous counting-rate, and if also we write a matrix synchronized with the scanning, then we build up a picture of the distribution of radioactivity.

The problem of observing the radiation through a small aperture presents difficulties, particularly with an extended source. If discrimination with respect to position is to be good, that is, if resolution of the picture is to be adequate, then we can only allow a very fine aperture; such an aperture, however, 'sees' only a small amount of radioactivity and the sensitivity of the system may therefore be very low.

The apparatus we have developed consists of three parts: (*a*) a mechanical scanning unit, (*b*) a pulse-shaping and integrating network, and (*c*) a display system.

The mechanical scanning unit (Fig. 1) comprises a head housing the detecting system, and capable of being moved so as to scan a preselected field uniformly and repetitively. This head consists of a block of lead of roughly elliptical cross-section, having in it three channels carrying respectively two Geiger counters and an optical system for producing a visible spot of light corresponding to the area 'seen' by one of the counters. The main protection of the counters is afforded by cylindrical blocks of tungsten alloy of high atomic number and having a density of approximately 16. These blocks have a length of approximately 6 cm., each block being about 3 cm. in diameter. Apertures of either 5 mm. or 3 mm. diameter have been drilled through this protective material, and the radiation detected reaches the counter through one of these apertures. The head design is, in practice, a compromise between the demands of protection of the counter, on one hand, and, on the other, adequate sensitivity and mobility, the latter being of particular importance inasmuch as this heavy head has to be moved backwards and forwards accurately and consistently. The motion of the head is effected in our apparatus by rotating cams driven by a motor via a chain of gears. Two cams are so arranged that one produces a rotation about a vertical and the other about a horizontal axis. By careful design it was found possible to obtain relatively smooth motion with approximately uniform velocity. In this way (Fig. 2) the Geiger counter head, pivoted on an equatorial mounting, is made to move backwards and forwards, left to right and right to left, one complete cycle taking two seconds. We find experimentally that the beam retraces its path accurately and scans an approximately rectangular area the extent of which may be recorded by exposing photographic material in the path of the light beam.

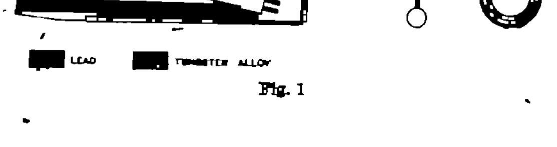


Fig. 1

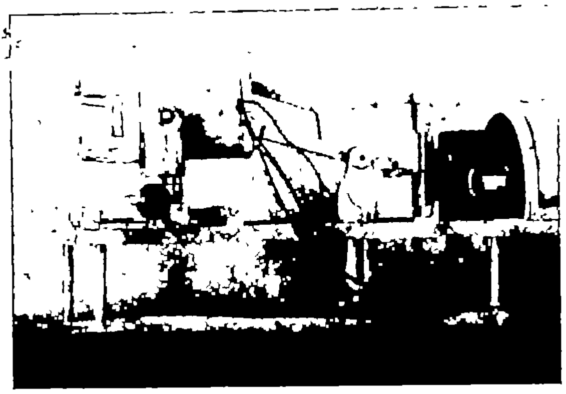


Fig. 2

A matrix of one hundred spots is obtained by two mechanical rotary switches driven from the motor. These switches select, in sequence, a series of potentials which are applied to the deflecting plates of the cathode-ray tubes in synchronism with the motion of the head. In this way we have applied ten potentials, thus deflecting the spot horizontally by ten consecutive steps. At the end of a line of ten spots the second switch comes into operation and deflects the spot one step vertically over a series of ten vertical steps. In this way we obtain a rectangular matrix of one hundred spots written downwards in a time of ten seconds. In early experiments we were impressed with the magnitude of the background even with a high degree of protection, and decided, therefore, to attempt to subtract this background automatically; hence the two counters in the head, one for main counting, the other to record the background and attempt to subtract it. In practice, we have found that in many circumstances background subtraction is not satisfactory, due to the asymmetry of the source with respect to the two counters; but if the source is at a fair distance from the head, the method appears to be fundamentally sound.

The pulses from the counter are first fed into a univibrator, the outgoing pulses of which, of constant size, then pass through a transitron pulse-shaping circuit. This network is necessary for the control of contrast in the final picture, since we obtain from the transitron circuit pulses of adjustable width, enabling us to obtain over a very wide range any required

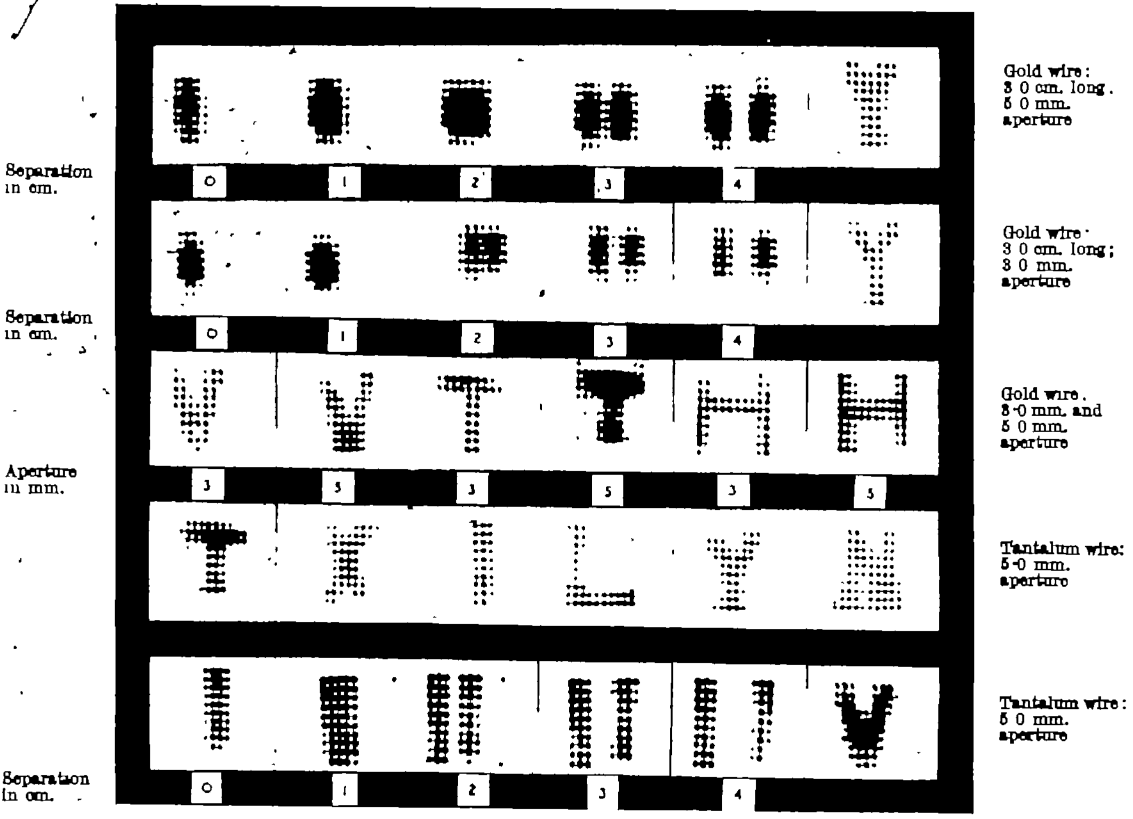


Fig. 3. Images of radioactive sources

D.C. voltage from a given number of pulses. The pulses from the transitron are then fed via a cathode-follower to the integrating circuit.

There are many possible methods of integrating these pulses and obtaining a proportional direct current. We have tried two of them, one using a simple time constant arranged to be slightly less than the duration of a single spot (that is, one tenth of a second), and a second method consisting of feeding groups of pulses corresponding to consecutive spots into consecutive condensers, and selecting resulting D.C. potentials in sequence with a mechanical switch. Experiments have been carried out with both systems, but at the present stage of development of the apparatus the former is simpler, though the latter should eventually give more accurate quantitative results. With either system we produce a D.C. voltage which is approximately proportional to the number of pulses which have occurred in the counting channel during the previous tenth of a second. By means of a balanced modulator driven by a local low-frequency oscillator, an output A.C. voltage of this same frequency is obtained the amplitude of which is fairly accurately proportional to the D.C. voltage. We may now feed this A.C. voltage into an amplifier of adjustable gain and take this amplified voltage through condensers to the control grids of the display oscilloscopes, one having a long-persistent screen for visual study and the second a blue screen for photography.

Some Theoretical Considerations

Some theoretical consideration has been given to the problems of the geometry of the systems of detection. Briefly, we may say that if we have a small point source and a detector of linear dimensions smaller than those of the aperture through which the radiation is coming, then we observe a fall in counting-rate in accordance with the inverse square law. If the source is still small and the detector fills the aperture, we still have inverse square law, but now to the aperture and not the detector. If, as is usually the case, the emitter is large enough to fill the aperture, then the conditions become more complex. If the source is, for example, a plane sheet of uniformly radioactive material and of infinite area, then as the source moves away the area 'seen' by the detector increases as the square of the distance, the radiation from each element decreases in the same ratio and the number of counts remains constant. If the source is linear the total amount of material 'seen' by the detector at any one time is approximately proportional to its distance from the aperture. We have verified experimentally that such relationships exist in practice. Simple calculations lead us to expect that in order to form a satisfactory visual image the detector of our system must 'see' at any moment approximately one half-millicurie of material, a result confirmed in practice.

We have not yet examined in detail the limit of photographic detection, but it is clearly very much lower. For example, a photographic exposure can easily extend over ten or a hundred sweeps; these hundred sweeps take place in about a quarter of an hour, which in many instances would be a reasonable time of exposure. It follows, therefore, that we may hope to photograph patterns corresponding to small fractions of a millicurie.

Experimental Results

Experiments have been carried out with active cobalt, tantalum, and gold wires arranged to form letters of the alphabet, in order to form an estimate of the capabilities of the instrument. Difficulties increase rapidly with increasing penetration of gamma radiation, but even with cobalt-60 we have found it possible to make reasonable visual images of simple sources. Fig. 3 shows the results of experiments with active gold and tantalum wires and illustrates the increased resolution obtained with a 3-mm. as opposed to a 5-mm. diameter aperture. The figure also indicates the degree of resolution obtainable as two parallel line sources are gradually moved relative to each other. It will be noted that the matrix of one hundred spots is adequate for these early experiments, resolution being determined largely by aperture diameter. The photographs represent reasonably the visual image produced on the long-persistent screen oscillograph.

In spite of obvious limitations we have produced with this apparatus recognizable visual and photographic images of radioactive sources, and are continuing with experiments to design and construct apparatus of greater sensitivity and resolution. We are also carrying out experiments with X-ray sources, as it seems that in the X-ray field the apparatus may have considerable application as an image amplifier. Other possibilities include studies of movement of radioactive materials by serial exposure, the formation of stereoscopic images and the direct presentation of the variation of counting-rate over an extended source. [Aug. 2.

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[1] Mayneord, W. V., and Belcher, E. H., Supp No. 2, *Brit J Rad.*, 259 (1950).

THE AMERICAN CHEMICAL SOCIETY AND INTERNATIONAL CHEMISTRY

THOSE who associate the United States with operations carried out with clockwork precision on a gigantic scale would not have been disappointed with the activities of the chemists who attended the Diamond Jubilee of the American Chemical Society in New York during September 3–7 and the Twelfth International Union and International Congress of Pure and Applied Chemistry during September 8–12; the Union completing its activities in Washington, D.C., on September 14–15.

The total enrolment for these events was more than 18,300. Detailed accounts of the proceedings of all three organizations, the technical sessions, lectures, speeches and dinners have already been published in the appropriate journals; indeed, three issues of the American periodical *Chemical and Engineering News* are almost entirely devoted to this subject. There were many interesting features well worthy of comment about these meetings of the largest collection of chemists ever assembled in the world.

While the annual meeting of the American Chemical Society was naturally a domestic affair, yet on this, its seventy-fifth meeting, that Society extended invitations to colleagues overseas and to other kindred domestic societies. There were present forty-one delegates representing societies from thirty-eight nations and seventy-seven delegates from domestic societies. The presentation of scrolls of congratulation took place in the Armoury in New York, where the delegates in their academic costumes were introduced in turn by Prof. Herman Mark to President N. H. Furman, who accepted the scrolls which were then placed by Secretary Alden Emery in a box on the stage. The ceremony on this gigantic scale was extremely impressive. It may not be generally known, but no less than 265 of the younger chemists from forty-five different countries were invited to the United States through the instrumentality of the Economic Cooperation Administration and the Ford Foundation. These had the opportunity of attending the meetings, visiting industrial plants in various sections of the country and of staying a few days in the homes of American scientific men to enable them to get a better appreciation of the American way of life. They were officially welcomed to the meeting by President Furman, Donald Shank of the Institute of International Education, Alden Boyd of the Economic Cooperation Administration and the Ford Foundation, and Alden Emery, the general secretary of the American Chemical Society. This was in addition to the hospitality lavished on the delegates themselves.

The importance of chemistry in the national life is a topic which usually receives attention only from the chemists themselves, but it may be of some importance to other countries to note that at these meetings there was read a letter of welcome from President Truman; an official civic welcome by the City of New York on the steps of the General Post Office; an unveiling of a bronze plaque by Dr. C. Parsons, former secretary of the American Chemical Society, on the wall of the house where the Society was founded seventy-five years ago in Washington Square, the Chelsea of New York; an able address by Governor Driscoll of New Jersey on "Politics in an Age of Science"; a speech by Allan Berkley, the Vice President of the United States, on the "Chemical Problems of the Farmer", in which he reminded his audience of the fact that Thomas Jefferson had regarded chemistry as "the most useful of sciences, big with future discoveries for the utility and safety of the human race". Finally, in Washington an after-dinner speech was given to the delegates of the International Union by Charles Sawyer, U.S. Secretary of Commerce.

The U.S. post office issued ten million commemorative stamps, of which, I believe, more than 2¼ million were sold within the first two days.

The formal meetings and dinners were diffused over the country both by radio and television; a number of the official delegates found several days exposure to 'Kleg' lights rather tiring. It was also significant that the three public speeches addressed to the American Chemical Society all dealt with the future rather than with past achievements; that of President Furman reviewing the present and indicating the future developments within the Society. Dr. J. B. Conant, president of Harvard, chose as his text "A Skeptical Chemist looks into the Crystal Ball", and Dr. Kenneth Mees, of the Kodak Co., dealt with "The View Ahead in Chemistry". These prophets were as optimistic as those who stood before Lars Porsenna.

Both English and American chemical journals and abstracts play a large and important part in world chemistry, and it is evidently desirable that such technical matters as symbols, nomenclature and abbreviations should be as uniform as is possible. This meeting of the American Chemical Society provided a welcome opportunity for those responsible on both sides of the Atlantic to meet and discuss this important matter. Semantics give us no decision between 'sulphur' and 'sulfur' or 'aluminium' and 'aluminum', but the two countries have found it possible to adopt the same symbols and identical logical methods for the necessary chemical shorthand.

As the oldest national chemical society, the president of that of Great Britain was asked to convey the congratulations of the chemical societies invited to this meeting to our hosts; and Arthur B. Lamb, professor emeritus of Harvard, past editor of the *Journal of the American Chemical Society*, was made an honorary life member of the Chemical Society in Great Britain.

In the proceedings of the International Congress, the world-wide ramifications of chemistry were most clearly revealed by the fact that the four official public lectures were given respectively by Prof. V. Deulofeu of Buenos Aires, Prof. K. U. Linderstrøm-Lang of Copenhagen, Dr. E. W. R. Steacie of Ottawa, Canada, and Prof. A. R. Todd of Cambridge in England, while the various committees and commissions of the Union and sections of the Congress were naturally international in character.

In Washington, the Union members were looked after by Dr. E. U. Condon, of the Bureau of Standards, and Dr. D. W. Bronk, of the National Academy of Science. The most important international action completed by the Union consisted in the re-admission of Japan and the admission of Western Germany and New Zealand to the Union. This meeting of the Union terminated the period under the presidency of Prof. H. R. Kruyt. Chemists who have the world interests of chemistry at heart are deeply indebted to one whose wisdom and skill have steered the Union through the difficult post-war period to a position in which it finds itself a living entity and has a real purpose in the complex times in which we live. Prof. Arne Tiselius was unanimously elected as successor, and the next meeting of the Union will be held in Stockholm in 1953. While the sectional meetings, of which there were so many, were managed with the skill born of long practice by the American Chemical Society, it proved too much for the Union, which found that having a congress of pure and applied chemistry on its hands was no joke. Delegates to the Union who thought they had sufficient work to do in the Union itself found that they had, in addition, to participate in many Congress activities. This, indeed, may be the last of the Congresses devoted to all phases of chemical activity. In Stockholm the Congress activities will be restricted to physical chemistry and one or two special topics.

All visitors to the United States are always impressed by the kindness and hospitality of their hosts. Those who attended these conventions will never forget the attentions showered upon them by American individuals, civic authorities, societies and industrial organizations for fourteen memorable days.

Eric K. Rideal

TWELTH INTERNATIONAL CONGRESS OF PURE AND APPLIED CHEMISTRY

THE Twelfth International Congress of Pure and Applied Chemistry was held in New York during September 9–13, immediately following the Diamond Jubilee celebrations of the American Chemical Society. Chemists attending the Congress came from forty-two countries and, of more than nine hundred papers presented, about one-third were by chemists from countries outside the United States. Through the help of the Economic Co-operation Administration and also the Ford Foundation, a number of young chemists from foreign countries were able to attend the Congress and, after its conclusion, were taken on tours of the principal industrial centres of the United States. The Congress was divided into sixteen general sections, but, due to the large number of papers presented, some of these had to be subdivided further. In addition, a general lecture was given each day by a leading chemist (two from Europe, one from North and one from South America) to a combined meeting of all sections.

The first of the general lectures was given by Dr. E. W. R. Steacie, Division of Chemistry, National Research Council of Canada, and was entitled "The Decomposition of Organic Compounds". Taking as examples the thermal decomposition of ethane and the reaction of a methyl radical with an aliphatic hydrocarbon, he reviewed the different approaches and trends over the past few years in the field of gas-phase reaction kinetics. He stressed that, though the original postulates and calculations about free-radical mechanisms have been useful in directing the investigations to date, much more experimental data are needed on a variety of simple reactions. The theoretical approach now involves too many assumptions and approximations, and can only be further advanced when reliable experimental data have been amassed.

Prof. K. U. Linderstrøm-Lang, of the Carlsberg Laboratories, Copenhagen, discussed, in his lecture "Structure and Enzymatic Breakdown of Proteins", the chemistry involved in the conversion of ovalbumin to plakalbumin. He presented evidence showing that when the protein ovalbumin is attacked by a bacterial proteolytic enzyme, the formation of plakalbumin II may correspond to the loss of a hexapeptide unit from the ovalbumin molecule. A reaction also occurs in which plakalbumin I is first formed, corresponding to the removal of a dipeptide (alanyl-alanine) from the original molecule, and then a tetrapeptide is split off more slowly to yield plakalbumin II. It was pointed out that although this comparatively small change in composition, namely, the removal of a peptide of low molecular weight, produces a remarkable change in the crystal form and solubility of the protein, dilatometric studies now reveal that there are other more profound changes in the molecule.

In the third lecture of the series, Prof. A. R. Todd, University of Cambridge, discussed "The Chemistry of the Nucleotides". Reviewing recent work in this field, particularly that of the Cambridge group, Prof. Todd considered the approaches to nucleotide chemistry in relation to nucleic acid structure. Three chemical problems are involved: the structure and synthesis of nucleosides, the phosphorylation of these to give nucleotides, and the method of linkage of dissimilar bodies through the phosphoric acid group. In discussing these, the proof of the β-glycosidic linkage in the nucleosides was described, followed by an account of the use of dibenzyl-chlorophosphonate as a mild phosphorylating agent. The uncertainty of the location of the phosphate group on either the 2- or 3-position of ribose in the nucleotides was explained by the possible cyclization of the phosphate group across these positions. This would also account for the alkali-instability of ribonucleic acid and for the isolation of isomeric adenylic acids by Carter and Cohn. In the light of the known chemical properties of the nucleotides, particularly their behaviour to acid and alkali, possible structures of ribo- and deoxyribo-nucleic acids were considered.

In the final lecture of the Congress, Prof. V. Deulofeu, National University of Buenos Aires, gave a short talk on "The Chemistry of some South American Plant Products". This dealt with the chemistry of the alkaloids and flavonols found in various plants and bushes in that region. The structure of γ-fagaradine and the other alkaloids from the plant *Fagara coco* was discussed by considering their relation to dictamine. The theoretical basis for their various reactions was considered, and the synthesis of analogues of α-fagarine with comparable pharmacological activity was described. The three Argentine species of *Erythrina* examined contain two main alkaloid fractions, one group being the free bases (for example, erythramine, erythratine), while the others are glycosidically bound and only liberated in extractable form by acid hydrolysis (for example, erysotrine, erysovine). The structure and inter-relation of these compounds and their relation to the parent base erythradine were discussed.

Several of the larger sections of the Congress organized their programmes to include symposia on particular aspects of current interest. Thus the Medicinal Chemistry Section, for example, held symposia on antibiotics, tuberculosis and cancer. In these the stress fell mainly on the chemotherapeutic approach, several papers being presented on the new antibiotic 'viomycin', derived from *Actinomyces vinaceus*, and on the use of compounds of the thiosemicarbazone group against tuberculosis and of the derivatives of ethyleneimine against cancer. The Biological Chemistry Section held a two-day symposium on proteins and amino-acids, and also symposia on nucleic acids, enzymes and microbiological chemistry. The sections entitled Plant Cell-wall Constituents, Air and Stream Pollution, Pesticides, etc., held symposia on specific aspects in those fields. The Physical and Inorganic Chemistry Section and the Organic Chemistry Section arranged very large general programmes covering many aspects.

The field of chemistry has now become so vast that for future international meetings it seems it will be necessary to subdivide the Congress into independent units. Accordingly, the next International Congress of Chemistry, to be held at Stockholm in 1953, in conjunction with a meeting of the International Union of Pure and Applied Chemistry, will be restricted solely to the Physical Chemistry Section.

D. HAMER

OBITUARIES

Mr. James Baddiley

MR. JAMES BADDILEY, who died in hospital on September 26, was one of the outstanding leaders in the renaissance of the dyestuffs industry in Great Britain. He was born in Yorkshire on July 15, 1885, and educated at Bradford Grammar School, whence he went to the University of Leeds and graduated with first-class honours in 1907. He then worked for two years with Prof. A. G. Green in the Clothworkers' Research Laboratory, and during this period published, with Green, in the *Transactions of the Chemical Society*, a paper in a series on colouring matters of the stilbene group, dealing with the action of caustic alkali on derivatives of *p*-nitrotoluene. In 1909 he joined Levinstein's, Ltd., at Blackley as research chemist, and in the next five years he worked chiefly on azo dyestuffs and intermediates, work which issued in twelve British patents with Dr. H. Levinstein as co-inventor.

By the outbreak of war in 1914, Mr. Baddiley had already established his reputation as a research chemist, and he quickly became the head of the Technical Research Department at Blackley, of which he retained charge when the British Dyestuffs Corporation was formed. In 1925, Prof. A. G. Green having meanwhile resigned his post as director of research, Baddiley became manager of the Research Department. In 1930, the British Dyestuffs Corporation having become part of Imperial Chemical Industries, Ltd., Mr. Baddiley became a delegate director, and joint technical manager of the Dyestuffs Group, remaining director in charge of research until his retirement in 1947.

Although only one scientific paper stands in his name, he was cited as co-inventor on some sixty British patent specifications. When the Board of Trade Dyestuffs Development Committee issued its first report in August 1920, it referred to five outstanding developments in dyestuffs chemistry, three of which were British discoveries, and with two of these Mr. Baddiley was associated. One was his discovery in 1922, with the late Mr. A. Shepherdson, of the valuable dyeing properties of dispersions of unsulphonated amino derivatives of anthraquinone for acetate rayon; the other was his contribution to the use of dispersions of azo dyestuffs for the same purpose. Both discoveries considerably assisted the development of the use of cellulose acetate as a textile fibre. A further discovery, also listed by the Dyestuffs Development Committee in its report, with which Mr. Baddiley was associated, was that of a special range of azo dyes giving level shades on the 'irregular' viscose rayon which at that time was frequently encountered. Mr. Baddiley's services to the industry were recognized in February 1939 by the award to him of the Perkin Medal of the Society of Dyers and Colourists. This, the premier award in the field of dyes and their application and textile chemical technology, was awarded "in recognition of his national services for the renaissance of the British dyestuffs industry through many important investigations in the field of colouring matters conducted or directed by him".

Mr. Baddiley retained to the end his interest in and enthusiasm for dyestuffs technology and organic chemistry, remaining a keen student of the literature. Only his last illness prevented him from presenting a paper he had prepared for the Society of Dyers and Colourists' conference last September. Outside chemistry his chief interests were in his family and, in early life, walking in the Peak district, the Lake district, or his native county, of the fells and inns of which he had an extensive knowledge. He came of farming stock and had also a keen interest in agriculture.

On the research side at least, no one else can have played a part in the renaissance of the British dyestuffs industry in any way comparable with that of Mr. Baddiley; but some who knew him may remember him as much as an inspirer and encourager of others as for his own technical achievements. A wide circle of colleagues who regret the passing of one who earned their respect and affection will extend their sympathy to his widow and children.

Dr. A. L. Green

We regret to report that Dr. Alfred Leonard Green, who was officer in charge of the Ionospheric Prediction Service of the Commonwealth Observatory, Mount Stromlo, Canberra, died in Sydney on August 29, after a trying illness. Dr. Green was born in 1905 in London and educated at Bancrofts School, Essex, from which he proceeded to King's College, University of London. In 1927 he became assistant to Sir Edward Appleton, and was engaged on investigations on the ionosphere, and in 1930 he joined the staff of the Radio Research Board in Sydney. He at once made an investigation of the polarization of down-coming waves in the southern hemisphere and found that it was opposite to that in the northern, thus carrying out a crucial test of the magneto-ionic theory. Dr. Green continued with the Radio Research Board, for which he conducted a number of important investigations, until 1935, when he joined Amalgamated Wireless (Australasia), Ltd., becoming chief of the Research Laboratories. In 1947 he became officer in charge of the Ionospheric Prediction Service at the Commonwealth Observatory, and introduced considerable improvement into the methods of forecasting. He was about to organize a programme of experimental work in the various ionospheric stations operated by the Service, the staff of which he had recruited, when he was incapacitated by his last illness. Green was a Ph.D. and later D.Sc. of the University of London. He is survived by a widow.

R. v. d. R. Woolley

NEWS and VIEWS

Nobel Prize for Medicine for 1951: Dr. Max Theiler

Dr. Max Theiler, who has been awarded the Nobel Prize for Medicine for 1951, was born in South Africa in 1899, a son of Sir Arnold Theiler, whose work in veterinary problems in Africa is widely recognized. Dr. Max Theiler received his medical education at St. Thomas's Hospital, London, and graduated in 1919. Upon completion of a course at the London School of Tropical Medicine, he accepted a post at Harvard University in the Department of Tropical Medicine, where his work ultimately led to the demonstration of the susceptibility of white mice to intra-cerebral inoculation of yellow fever virus. This made possible for the first time work with yellow fever virus in a small and inexpensive animal. Dr. Theiler eventually developed the mouse protection test which has become one of the principal tools in yellow fever epidemiology. It was after Dr. Theiler had moved to the International Health Division of the Rockefeller Foundation in New York that the historic discovery of the innocuous nature of the *17 D* sub-culture of the well-known Asibi strain of yellow fever virus was made. This is the strain which served for the major portion of the millions of yellow fever immunizations given during the past decade. If further evidence of Max Theiler's careful workmanship is necessary, this is furnished by his discovery of the interesting murine encephalomyelitis virus which bears his name.

Dr. Theiler is certainly one of the most modest of men. He rarely attends scientific meetings, despite an extremely affable and friendly nature, and in his laboratory he seldom presents a picture of the intensity which is customarily expected of the scientific investigator. This easy-going approach to his work, however, disguises very effectively the enormous amount of thinking which lies behind each and every one of his experiments. He is most characteristically found sitting at ease in his laboratory, examining and re-examining the results of the experiments being conducted by his team of very competent technicians, whom he has himself trained. While he will no doubt be greatly pleased by the award of the Nobel Prize, it is unlikely that the very human Max Theiler will be changed one whit by it.

Grande Médaille Osmond: Prof. E. N. da C. Andrade, F.R.S.

On October 26, during the autumn conference of the Société Française de Métallurgie, Prof. E. N. da C. Andrade was presented with the Grande Médaille Osmond, a premier award in the field of metallurgical science. This honour was instituted in 1949 on the occasion of the centenary celebrations of the birth of Floris Osmond, a pioneer in metallography, and is awarded—to translate literally the conditions laid down—"without condition of nationality, in principle every two years, to a metallographer whose scientific works have had important consequences for metallurgy and the study of metals, so as to constitute a crowning award to work judged of first importance in metallurgical science". The first award was made to the distinguished Swedish man of science, Prof. Carl Benedicks. Present-day knowledge of deformation processes in metals owes much to the painstaking work and penetrating observations of Prof. Andrade. His early experiments on the creep of metals led to the relationship now generally known as the 'Andrade creep law', and to the recognition of the fact that at least two physically distinguishable processes play a part in creep phenomena. He was among the earliest investigators to prepare single crystals of metals and study their deformation. Characteristically, he devised methods for the preparation of the more difficult materials and elucidated their modes of deformation. The methods he devised, both for preparation and testing of the materials, have found widespread use in laboratories all over the world. More recently, his work has established the importance of the role of the surface in the mechanical behaviour of both polycrystalline and monocrystalline metals. Already, as with many other phenomena to which he first directed attention, these observations have been pursued by other workers with fruitful results. This work, for which the Médaille Osmond has been awarded, constitutes, of course, but a part of Prof. Andrade's contributions to science as a whole; his original work has ranged over the whole field of physics, while he has yet found time to interpret science to the layman and make significant contributions to the literature of the history of science.

Mechanical Engineering Research Organization : Dr. D. G. Sopwith

DR. D. G. SOPWITH, until recently superintendent of the Engineering Division, National Physical Laboratory, Teddington, has been appointed director of mechanical engineering research in the Department of Scientific and Industrial Research in succession to the late Dr. G. A. Hankins. Since the death of Dr. Hankins in November last year, Dr. Sopwith has been acting director. He will now take complete charge of the new Mechanical Engineering Research Organization, the laboratories of which at East Kilbride, near Glasgow, are already partially built (see p. 779). Dr. Sopwith, who is forty-five years of age, was born in London and was educated at Manchester Grammar School and the University of Manchester. At the University he obtained a Whitworth Scholarship and graduated with first-class honours in mechanical engineering in 1928. He then joined the staff of the National Physical Laboratory, Engineering Division, becoming superintendent of the Division in 1948. He has published many papers on a wide range of subjects, including the design and causes of failures of engineering components, and others on chains and lifting gear, fatigue, helical compression springs, screw threads, the penetration of armour plate, and breech mechanisms.

British Caribbean Meteorological Service : Mr. W. A. Grinsted

MR. W. A. GRINSTED, director of the newly established British Caribbean Meteorological Service, has recently taken up his appointment at the headquarters of the Service in Trinidad. Mr. Grinsted joined the Meteorological Office in 1920 and was appointed to the British East African Meteorological Service in 1934. In 1942 he was made assistant director of what, in 1948, was to become the Meteorological Department of the East Africa High Commission. Since the Second World War, meteorological services in the Caribbean have been operated by the Air Ministry. The establishment of the new Service was recommended by a conference which met in Trinidad in January, at which it was decided that the Government of Trinidad and Tobago would administer the scheme on behalf of the other Governments concerned, though the director would have direct contact with the other Governments. The cost of the new Service will be met by these Governments, assisted by grants from Great Britain from Colonial Development and Welfare Act funds and by a contribution from the Ministry of Civil Aviation.

Leadership Training in the Universities

SIR WALTER MOBERLY'S Walker Trust Lecture on Leadership, which he delivered to the University of St. Andrews on February 13, and which is now published (London : Oxf. Univ. Press. 2*s*. 6*d*.), was an examination of the grounds on which the universities' traditional task of leadership is disclaimed to-day. Sir Walter suggested that there is no longer a keen demand for the qualities fostered by a traditional university education, and that for the universities to aim deliberately at producing numbers of a ruling class is wrong in principle as well as impracticable. Again, even if education for leadership were a desirable aim in itself, we are now asked whether, in the present cultural situation, it is possible for the universities to impart it or for students to acquire it. It is urged by Mr. T. S. Eliot that we are sacrificing quality to quantity and that the training of an élite of gifted individuals cannot entirely compensate for the disappearance of an upper class. Finally, the disappearance of any ground-pattern of common belief and behaviour is a crippling handicap. Sir Walter concedes the weight of these objections, but maintains that education for social responsibility is nevertheless still a legitimate and essential task of the universities. Whenever the management of affairs or the guidance of public opinion is left to persons or groups who are not really respected, the life of the community suffers. "The imaginative understanding which illuminates facts" is the one quality most urgently needed in statesmen and all leaders of opinion to-day. If the universities are still to educate for leadership, but for leadership of a more novel kind, Sir Walter suggests first that the family life of the university to-day needs special emphasis. Next, members of a university community should go out of their way to mix with those whose background, professional interest, opinions, and perhaps nationality, differ from their own ; and thirdly, they should seek to avoid the danger of narrowness, for example, by everyone examining the tacit assumptions of his own subject of study and by thinking strenuously about the great issues of right and wrong, liberty and order, faith and scepticism.

Royal Meteorological Society : First Annual Dinner

THE Royal Meteorological Society celebrated last year its centenary, and this year the new session commenced with the inauguration of the Society's first annual dinner, which was held on October 17 in London. The Society's new president, Sir Charles Normand, welcomed the guest of honour, Sir John Slessor, chief of Air Staff, who in proposing the toast of the Society gave many important instances of the use of meteorology as a weapon of war, particularly in aviation. Sir John pointed out, however, that aviation is equally important to meteorology. The Meteorological Research Flight at Farnborough, for which the R.A.F. supplies the aircrews and the Meteorological Office the scientific observers, has rendered unique service to meteorological research. In responding, the retiring president of the Society, Sir Robert Watson-Watt, drew a careful distinction between the Royal Meteorological Society and the Meteorological Office. Sir Robert commented on the disparity in the *per capita* expenditure in Great Britain on meteorology and that in the United States, which is greater in the ratio of 17 : 10. An expansion of the meteorological service would be of great value to Britain, not only to aviation but also in many other directions, and notably to agriculture.

The Wood Pigeon in Britain

FOR many years it has been recognized that the wood pigeon in Britain is harmful to agriculture, and varied attempts have been made to prevent its depredations. With the coming of the Second World War, renewed interest was taken in the protection of growing crops and in reducing the number of wood pigeons. In due course the British Trust for Ornithology received a grant from the Agricultural Research Council for research on the biology and control of this species. During the war years the Wood Pigeon Investigation, which was given facilities for working at the Edward Grey Institute of Field Ornithology, Oxford, was naturally preoccupied with the problem of control, and research on the habits of the species was built up on this central theme. For example, a survey of nests was undertaken with the object of discovering whether the pigeons could be controlled in their breeding quarters; plumage was studied to obtain a clue to the migration problem; a knowledge of the relative density of the population was obviously desirable; and a similar knowledge of the feeding habits and feeding grounds was essential for the main purpose in view. The work on control has now been closed and it is possible to knit together the results of research on the biological side, which together form a study of the effect of human activities on one species of bird. Although the wood pigeon is as wild and unapproachable as any member of the British fauna, it would be difficult to name any animal the life-history of which is more closely interwoven with that of man. This life-history has been described by M. K. Colquhoun in an account which should be of interest not only to ecologists but also to those associated with the practice of agriculture and forestry (Agricultural Research Council. Report Series No. 10. London: H.M.S.O. 3*s*. net).

Material Culture of a Micronesian Atoll

Kapingamarangi, an atoll south of the Caroline Islands and just north of the equator, was chosen as the field for an expedition to Micronesia, since it was known to be inhabited by a Polynesian stock. The people are taller and more robust than the Micronesians, with typically Polynesian brown skin and wavy or curly hair, and they are friendly and hospitable. There are thirty-three islets on the reef around the central lagoon, with a population of more than five hundred. This atoll, then, formed a highly compact area for an intensive survey—and how intensive it was is shown by an account of "Material Culture of Kapingamarangi", by Te Rangi Hiroa (Peter H. Buck) (Bernice P. Bishop Museum, Honolulu; Bull. 200; pp. 291; 1951). The field has been covered minutely, and the profuse illustrations are of high merit; in fact, the whole publication serves as a model of how such a survey should be presented. It is interesting to find a community nowadays living such a balanced life. They are isolated, but not entirely so; they are self-supporting, healthy and happy, and what outside culture—social and material—they now desire can be supplied by their outside contacts. Let us hope that this balance is not upset by so-called civilization.

Library Catalogue of the Timber Development Association

The Timber Development Association, Ltd., has at its headquarters (21 College Hill, London, E.C.1) a library containing more than a thousand books treating of matters of importance in the timber and wood-working industries, and so forth. The titles of these books are given in the "Library Catalogue" (pp. 54), the third edition of which appeared in April 1950 and was reprinted in February 1951. The catalogue does not include any of the many brochures, pamphlets, and trade catalogues which may be inspected at the headquarters. The catalogue is drawn up on the usual lines, and forms a valuable aid to those who are associated with timber development.

World Power Conference: Annual Report for 1950

The annual report of the World Power Conference for 1950 (pp. 22; London: World Power Conference, 1951) records the admission of Iceland and Israel to membership at the 1950 meeting of the International Executive Council, and national committees have been formed in both countries. A brief chronicle of the Fourth World Power Conference is appended to the report, and the transactions of the Conference are being prepared for publication. The International Executive Committee protested unsuccessfully against the decision of the Economic and Social Council of the United Nations to transfer the World Power Conference from the list of organizations having category-*B* consultative status to the Secretary-General's Register. A list of publications as well as the statement of accounts is appended to the report, the income and expenditure account showing a deficit of £261 on the year.

"Runs in a Sequence of Observations"

Referring to the communication under this title published in *Nature* of September 29, p. 557, Prof. P. V. Krishna Iyer writes: "The determinantal difference equation should be read as follows: The difference equation reduces to a determinant of the k^2 order given by

$$\| A_{rs} \| \varphi(m-2) = 0,$$

where A_{rs} is a $k \times k$ matrix such that when $r \neq s$, all rows excepting the sth row are zero, the sth row being $[-p_{rt} \; -p_{rt} \; . \; . \; . \; -p_{rt}]$. When $r = s$, the rth row is $[-p_{rt} \; -p_{rt} \; . \; . \; . \; (E-p_r) \; . \; . \; . \; -p_{rt}]$, the diagonal elements are $[E \; E \; E \; . \; . \; . \; E-p_r) \; . \; . \; . \; E]$, all the other terms being zero".

University of London

The following announcements have been made by the University of London. Mr. A. G. Smith has been appointed to the University readership in applied thermodynamics tenable at the Imperial College of Science and Technology. Doctorates have been conferred as follows: *D.Sc.*, J. G. Boswell (King's College), Miss M. S. Leslie (Bedford College), Miss L. M. Pickford (University College) and F. L. Warren (Imperial College of Science and Technology); *D.Sc.(Eng.)*, F. W. Preston (external student).

Announcements

Mr. Ben Smith, national organizer of the Association of Scientific Workers, has been appointed general secretary of the Association in succession to Mr. T. Ainley.

The new laboratories of the British Food Manufacturing Industries Research Association at Randalls Road, Leatherhead, will be opened by Lady Engledow on November 8.

A British Commonwealth Scientific Official Conference will be held in Australia in 1952. This is the first time the Conference has been held outside the United Kingdom; the last Conference met in London in 1946. The Conference will open in Canberra on February 18, and will close in Melbourne on March 7; the formal sessions will be broken by visits to enable delegates to study problems of Australian development. Local arrangements for the Conference are in the hands of the Commonwealth Scientific and Industrial Research Organization, 314 Albert Street, East Melbourne.

REPRODUCTIVE ORGANS OF NEAR-TERM AND NEW-BORN SEALS

By Prof. E. C. AMOROSO
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AND

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THERE is convincing physiological evidence indicating that, in several species of mammals, including man, horse and donkey, œstrogens and progesterone are elaborated by extra-ovarian tissues[1,2]. It is generally believed that the placenta represents the new source, though the available evidence falls short of finality[3,4].

The genital organs of the human infant at birth and of the fœtal foal show characteristic gross and microscopic alterations, and it is evident that they have been exposed to strong and physiologically effective stimulation from endocrine substances. Histological and biochemical investigations, fully presented for man by Fraenkel and Papanicolaou[5], and by Dobszay[6], and for the horse by Cole, Hart, Lyons and Catchpole[7], and by Amoroso and Rowlands[8], have revealed certain details of these transitory phenomena. On the other hand, data regarding the histological structure of the reproductive tract in mature fœtuses or in the new-born of other species have not been reported in sufficient detail to enable comparisons to be made, or to assess the endocrine status of the extra-ovarian tissues that may be involved. In the cat, for example, the uterine glands of the new-born kitten are stated to be active; but this activity ceases soon after birth[9], while in mature fœtuses of the African elephant, Perry[10] has described a pronounced enlargement of the gonads which regresses soon after delivery.

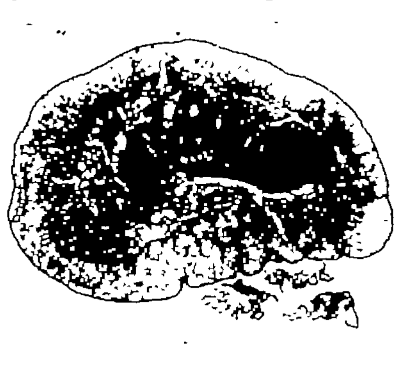
We have recently examined the reproductive organs of a number of near-term and full-term seal fœtuses, and new-born and recently born seal pups of both sexes. In several instances the maternal ovaries and portions of the maternal genital tracts have been sectioned. Material from different species (*Halichoerus grypus*, *Phoca vitulina* and *Callorhinus ursinus*, and three species of Antarctic seals, *Leptonychotes weddelli*, *Lobodon carcinophaga* and *Hydrurga leptonyx*) has been examined. The gross and microscopic findings are essentially similar, although not yet confirmed at every stage, for each species. We find a remarkable enlargement of the gonads of all near-term fœtuses and new-born pups, an observation already made by one of us[11] in *P. vitulina*. A characteristic hypertrophy and engorgement of the uterus, changes in the vaginal epithelium and a large plug of tenacious mucus in the anterior vagina are associated with this phenomenon.

The ovaries of near-term and new-born seals present a picture which is remarkably different from the appearances seen some weeks after birth[11]. The ovaries are strikingly enlarged—larger, in fact, than those of the mother—but are devoid of follicles in a stage of development more advanced than those lined by a single layer of follicular epithelium. The large size is due to an especially developed proliferation of interstitial cells which make up the bulk of the organ. At birth the ovaries weigh 32–36 gm. and those of the mother weigh 25–28 gm.

In the ovary of the new-born, the primordial follicles lie immediately below the tunica albuginea and tend to be arranged in clusters in the neighbourhood of sub-surface crypts of germinal epithelium, which are present at irregular intervals in the cortical zone[12,13]. The remainder of the organ consists mainly of loosely arranged, well-vascularized interstitial tissue. The interstitial cells are large, oval or polyhedral, and have abundant eosinophilic cytoplasm. In the majority of cells, the nucleus is eccentrically placed and is large and vesicular; but it is occasionally shrunken and pyknotic.

Involution of the ovaries begins three or four days after delivery and is well advanced by the second week (see illustration). The ovaries weigh 8–10 gm. during the second week, and 2–4 gm. when involution is completed. During involution the interstitial cells undergo a lipid transformation, shrink considerably and become densely packed. The majority of the nuclei are now shrunken and pyknotic.

The uterus of new-born seals is relatively large and congested, and, as in the human neonate[5], the cervical canal is more definitely patent during the neo-natal period than immediately thereafter. Macroscopically the uterine horns resemble those of the bitch when in œstrus. In sections, the uterine mucosa is thickened and the uterine epithelium is frequently several layers thick. The uterine glands are numerous,



Photograph of longitudinal sections through the greatest diameter of (above) full-term fœtal and (below) approximately week-old phocid ovaries. Natural size enlarged and extend in coils to the base of the mucosa. There is definite evidence of active secretion. A week after birth the uterus has started to shrink; the uterine epithelium is single-layered, the glands are smaller and their cells heavily vacuolated, and there are only traces of secretion.

The vagina contains a large coherent plug of thick mucus lying immediately caudal to the cervix uteri. During involution, the amount of mucus in the vagina decreases and the viscosity is lowered. Histologically, a multi-layered hypertrophy of the epithelium of the posterior vagina prevails; but anteriorly it is converted into a mucus-secreting type, frequently with a superficial layer of tall columnar cells, and containing occasional, large, darkly staining, granular cells, the nature of which has not yet been determined. The secretions which accumulate in the lumen of the vagina contain desquamated epithelial cells in addition to red and white corpuscles. Usually the extravasated blood in the vagina is small and insufficient to colour the mucus, but occasionally—and especially during involution—it may accumulate in such quantities to stain the secretions a dark red colour. About a week after birth the vaginal epithelium is thinner, and in many places has the appearance of a transitional epithelium.

In male pups the gonads follow a similar curve of growth and decline as do the ovaries, and in the new-born weigh 34–40 gm. The testes are covered by a well-defined tunica albuginea which varies in thickness from 600 to 800 µ. They contain large islands of interstitial tissue, between which are found numerous, convoluted seminiferous tubules that contain an occasional spermatocyte. The majority of the tubules are patent, but some are solid. On an average, the tubules measure about 60 µ in diameter.

Our observations on the maternal ovaries just before, during and after parturition confirm those of Enders, Pearson and Pearson[14]. The ovary containing the heavily vacuolated corpus luteum of pregnancy possesses very few, small atretic follicles; the other contains numerous healthy follicles 0·2–4 mm. in diameter and frequently, as in one cow which died during labour, one or more follicles up to 12 mm. in diameter. It is one of these larger follicles which is probably destined to rupture at the post-parturient ovulation some three to eight days after delivery.

The modifications of the reproductive organs of the seal which normally prevail at birth parallel in almost every respect those described in the new-born infant and the fœtal foal. But whereas the changes in the uterus and vagina of the aforementioned species can be ascribed almost entirely to circulating œstrogens, the occurrence of coiled endometrial glands and vaginal mucification in the seal suggests that progesterone is acting upon an œstrogen-primed genital tract. It is probable from the appearances of the maternal ovaries in the seal just before and at birth that they are at least a contributory source of circulating œstrogens, and possibly of progesterone. The extent to which gonadal enlargement can be attributed to the same cause is more difficult to assess. The reaction of the interstitial cells in the gonads resembles a response to the luteinizing fraction of the anterior pituitary; and unless we can assume that endocrine substances having the property of chorionic gonadotrophin are secreted by the cytotrophoblast of the seal's placenta (as has been demonstrated for man), then the remarkable changes in the ovary of the seal at birth might be ascribed to the presence of circulating œstrogens or to changes in the kind and quantity of gonadotrophic hormones secreted by the fœtal pituitary. [June 26.

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CHEMISTRY OF THE OXIDATIVE METABOLISM OF CERTAIN AROMATIC COMPOUNDS BY MICRO-ORGANISMS

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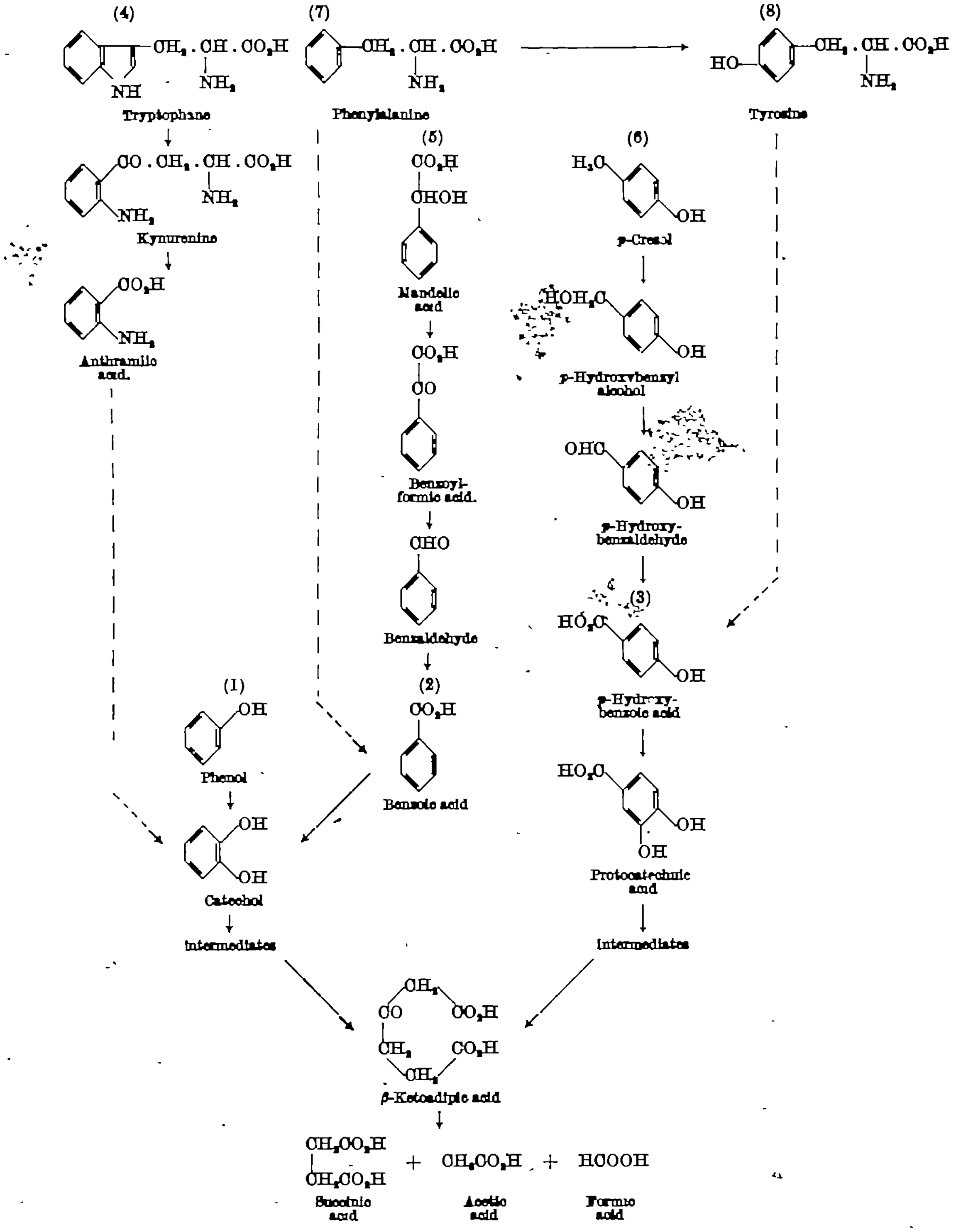
SEVERAL types of micro-organisms, classified into the following six families, Coccaceæ, Mycobacteriaceæ, Bacteriaceæ, Pseudomonadaceæ, Spirillaceæ and Bacillaceæ, are known[1], which grow in a simple mineral salt medium with an aromatic compound as the sole source of organic carbon. During growth, the benzene ring undergoes fission, the compounds formed being utilized in the diverse processes associated with cell metabolism. Such organisms have been isolated from soil, sewage and mammalian fæces, and are widely distributed in Nature. Indeed, the biological function of these micro-organisms by virtue of this property may be regarded as an essential step in the 'carbon' cycle. Their use as industrial scavengers is common, since percolation of phenolic waste-products through sewage beds provides a cheap method of detoxicating aromatic substances potentially harmful to aquatic life. Useful reviews by ZoBell[2] on the bacteriological aspects of this phenomenon have been published.

The biochemistry of bacterial aromatic ring fission has been investigated by the application of two entirely distinct methods of approach, and has been reviewed by Happold[3]. These are the traditional one of attempting the isolation of intermediates from growing cultures, mainly by Evans and Happold and their collaborators, and, secondly, through the utilization of the technique of 'simultaneous' or 'successive' adaptation by Stanier. Recently, cell-free enzyme preparations from bacteria which have grown on one aromatic substrate, and therefore

TABLE 1. PATHWAYS IN THE OXIDATIVE BACTERIAL METABOLISM OF SOME BIOCHEMICALLY IMPORTANT AROMATIC COMPOUNDS


(4)
(7)
(8)
Tryptophane
Phenylalanine
Tyrosine
Kynurenine
Anthranilic acid
(5)
Mandelic acid
Benzoylformic acid
Benzaldehyde
(2)
Benzoic acid
(6)
p-Cresol
p-Hydroxybenzyl alcohol
p-Hydroxybenzaldehyde
(3)
p-Hydroxybenzoic acid
Protocatechuic acid
(1)
Phenol
Catechol
intermediates
intermediates
β-Ketoadipic acid
Succinic acid
Acetic acid
Formic acid

possessing the adaptive enzyme pattern for its metabolism, have yielded important new information concerning the chemical steps in this metabolic pathway.

Table 1 summarizes the knowledge gained by several investigators concerning the bacterial 'aromatic fission' type of metabolism of some biochemically important substances.

It is now generally recognized as desirable that before any presumed intermediate is finally accepted as participating, it must, first, obey the criteria of simultaneous adaptation and, secondly, have been identified chemically, either from the culture or as a product of reaction of an enzyme preparation made from the adapted cells acting on a preceding member in the reaction chain. Some comment on the unified scheme presented in Table 1 is useful at this stage.

Pathways (1), (2), (3). Using *Vibrio* 01, Evans and Happold[4] isolated catechol from a culture growing on phenol media; with *p*-hydroxybenzoic acid as initial substrate, Evans[5] identified protocatechuic acid as one of the products. The course of the metabolism of benzoic acid proved more difficult to determine, since none of the monohydroxybenzoic acids appeared to be formed, neither did the three isomers obey the criteria of simultaneous adaptation. Stanier[6] provided evidence, by the latter technique, that the metabolic pathways of benzoic and *p*-hydroxybenzoic acids with his *Pseudomonas fluorescens* organism are initially separate and distinct. Almost simultaneously, Evans, Parr and Evans[7] isolated catechol from a benzoate culture of *Vibrio* 01. No known intermediate has been found to take part between these two compounds, and it appears probable that these organisms produce catechol from benzoic acid in a single oxidative reaction.

In the original biochemical work on phenol breakdown, Evans and Happold[4] and Evans[5] detected the transient formation of a keto-acid which gave a positive Rothera and Gerhart test, but which was not identical with aceto-acetic acid. This elusive intermediate was finally characterized by Kilby[8] as β-ketoadipic acid. Afterwards it was shown by Evans, Parr and Evans[9] that protocatechuic acid also gives rise to β-ketoadipic acid after ring cleavage. Whether β-ketoadipic acid is the immediate product of ring opening in pathways (1), (2) and (3) remained obscure until quite recently.

Pathways (5), (6), (7), (8). That mandelic acid is metabolized through benzoic acid by *Pseudomonas fluorescens* was established, through simultaneous adaptation, by Stanier[6]. Recently, Evans and B. S. W. Smith[10] have shown that *p*-cresol gives rise to *p*-hydroxybenzoic acid by its isolation from culture. Evidence has also been obtained by the latter workers indicating that phenylalanine and tyrosine undergo side-chain oxidation to *p*-hydroxybenzoic acid prior to ring cleavage.

Pathway (4). Suda, Hayaishi and Oda[11] studied the adaptive behaviour of *Pseudomonas* spp. in tryptophane metabolism. One of the significant results of their work was that this occurs through kynurenine and anthranilic acid, to catechol, this latter compound being further metabolized by ring fission. In fact, Hayaishi and Hashimoto[12] succeeded in purifying an enzyme system from these *Pseudomonas* spp. which they termed 'pyrocatecase', able to convert catechol to what was believed to be *cis-cis*-muconic acid. When, however, the substance isolated was tested by Stanier and Hayaishi[13] with a crude enzyme preparation which catalyses the reaction

$$\text{catechol} + O_2 + H_2O \rightarrow \beta\text{-ketoadipic acid},$$

it was found incapable of giving the keto-acid, a fact which excluded it from being a true intermediate in this reaction. The position, therefore, remained for a time rather puzzling.

At this stage the investigations of Elvidge, Linstead, Sims and Orkin[14] on the stereochemistry of the muconic acids threw light on the microbiological problem. These workers isolated a new *cis-trans*-muconic acid from the alkali-catalysed isomerization of a related unsaturated lactone. The new acid (m.p. 184° C.) resembled very closely the *cis-cis*-muconic acid which can be prepared by the chemical oxidation of phenol[15]. When the *cis-cis*-acid is merely boiled with water, it is inverted into the new *cis-trans*-isomeride. This means that many samples of '*cis-cis*'-acid used by previous workers must have been inverted by the usual processes of purification. Methods of identifying the two stereoisomerides and the proof of their configuration have been described[14]. It may be added that the configurations have recently been confirmed by semi-hydrogenation experiments (in which the *cis-cis*-muconic acid gives only *cis*-Δ^{α}-dihydro-muconic acid, whereas the *cis-trans*-acid gives both *cis*- and *trans*-Δ^{α}-dihydro-muconic acids)[16].

A difference between the acids is also clearly shown in the microbiological work as follows. The three muconic acids were examined as substrates by Evans and B. S. W. Smith[17]. These experiments showed that the bacterial enzymes which convert catechol to β-ketoadipic acid do so through the intermediate formation of the *cis-cis*-form of muconic acid (I). The enzymes show a rigid biological specificity in this respect, being without action on the other two geometrical isomers. These facts explain why the muconic acid isolated by Hayaishi and Hashimoto was not converted into β-ketoadipic acid by the appropriate enzyme system. In their process of isolation, isomerization of the *cis-cis*-muconic acid to the *cis-trans* form must have occurred. That this explanation is correct has been confirmed by Stanier and Hayaishi[13]. *cis-cis*-Muconic acid, however, does not appear to participate in pathway (3), but Stanier[18] has provided evidence of the formation of a tricarboxylic acid, possibly β-carboxy-muconic acid, in this pathway.

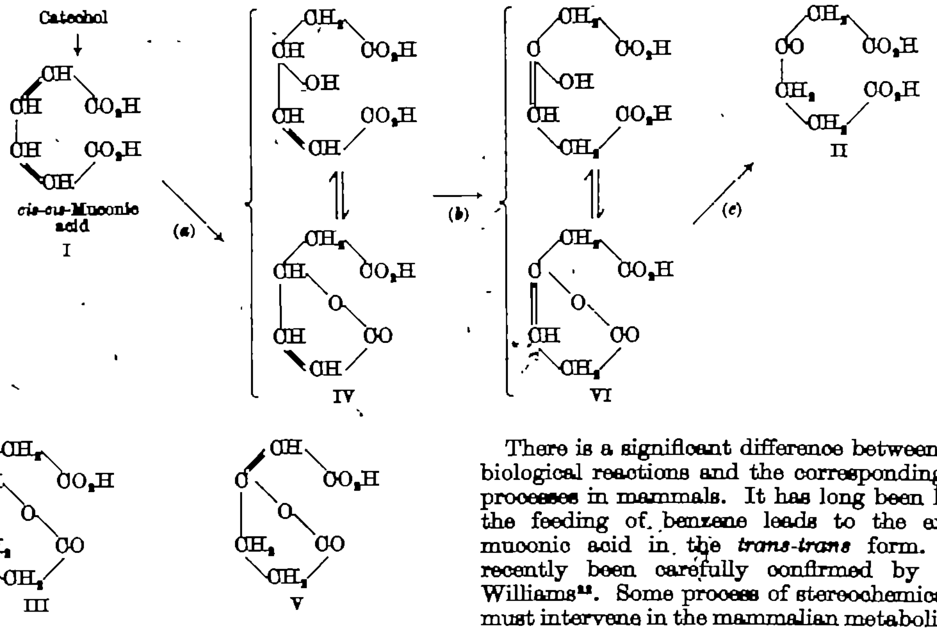
Attention has now been given to the possible intermediate stages between *cis-cis*-muconic acid (I) and β-ketoadipic acid (II), which is the common intermediary metabolite of the various substrates (1)–(8).

Using an enzyme preparation from catechol-adapted cells of *Vibrio* 01 and *Pseudomonas fluorescens* strains, it was first demonstrated manometrically that this reaction (I) → (II) proceeds quantitatively without the participation of molecular oxygen (the β-ketoadipic acid produced was estimated by measuring the carbon dioxide formed on decarboxylation with aniline citrate). This meant that no change was likely to occur in the oxidation-level of the metabolites, and this was confirmed by experiments in which adipic acid, and the saturated lactone (III) equivalent to β-hydroxyadipic acid, were incubated with the cell-free enzyme system. The formation of β-ketoadipic acid was tested for by the Rothera reaction and the ferric chloride reaction. None was formed.

TABLE 2. ACTION OF THE AROMATIC RING-SPLITTING ENZYME SYSTEM FROM CATECHOL-GROWN CELLS ON POSSIBLE INTERMEDIATES IN THE PRODUCTION OF β-KETOADIPIC ACID

Substrate (50 mgm. in 7 ml. M/20 phosphate buffer, adjusted to *p*H 7; 3 ml. enzyme solution)	Production of β-keto-adipic acid after:		
	15 min.	30 min.	60 min.
Catechol	+	+	+++
cis-cis-Muconic acid	+	++	++++
cis-trans-Muconic acid	–	–	–
trans-trans-Muconic acid	–	–	–
Protocatechuic acid	–	–	–
γ-Carboxymethyl-Δ^{α}-butenolide (IV)	++	+++	++++
γ-Carboxymethylenebutanolide (V)	–	–	–
Dihydro-lactonic acid (III)	–	–	–
Adipic acid	–	–	–

Table 3.—Mechanism of the Conversion of *cis-cis*-Muconic Acid to β-Ketoadipic Acid by the Aromatic Ring-splitting Enzyme System from Catechol-grown Bacterial Cells



β-Ketoadipic acid differs from muconic acid by the elements of a molecule of water. Addition of water to *cis-cis*-muconic acid would be expected to yield the β-hydroxy acid which could readily cyclize to the unsaturated lactonic acid, γ-carboxymethyl-Δ^{α}-butenolide (IV). This has recently been prepared by Elvidge, Linstead, Orkin, Sims, Baer and Pattison[19]. Another related substance at the same level of oxidation and hydration is γ-carboxymethylene-butanolide (V)[20]. Incubation experiments were accordingly carried out with these unsaturated lactones, β-ketoadipic acid being tested for by colour reaction and, in some cases, by isolation from the reaction mixtures.

The Δ^{α}-unsaturated lactone (IV) gave strong positive results, the isomeride (V) being negative. Table 2 summarizes these experiments, positive signs denoting the extent of appearance of β-ketoadipic acid. Control experiments on the substrate together with a boiled enzyme solution gave entirely negative results under the same conditions.

In summary, γ-carboxymethyl-Δ^{α}-butenolide (IV) is converted to β-ketoadipic acid, appreciably faster than is *cis-cis*-muconic acid, which is, in turn, faster than catechol. We therefore propose the reaction mechanism given in Table 3 for the missing stages in the total process.

The essential stages are (*a*) addition of water or isomerization; (*b*) migration of the double bond; (*c*) ketonization of the enol corresponding to the βγ-unsaturated lactone (VI). We do not know whether the tautomeric change (*b*) occurs between the open-chain hydroxy acids or their lactonic counterparts. The lactone (VI) is as yet unknown, but the overall changes (I) → (IV) and (IV) → (II) have been realized in purely chemical reactions (see ref. 19; also Kuehl, Linstead and Orkin[21]), making it highly probable that the scheme is essentially correct.

It is particularly interesting that the γδ-unsaturated lactone (V) is not an intermediate in the biochemical transformation (I) → (II), although both of the steps (I) → (V)[19] and (V) → (II)[20] have been effected *in vitro*.

There is a significant difference between the microbiological reactions and the corresponding metabolic processes in mammals. It has long been known that the feeding of benzene leads to the excretion of muconic acid in the *trans-trans* form. This has recently been carefully confirmed by Parke and Williams[22]. Some process of stereochemical inversion must intervene in the mammalian metabolic processes.

One of us (W. Charles Evans) is grateful to the Royal Society for a grant.

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INSTRUCTIONAL FILM RESEARCH IN PENNSYLVANIA

The Pennsylvania State College Instructional Film Research Program, which is still in progress, exceeds in scope any previous research on the instructional film. It was begun in 1947, under the sponsorship of the Special Devices Center of the Office of U.S.A. Naval Research, and is now controlled by a Joint Services Advisory Committee of both the Army and the Navy. These Departments are interested in securing improvements in the instructional film, because they use the film for training purposes. They are also anxious to discover how far the film may displace—rather than merely aid—a skilled instructor. But the research—in which a number of divisions of Pennsylvania State College are co-operating—is of a fundamental kind. The results being obtained are of importance to all who use or make educational films.

An account of the work is given in a series of reports issued by the Special Devices Center, Port Washington, N.Y.; application for which can be made to the director of research, Dr. C. R. Carpenter, Pennsylvania State College, U.S.A. (In preparing the present article the reports chiefly consulted were four Technical Reports S.D.C. 269-7-6, 9, 10, 13; two Progress Reports 11-12, 14-15-16; Incidental Report No. 1; and Special Report No. 2.)

A general method of experimentation has been to produce different versions of a film, and to show them to matched samples of an appropriate audience. Tests, either of the objective multiple-choice question type or of actual performance, are then used to determine the relative teaching effectiveness of the versions. The films used in the experiments have been sound films, predominantly of the commentary-picture type.

Some of the main conclusions so far reached may be characterized as confirming previous opinion. The need for limited and specific objectives in instructional films is much stressed. The rate of development (that is, of putting forward new facts and ideas) of most present-day instructional films is too fast. Good projection and related conditions are of prime importance.

Many of the conclusions are on matters of technique about which, without details of the Pennsylvania experimentation, it would be impossible to form an opinion. In teaching a manipulatory task, the view given should as nearly as possible correspond with that of the learner in performing the task. There is an optimal level for the amount of verbal explanation (found to be about a hundred words a minute for the films used). To establish learning points, commentary should usually be in advance of the picture. The imperative form of address appears the most effective, and the third person passive least effective. There is no advantage in colour, except where it supplies determining learning cues, nor in background music for films of the commentary-picture type. Educational film sessions can last up to one hour with no decrease in effectiveness of teaching. The prestige attached by an audience to the principal exponent in a film increases the influence of the film on attitudes and factual learning from the film. Visual or sound attention-gaining devices, which are themselves irrelevant to the subject-matter, are no advantage.

The most provocative conclusion derived from the experiments is perhaps the one which states that a body of factual information can be taught as well by films alone as by standard lecture – text-book methods. This would seem to imply that films in some circumstances may displace the teacher in the classroom or lecture theatre in a more far-reaching sense than has formerly been realized, and for longer periods. But the Pennsylvania conclusions also make clear that an indispensable part is played by the teacher in 'face-to-face leadership'.

C. Denis Pegge

FILARIASIS IN THE PACIFIC

WHAT should be regarded as an important step forward in the welfare of the Pacific region and the very varied races that populate its myriad islands has been the creation of a South Pacific Commission with representatives from the widely scattered peoples of this area. The first conference of this newly constituted international body met in Suva during April and May 1950, under the presidency of the Governor of Fiji, Sir Brian Freeston. On the recommendation of this conference a congress in Tahiti of experts on filariasis and elephantiasis was arranged, and met during August 21–September 1, 1951, under the presidency of the Governor of French Oceania in the meeting room of the Representative Assembly at Papeete. Dr. E. Massal, a member of the South Pacific Commission, was elected chairman.

The proceedings of the congress have appeared, with commendable promptitude, in some twenty-two typewritten double-sided sheets. If the nature of the headings and the abstracts of the proceedings are any measure of the labours of this congress, then certainly it must be confessed that an immense amount of work was accomplished. It is gratifying to note that, taking part in the congress and thus adding to its international character, were representatives from Oceania as well as from France, the United States, New Zealand and Australia.

The work of the congress was divided under a number of headings. Under parasitology it was agreed to consider the local filaria as the Pacific variety of *Wuchereria bancrofti*, as suggested originally by the reviewer, and it was regarded as essential that the minute morphology of the adult stages should be worked out, that studies should be undertaken on the longevity of this parasite and its intermediate immature stages in the human body, and that a review of periodicity throughout the Pacific should be made. Under entomology, a paper on the mosquito vectors of human filariasis in Oceania was read by Dr. L. Rosen, of the School of Medicine, University of California, paying special attention to the *scutellaris* group of *Aëdes* with particular reference to *A. horrescens*. A film on the filariasis control programme in Tahiti was shown. It was further urged that experimental studies on mosquitoes in each area should be made to determine their potentialities as vectors of *Wuchereria* with special reference to the ability of *W. bancrofti* to develop in *Culex fatigans* in Polynesia and Melanesia. Dr. E. R. R. Brygoo, director of the Institut Pasteur, Saigon, presented a paper on the epidemiology of filariasis in the South Pacific, in which the example of New California was adduced, where neither Anopheles nor the *scutellaris* group of *Aëdes* are found, but where filariasis is widespread. The possibility of *W. malayi* being present in New Guinea was raised. The value of intradermal diagnostic tests was discussed, and the result obtained in Tahiti, Fiji and New Caledonia was compared with indefinite results. A new flocculation test was demonstrated by Dr. W. H. Wright, chief of the Laboratory of Tropical Diseases, National Institutes of Health, Bethesda, United States.

Under the heading of clinical pathology, Dr. P. E. C. Manson-Bahr, physician-specialist, Fiji, read a paper in which he proposed a conception of the infection occurring in three manifestations—primary or allergic, secondary or carrier state, and tertiary or obstructive; and it was agreed that this should form a working basis and that further investigations into the exact mechanism of elephantiasis should be carried out. Under treatment, Dr. W. H. Wright stressed the inadequacy of information of the lethal action of 'Hetrazan' on the adult worms. The role of anti-histamine drugs and antibiotics, such as penicillin, was discussed. The control and prophylaxis of bancroftian filariasis in the South Pacific was in the hands of Dr. H. K. Beye, field director of the Pacific Tropical Diseases Foundation, University of California, who cited instances where mosquito control had resulted in decrease in the microfilaria rates. Present observations relating to mass drug therapy and mosquito infection rates indicated that the most effective procedure is to keep the blood permanently free of microfilariæ. Dosage schedules of 'Hetrazan' now under investigation give promise of meeting this object. The value of educational and other measures was discussed. Especial importance was paid to the training of native personnel in filariasis control. The subjects of standardization and procedures regarding blood examination and documentation had universal support. Standard methods of recording mosquitoes or their larvæ, the laboratory diagnosis for microfilariæ, the recording of clinical manifestations and standards for intradermal tests were agreed upon.

An annotated bibliography of filariasis is being drawn up especially as regards the South Pacific. Finally, it was decided to publish the final report of the conference as a public document.

As the original work on filariasis in the Pacific was undertaken by a member of the staff of the London School of Tropical Medicine in 1910, and as his results were reinforced and expanded later by O'Connor, Prof. P. A. Buxton and others, it is a considerable source of satisfaction to record that, not only has their work been confirmed, but also that it is now being placed upon a practical basis, so that this, the chief scourge of the Pacific, may soon be eliminated altogether. PHILIP MANSON-BAHR

THE ANCIENT KHMER EMPIRE

AN entertaining and scholarly history of the Khmer Empire from the first to the fifteenth centuries, entitled "The Ancient Khmer Empire"*, has been written by L. P. Briggs. The data are derived from Chinese dynastic histories and Oriental travellers' accounts; Sanskrit and Khmer epigraphy; Buddhic and Brahmanic iconography; architecture, art and sculpture; bas-reliefs; and excavations.

Three periods are distinguished: the Funan (first to sixth centuries); the Chenla (sixth century to 802); and the Kambuja or Angkor (802–1431). The Funan period is that of a small kingdom on the Mekong delta, inhabited by a people who may have had negrito racial elements and have spoken a pre-Khmer Austro-Asiatic language. They are believed to have been conquered in the first century by a foreign invader (possibly Malay) who married their queen and introduced clothing among their women. Direct relations with India and China date from the third century. An Indian Brahman is recorded to have become king of Funan in the fifth century, and to have introduced, among other customs, state worship of the Siva-linga and a Central Indian alphabet.

Funan was conquered and became a vassal kingdom of Chenla to the north in 550, the Chenlas being a Mon-Khmer people who had obtained their own kingdom by an earlier conquest of the Chams. The Chenla people were already acquainted with the Siva cult and with the Sanskrit Puranas and Epics. The united kingdom of Chenla and Funan was temporarily conquered by the Malays some time in the eighth century.

The Kambuja period opens with a line of kings who considered themselves incarnations of Siva and who founded a Devaraja cult, each new king being appointed by the head of a family of Brahman *purohitas*, among whom, unlike the rest of the population, descent was matrilineal. This was the classical period of Cambodian history, marked by a great expansion of the empire, a magnificent flowering of architecture and art, and a unique syncretism of Saivism, Vishnuism and Mahayana Buddhism. With the increasing influence of Buddhism, the Devaraja cult gave place to the cult of a Buddharaja. There was a decline in art and architecture in the thirteenth century, probably coincident with the introduction of Hinayana Buddhism. The period ends with the Siamese sacking of Angkor in 1431, and the removal of the capital to the south-east part of the kingdom. Though the Khmers gave to the world no system of administration or ethics, no literature and no philosophy, their civilization saw the summit of Oriental architecture and decoration.

KATHLEEN GOUGH

FOREST RESEARCH IN SWEDEN

VOL. 39 of the memoirs of the Forest Research Institute of Sweden* contains a number of articles of varied interest. Erik Holmsgard discusses height increment, development of the crown, self-pruning, etc., in young beech stands. His investigations seem to show great variations in height increment in various years, and this does not necessarily depend upon changes in climate; thus, the highest trees in a young stand will not necessarily remain so. The growth in height of the lateral branches and the height increment of the lower trees are more influenced by the light conditions than by the climate. It is impossible to give here the author's detailed conclusions, for which the paper should be consulted.

Henrik Petterson deals with the application of the new forestry conservation law passed in 1948, which aims in general at economic forest utilization with a constant yield. Mr. Petterson admits that it may seem futile under present conditions, when the outlook is so uncertain, to attempt to direct the utilization of forests toward an economic goal. The law differentiates between well-grown forests and those which are badly grown or tended: the former, apart from thinnings, may not be clear-felled without the consent of the Forest Conservation Bureau; and the latter must not be treated in such a manner as to result in further deterioration. Further, such measures must be carried out as will result in an improvement of the stocking of the forest within a reasonable time. The paper discusses the methods by which the law can be carried out. There is no indication that it proposes anything quite so drastic as the dedication scheme envisaged by the Forestry Commission in Great Britain.

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* "The Ancient Khmer Empire." Pp. 295, with 17 maps and 58 figures. (*Trans. American Phil. Soc*, 41, Part 1; 1951.)

* Meddelanden fran Statens Skogs-Forskningsinstitut, Band 39, 1950–51 (Stockholm, 1951).

A third paper of interest, by Marianne Lekander, treats of the invasions of insect pests in the Swedish forests during 1741–1945. The author has studied the whole of the literature—the forestry and entomological, administration and departmental reports of the State and reports of forestry conservators and the institute of research—and the paper appears to be an admirable piece of work. Mass invasions or slighter ones occurring more often are classified for each species of insect in a chronological order and are given for each of the forest conservancies in each province. A tabular statement is given at the end of the paper enumerating the chief pests of the forests during a period of fifty years, 1896–1945. An alphabetical list of the insects mentioned is given in Latin and Swedish.

Another paper, by Lars Tiren, is "On Clearing Spruce and its Significance for the Reforestation of Spruce Forest Clearings in Northern Sweden". The main objective was to study the nature and abundance of the seed and resulting seedling growth occurring from the spruce trees left standing in the forests in northern Sweden, and a good opportunity occurred in the good spruce seeding year 1942–43. In these northern spruce forests the future crop largely depends upon the poor type of tree called 'clearing spruce' or 'remnant spruce'. Even though these trees often appear very insignificant and inefficient for the purpose required, they do in effect function as seed-bearers, though often assisted by contributions from any forest border trees surrounding them. Briefly, the study has shown that some artificial help can assist, which may consist of raking under the trees or burning under them, providing a sufficiency of good trees remains to assist the others. Much further research requires to be carried out, which should prove of value to other parts of the world where forests growing under the same type of conditions exist.

CHEMICALS IN FOOD

THE United States Congress established in June 1950 a Select Committee, known as the Delaney Committee, which was given the task of assessing the dangers to public health arising from the increasing use of chemical substances in food manufacture and from the presence in foods of residues from the pesticides now widely employed in agriculture. This Committee has issued its preliminary findings* together with a full report† which is an important document embodying in its eight hundred pages the views of some seventy scientific workers, physicians and industrialists who appeared as witnesses.

The Committee heard the striking evidence submitted by the officers of the Food and Drug Administration, who stated that 704 extraneous substances were thought to be in use; of these, only 428 were considered harmless as normally employed, leaving a further 276 of which the safety was open to question. Attention was directed to a conflict of opinions regarding the suitability of various compounds. There are several which were at one time considered harmless and which found a place among food ingredients; later investigations established their toxic character. In this category are p-phenetyl urea, used for more than fifty years as a sugar substitute; chloracetic acid, a preservative for wines; and thiourea, an anti-browning agent for fruits. The dyestuff butter yellow served for many years as a food colour before its carcinogenic action was recognized, and lithium chloride was considered safe until it was shown to be fatal to persons living on a low salt (sodium chloride) diet.

The above substances are no longer employed, but there are others in use which are the subject of controversy; and although those materials which act as preservatives, anti-oxidants and mould inhibitors are added to food in very small quantities, others such as the synthetic emulsifiers used in the United States baking industry may be present in considerable amounts. Many witnesses pointed to the dangers that could result from the incorporation of these newer ingredients in a staple commodity such as bread.

Consideration was given not only to those substances which are added deliberately to foods to produce some desired effect, but also to others which may become associated with foodstuffs by accident. Among these are the surface-active agents employed in the cleaning of food utensils and machinery, and the pesticides, such as DDT, which may adhere to crops and find their way into foodstuffs. The very properties which make these substances so effective in the control of lower forms of life may lead to their absorption by plant tissues and to their injurious effects on higher animals.

Testimony was given regarding the difficulties experienced in devising suitable methods for the accurate estimation of many of the newer synthetic substances, especially at the low levels at which they are likely to occur in foods. Sound practical analytical methods are essential if there is to be adequate control of the degree of contamination of foods and if the pharmacological properties of the compounds are to be investigated.

Many scientific workers stressed the necessity of carefully designed toxicity studies. They pointed out that, in the past, the main emphasis had perhaps been on acute toxicity tests to discover the levels at which a substance would produce deaths in experimental animals within a short period of time after it had been given by mouth or by injection. In the light of experience gained over the past decade more detailed investigations are required—feeding experiments at different levels on several species of animals over a period of perhaps two years, together with a thorough study of the metabolism of the substance under discussion, its effects on the tissues of the experimental animals and its relation to growth, reproduction and lactation. The results of some of these *chronic toxicity* studies were quoted; there were substances which appeared to be harmless in short-term experiments—in that they did not cause death immediately following ingestion—yet small amounts accumulated in the body and ultimately produced permanent injury.

Experiments on the chlorinated hydrocarbon DDT were described which demonstrated that DDT appeared in the flesh of chickens, cows and sheep which had eaten crops sprayed with the pesticide. It was present also in eggs and in milk. Moreover, lactating cows in a byre treated with DDT secreted in the milk within forty-eight hours quantities of 2 parts per million. This amount was shown to be significant in that DDT when fed to laboratory animals was stored in the body fats; diets containing as little as 5 parts per million produced liver injury in rats. Other pesticides are even more highly toxic, and it was suggested that some should be banned completely from use on food crops.

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* Investigation of the Use of Chemicals in Food Products. 1951. Union Calendar No. 1139. Report No. 3254. (U.S. Gov. Printer, Washington, D.C.)

† Chemicals in Food Products. Hearings before the House Select Committee. 1951. (U.S. Gov. Printer, Washington, D.C.)

Many other topics were reviewed by the Delaney Committee; for example, the impairment of the nutritive value of prepared foodstuffs through the replacement of naturally occurring constituents such as fat by synthetic materials which cannot be utilized by the body and which may interfere with the normal absorption and metabolism of nutrients. Information was also given regarding the unforeseen consequences of the introduction of synthetic hormones into poultry husbandry; mink fed on the offal of chickens treated with hormones became sterile, an observation which has naturally led to a demand for a full inquiry.

There is now a substantial body of public opinion in the United States which favours legislation to deal with the various problems outlined above, and this proposal is supported by members of the medical profession and by others working in the fields of biochemistry and nutrition. The central issue under discussion is how to frame suitable legislation which, on one hand, will provide adequate protection for the consumer and, on the other, will also give freedom for new and legitimate developments in agriculture and food technology.

FRANCIS AYLWARD

MECHANICAL ENGINEERING RESEARCH ORGANIZATION

REPORT FOR 1947-50

UNTIL recently it was clear that in Great Britain research in mechanical engineering suffered from lack of any central co-ordination: a considerable amount of work was being done in government, industrial and university research laboratories, but in some branches the researches carried out were insufficiently fundamental, being directed towards the solution of immediate problems. A new organization was clearly needed, both to conduct basic research not carried out elsewhere and to serve as a focal point for all other research work. To meet this need the Mechanical Engineering Research Board was appointed in 1946 to advise on the organization and equipment of the government-sponsored Mechanical Engineering Research Organization, to which funds amounting to some £300,000 a year were allotted.

The first report of the director of the Organization has now been issued*. It is prefaced by a report of the Board, which reviews the broad issues involved and the progress achieved in the establishment of this new Organization. It gives a clear and concise account of the whole situation: the objectives, the resources available, the constructional work complete or projected, the research now in hand or planned, and the collaboration with other research bodies.

A new organization of this type cannot grow without any roots: it is necessary to train the teams who will work together, before they can be transplanted to other premises. There must be a proportion of well-established lines of research in addition to those that are quite new. In this case the greatest debt is to the Engineering and Metrology Divisions of the National Physical Laboratory, from which the nucleus of the Mechanical Engineering Research Organization has been formed.

It was decided, on broad national grounds, that the new laboratory should be situated in Scotland. The site adopted is at East Kilbride, near Glasgow, together with temporary premises a few miles away at Thorntonhall, and sufficient laboratories and essential services are now ready at East Kilbride for research work to begin there. The establishment is being organized into seven main divisions, the work of each being under the supervision of a committee of experts from industrial and other research laboratories. In addition, a considerable amount of extra-departmental research is being undertaken in collaboration with each division.

The first director of the Organization was Dr. G. A. Hankins, formerly superintendent of the Engineering Division of the National Physical Laboratory. Since his death in November 1950, Dr. D. G. Sopwith, his successor at the National Physical Laboratory, has been in charge on a part-time basis (see p. 769). His report gives a fairly complete picture of the work done during the first three years of the existence of the Organization. In the early stages the main emphasis was naturally on the formulation of future research programmes; this changed to the detailed design of laboratories and equipment and the recruiting and training of staff. The total staff in 1948 numbered only seventeen, but by December 1950 the scientific and technical staff had increased to sixty-three, together with a roughly equal number of ancillary laboratory, office and industrial staff.

The progress of the various researches and future work planned by each division is detailed, together with an account of extra-departmental projects. Even an outline of all the work undertaken or contemplated is impossible in this article. It ranges from the comparatively familiar tests and techniques used in the testing of materials to the development of the use and analysis of mechanisms, a branch of engineering science which has remained practically static for some fifty years. It is apparent how closely allied many of the researches are to other fields of scientific, as opposed to technological, research; it is, of course, quite impossible, and undesirable, to make any such distinction. It is intended, however, that the work of the Organization shall be carried through to the development stage, should it be considered essential to do this in order to make apparent the industrial advantages to be gained from the results of basic work.

This publication is likely to prove of interest to those engaged in scientific research of any sort, and it can be recommended as giving a clear idea of the progress and aims of the new venture. No longer can it be maintained with justice that technological research in Great Britain lags behind general scientific research, either in relation to its fundamental nature or to the breadth of outlook of those concerned with it.

R. H. MACMILLAN

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* Department of Scientific and Industrial Research. Report of the Mechanical Engineering Research Board, with the Report of the Director of Mechanical Engineering Research for the Period May 1947 to December 1950. Pp. 59+8 plates. (London: H.M.S.O., 1951; 2s. 6d.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Existence and Nature of the 'Positive Particles' near a Source of Radium E

We have recently taken two thousand pairs of photographs of the cloud-chamber tracks of particles emitted from radium E. The rays entered through a small aperture from a source situated outside the chamber, across the centre of which was stretched a foil of aluminium of mass 0·046 gm./cm.^{2}. The applied uniform magnetic field was about 220 gauss, and almost all the tracks showed a curvature indicating a negative charge. In a total of some 12,000 tracks, not more than twenty were found which proceeded from the source and which had a curvature in the opposite direction from that of the negative β-particles. Applying further very rigorous criteria of perfection, we can select three tracks *A*, *B* and *C*, of which *A* and *B* have $H\rho$ about 2,400, while the value for *C* is the highest recorded at 3,600.

It may easily be shown by the application of the conservation laws of energy and charge in the radium E→radium F transition that there is insufficient energy for positron–electron pair production with the observed momenta. Proceeding systematically to consider the values of e and m which would satisfy the observed values of $H\rho$, the available energy in the radioactive transformation and the conservation of charge, the remarkable fact emerges that the observations are plausibly satisfied only if $e = e_0/2$ and $m = m_0/2$ or zero, where e_0 and m_0 are the electronic charge and mass. The former particle would have e/m identical with that for an electron and would be indistinguishable from it in several qualitative aspects. Now particle *A* fails to appear on the other side of the foil, and in this respect it corresponds to the observed behaviour of many of the negative β-particles of similar $H\rho$. On the other hand, particle *B* appears to traverse the foil with little loss in energy, which is what might be expected for a particle with the high kinetic energy to be associated with a particle of zero rest mass. These ideas have been applied to the examination of earlier results obtained by other workers in this field and consistent results are obtained.

However, apart from their feeble intensity, it still remains very difficult to explain why such particles have not been detected by a conventional 180° β-ray spectrometer, since the action of the latter depends only on the values of $H\rho$ as a measure of the momenta of the particles, and is independent of the particular values of e/m. Further consideration of our photographs shows that, while the probabilities are remote, it is still possible to explain the 'positive tracks' without the introduction of any particles other than the negative β-particles. Particle *A* could be due to a scattered negative β-particle which has been deflected through about 140° just before reaching the foil, for in earlier work on large-angle scattering of fast β-particles by nitrogen nuclei, one such deflexion occurred in a similar total length of track. It must be pointed out, however, that to satisfy the experimental observations, not only is a scattering angle of this magnitude required but, in addition, the scattered particle must proceed directly towards the source in the plane of the chamber throughout its entire length. There is also the grave difficulty that the track, which might correspond to the parent before scattering, is seen to be in a different plane from the scattered track.

Since the source was situated outside the chamber, the chances of radioactive contamination were reduced to a minimum, although it was not completely absent. With regard to particle *B*, the two portions of the track which appear on each side of the foil could arise from independent events where one track originates from contamination on the chamber wall and proceeds to the foil, while the other could come from contamination on the foil itself (at the identical spot and at the same time as the first track) and then proceed to the source. The two tracks would have to be of about equal momenta and to proceed in the same direction at the foil. The chance of all these conditions being satisfied simultaneously appears utterly remote, even bearing in mind the fact that the momentum involved in these cases is, in fact, that corresponding to the most probable momentum of the negative β-particle spectrum. On the other hand, it can be shown on plausible grounds, based on the fact that the most probable β-particle energy is about one-third that of the upper limit of the β-particle energy spectrum, that this $H\rho$ is also the most probable value likely to occur if the existence of the new particles were real.

In view of the work already done, together with the present results, it seems unlikely that more cloud chamber experiments of this type will throw further light on this extraordinarily elusive problem; but it would be interesting to use other techniques for detecting the existence of these 'positive particles' now that the present work has suggested possible values of mass and charge. There does not seem less evidence for the reality of their existence than exists for the neutrino at present.

F. C. Champion
A. A. Ahmed

Wheatstone Laboratory, King's College,
University of London, W.C.2. Sept. 26.

An Experiment on Nuclear Alignment: the Anisotropy of γ-Radiation from Oriented Cobalt-60 Nuclei

Radiations from radioactive nuclei oriented at random are isotropic; but if the nuclei are even partially aligned, an anisotropic distribution should in general be found provided I is greater than $\frac{1}{2}$, as shown by Spiers[1]. In order to align nuclei, one makes use of the energy differences between the various orientations of the nuclear spin. By cooling to low enough temperatures, the lower levels will be preferentially populated, and in suitable systems this corresponds to a spatial alignment. In general, these energy differences are so small that temperatures obtainable only by adiabatic demagnetization must be used.

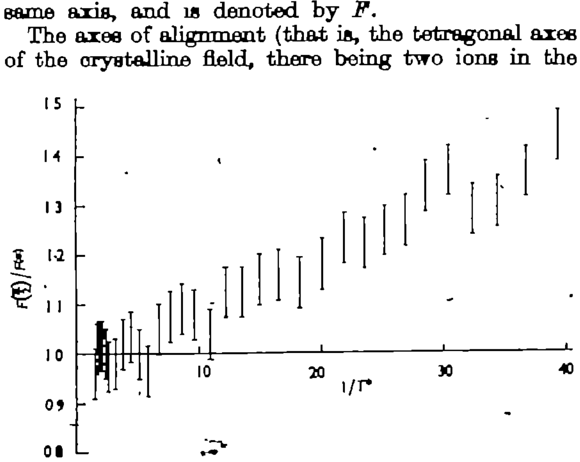
Besides the obvious and quite general method for producing these energy differences by an external magnetic field[2], the following more specific mechanisms have been suggested: by interaction between the nuclear electric quadrupole moment and the crystalline field (Pound's method[3]), or by the magnetic interaction between the nuclear spin and the resultant magnetic moment of the electrons in a paramagnetic ion. In this latter case the electronic moments must first be aligned, and this may be done either by a small external magnetic field (Gorter–Rose method[4,5]), or through the interaction of the electrons with the crystalline field (Bleaney's method[6,7]). Gorter, de Klerk, Poppema, Steenland and de Vries[8] carried out preliminary experiments using the Gorter–Rose method on the γ-emission from iron-59, and on neutron absorption in gadolinium, but inconclusive results were obtained. Thus, in the case of iron-59, only one experiment is reported to have given an anisotropy, which, however, was only 2 per cent with an experimental error of 1 per cent.

In the experiments which we report here Bleaney's method was used. The substance was a mixed Tutton salt with the composition (1% Co, 12% Cu, 87% Zn) $SO_4.Rb_2SO_4.6H_2O$. Copper acted as cooling agent, zinc as a non-magnetic diluent to reduce magnetic interaction and rubidium was chosen as monovalent cation so as to reduce exchange interaction[9]. This enabled us to attain a lower temperature than would have been possible with a concentrated salt, namely, about 0·02° K. from an initial H/T of 30,000 Oe./°.

Six single crystals of a total weight of 4 gm. containing about 70 microcuries of cobalt-60 were mounted in a demagnetization cryostat with parallel crystallographic orientation, and the K_1 and K_2 axes (two of the principal axes of susceptibility) in a horizontal plane. The γ-radiation was detected by four Geiger counters (G.E.C. Type *GM*4), two each along the K_1 and K_2 axes of the cobalt ions, placed at 10·5 cm. from the centre of the specimen and subtending an angle of 13°.

The counting-rate was taken for successive 10-sec. periods while the specimen warmed up, and, at the same time, readings were taken of the magnetic susceptibility of the specimen. It was necessary to use short measuring times because the specimen remained at a low enough temperature for about five minutes only. This was on account of the very small thermal capacity of the salt, and of the heating-rate of some 150 ergs/min., composed of the self-heating due to the radioactivity of the crystals, and of a small heat leakage. Frequent tests showed that the counters were stable, and that the counting-rates followed the normal statistical distribution; this has been assumed in evaluating the probable error of individual measurements. The number of counts observed in a particular 10-sec. period was normalized to the mean counting-rate obtained in the same counter when the specimen had warmed up to 1° K. This figure for each particular counting period was averaged with respect to the two counters on the same axis, and is denoted by F.

The axes of alignment (that is, the tetragonal axes of the crystalline field, there being two ions in the unit cell and hence two alignment axes) are perpendicular to the K_2 axis, and each makes an angle α (= 37·5° in cobalt rubidium sulphate[10]) with the K_1 axis, that is, with the horizontal plane[7]. Accordingly, the two values of F are denoted by $F\left(\frac{\pi}{2}\right)$ and $F(\alpha)$ respectively. Altogether, thirteen demagnetizations have been carried out on four different days under different experimental conditions, and all gave consistent results. Anisotropies of up to 44 per cent were observed, and the result obtained from one demagnetization which gave the maximum effect is shown in the accompanying graph, where $F\left(\frac{\pi}{2}\right)\Big/F(\alpha)$ is plotted against $1/T^*$. The 'magnetic temperature' T^* (defined by means of Curie's law) is not very different from the absolute temperature for this substance.



Variation with temperature of the anisotropy of γ-ray emission from cobalt-60 in dilute cobalt rubidium sulphate

In order to eliminate any effect due to individual counters, the experiments were repeated with the pairs of counters interchanged. It was also shown that the observed effect was not due to extraneous magnetic interference, because, on carrying out several demagnetizations starting from higher temperatures which resulted in little or no cooling, no anisotropy was observed.

The maximum effect observed by us, namely, 1·44 ± 0·05, is, judging from the shape of the curves and knowledge of the entropies, unlikely to be the saturation value. In comparing our values with theory it must be borne in mind that Spiers's discussion relates to γ-emission from aligned nuclei. In our experiment it is the cobalt-60 nucleus which is aligned, whereas the γ-radiation is emitted by the daughter nucleus nickel-60 formed by β-decay. If this β-transition from cobalt-60 to nickel-60 is accompanied by a change of angular momentum, the alignment may be partially destroyed. This has been discussed by Steenberg[11], who showed that no great reduction in the anisotropy of the γ-rays was to be expected for the possible angular momentum changes involved in the cobalt-60 β-decay. The maximum value of our effect is consistent with the saturation value predicted by Steenberg (1·6–1·7, according to the nature of the β-transition).

This experiment would not have been possible without the guidance and co-operation of Dr. N. Kurti and Dr. H. Halban. We wish to thank also Dr. B. Bleaney for stimulating discussion, and Prof. F. E. Simon for his continued advice and encouragement. Acknowledgment is due to the Department of Scientific and Industrial Research for generous help which made this research possible.

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F. N. H. Robinson

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Oxford. Oct. 16.

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Detection of Circularly Polarized γ-Rays and the Production of Polarized Electrons

In a recent communication[1], it was pointed out that the $(n-\gamma)$ processes induced by polarized neutrons will in general lead to partially or totally polarized end-products. In particular, it was shown that for spin values of the initial and resulting nucleus of 0 and $\frac{1}{2}$, respectively, the γ-ray emitted in the direction of the spin of the incident neutron is completely circularly polarized. The same result holds true for the pair of spin values $\frac{1}{2}$, 0.

I wish to report now on some simple results concerning possible experiments with circularly polarized γ-rays. Choosing a special case of the Compton effect in which the quantum is scattered backwards and the electron forward in the direction of incidence, one finds that for moderately large quanta $\left(\frac{h\nu}{mc^2} \gtrsim 3\right)$ and an unpolarized electron initially at rest, the scattered electron is almost totally polarized, its spin pointing in the direction of propagation.

Similarly, if the electron is initially suitably polarized, the scattering cross-section will vary (in the approximation used) between zero and twice the value obtained for an unpolarized electron.

A detailed discussion, including that of other interactions between γ-rays and electrons, will be published in the *Physical Review*.

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The Helix as a Linear Accelerator for Protons

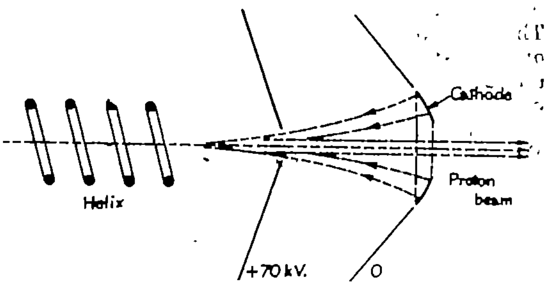
An electrostatic generator, designed for 4 MV., has been built at this Laboratory to accelerate positive ions, and the possibility of increasing the energy of protons from this machine to about 20 MeV. by means of a linear accelerator has been considered.

The disk-loaded wave-guide type of linear accelerator used for electron acceleration is impracticable for protons in this energy-range on account of the low phase-velocities required (0·1–0·2c). The high-frequency losses would be prohibitive and the tolerances in dimensions impossible to meet.

A more practicable form of proton accelerator is that suggested by W. Walkinshaw[1], consisting of a circular wave-guide made up of a closely wound helical wire. Roughly, the travelling wave tends to follow the wire and is slowed down in the ratio of the pitch to the circumference of the helix. More accurately, the phase-velocity can be calculated from an approximate field solution given by Pierce and Schelkunoff[2].

In a proposed design, assuming the helix radius to be 1 cm., the optimum free-space wave-length is found to be 1 metre. If the radio-frequency power flowing down the guide is 2 MW., an accelerator 11 metres long will accelerate the protons from 4 to 20 MeV. The power dissipated in the helix is 380 kW.; the remainder can be fed back from output to input through an external line and suitable phase-correcting network.

The chief difficulty in principle arises from the defocusing effect of the wave on the proton beam. Those protons which get caught up by the wave and accelerated with it oscillate slowly about a stable phase-point which lies in front of the peak of the axial field; that is, in the region where there is a radial component of electric field outward. This radial component would cause a proton beam of initial radius 1 mm. to spread and touch the helix in a distance of about 1 metre.



Possible arrangement of electronic gun

It is suggested that this may be prevented by sending a beam of electrons along the axis of the guide, in the opposite direction to the protons for convenience. The beam would be launched by some form of annular gun through which the proton beam could pass. The space charge per unit length of the electron beam must be sufficient to create a radial electrostatic field inward, equal to the maximum outward field arising from the wave. The energy of the beam must be such that no electrons are turned back by the wave at any point along the guide or at any phase of entry. Simple calculations indicate that a beam of 1 amp. at about 70 kV. is required. The electron gun may be pulsed in synchronism with the radio-frequency oscillator in order to ease problems of heat dissipation and X-ray intensity. An electron gun has not yet been designed, but the accompanying diagram suggests a general arrangement of electrodes at the output end of the helix.

It is further suggested that the spreading of the electron beam under its own space-charge forces may be prevented by applying an axial magnetic field along the guide by means of a long solenoid. The electrons then acquire a cycloidal component of motion in a plane normal to the axis, similar to the motion in a cylindrical magnetron. Assuming the initial radius of the beam to equal that of the proton beam (1 mm.), and using the magnetron cut off equation, one can calculate the magnetic field required to prevent the beam radius from exceeding the value needed to keep the proton beam properly focused. Values obtained in this way range from 870 gauss at the input end of the accelerator to 570 gauss at the output end. The divergent field at the open end of the solenoid may be used, with careful design, to guide the electrons from the annular cathode in towards the axis.

The spread of energy in the emerging proton beam will depend on how far the stable phase-point is in advance of the peak of the field. Taking this phase angle to be 35°, the maximum amplitude of phase excursion a particle can have is 70°. The maximum kinetic energy such a particle can have relative to the wave is that due to this phase excursion through the axial field, and amounts to 50 keV. at the output end. Converting this to velocity, transforming to the laboratory frame of reference, and reconverting to energy, one finds that the energy spectrum of the output beam has a maximum value of ± 10 per cent, or approximately ± 7 per cent at half amplitude. This spread can be reduced by reducing the angle of the stable phase-point, with a corresponding reduction in number of protons caught up per cycle by the wave, and hence in the mean output current.

We wish to thank Messrs. R. L. Fortescue, W. W. Walkinshaw and J. S. Bell[3] for valuable discussions and suggestions in connexion with this work, and we are indebted to Dr. T. E. Allibone for permission to publish this communication.

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Polymorphism arising from Screw Dislocation

Frank[1] predicted from theoretical considerations that crystal growth may proceed owing to the presence of screw dislocations. Spiral growth-steps confirming these ideas were observed by Griffin[2] in beryl crystals and by Dawson and Vand[3] in *n*-paraffin crystals. The dislocation responsible for the growth of a crystal may be described by means of a Burgers vector. For a simple screw dislocation, this vector is one structural unit in length and perpendicular to the growing face, so that a spiral growth-step one unit in height is generated. In a certain number of cases the Burgers vector is several units in length, the original length being determined by the detailed shape of the primary nucleus or other accidents of growth.

In many layer structures, several kinds of stacking having nearly equal energies are possible, the best-known example being the cubic and hexagonal stacking of layers of spheres. If the crystal grows by successive deposition of fresh layers, then a random disorder in the succession of the layers would result. However, if the crystal grows by means of a screw dislocation, then it consists of a single sheet spirally wound around the screw dislocation, the pitch of the screw so formed being equal to the Burgers vector. When the growth-sheet is several packing layers thick, any original packing mistakes in the sheet would repeat themselves throughout the crystal with the periodicity of the Burgers vector. Crystals so formed may be regarded as exhibiting polymorphism, the particular polymorphic form being defined by its unit-cell dimension and the arrangement of the stacking within the unit cell.

In order that this type of polymorphism could be observable, the following conditions must be fulfilled: (*a*) more than one possibility of stacking of layers should be available; (*b*) the crystal growth should proceed by means of screw dislocations having a Burgers vector more than one structural unit in length; (*c*) the screw dislocation system should be stable, that is, the Burgers vector should remain the same throughout the growth of the crystal.

If the last condition is not fulfilled, then twins or multiple intergrowths, each in a different polymorphic form, would result.

It is possible that this type of polymorphism may be quite widespread in Nature. The best example is that of silicon carbide, which is known to exhibit a wide variety of polymorphic forms. In silicon carbide, the screw dislocations must be very stable, as large crystals all in the same polymorphic form occur. Another substance which shows this type of polymorphism is graphite; but, owing to its softness, its polymorphism can be studied only on very small crystals. A more detailed discussion will be published elsewhere. I wish to thank Prof. J. Monteath Robertson for his interest, and Drs. I. M. Dawson and F. C. Frank for valuable discussion.

Note added in proof. In a recent paper, Frank[4] has advanced a similar explanation of polymorphism (polytypism) of silicon carbide.

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Growth Spiral Patterns on Carborundum Crystals

Observations on growth spirals on carborundum crystals have been reported earlier[1], affording experimental evidence of Frank's theory of crystal growth depending upon dislocations. Some new and unpredicted features of these growth spirals are reported here.

In Fig. 1 is shown part of an interlaced spiral in which in any one orientation *seven* steps are seen to group together. On following these steps to the other side of the interlaced portion, the same sequence of spacing repeating itself has been observed (not shown in Fig. 1). Under low magnification these grouped steps give an appearance resembling optical band spectra.

On another crystal a similar grouping of *five* steps has been observed. In addition, on one face of a crystal the number of steps grouped together has been observed to change in certain regions.

These features can be explained thus. The different polytypes of carborundum have the Ramsdell's zig-zag sequence[2] or Zhdanov[3] symbol of $[(33)_n32]$. Using Frank's notation[4], the structure can be written as $[(\nabla\nabla\nabla\Delta\Delta\Delta)_n\nabla\nabla\nabla\Delta\Delta]$. Whichever layer has the slowest velocity of growth in any one orientation—say, the first ∇ after a series of Δ's—then it will repeat itself after six such layers, making the growth steps 15 A. high, until we reach the last layer $\nabla\nabla\nabla\Delta\Delta$, which will be only 12·5 A. high. After this the whole sequence will go on repeating itself. Thus, depending upon the number *n*, we will have a certain number of steps grouping themselves together. The observation of the changing number of grouped steps together suggests a change in type from one part of the crystal to another. This may account for the disagreement between crystal symmetry and X-ray diffraction data sometimes observed[5].

The observation of this grouping of steps is another visual confirmation by crystal growth patterns of the repeat sequence predicted by X-ray phenomena.

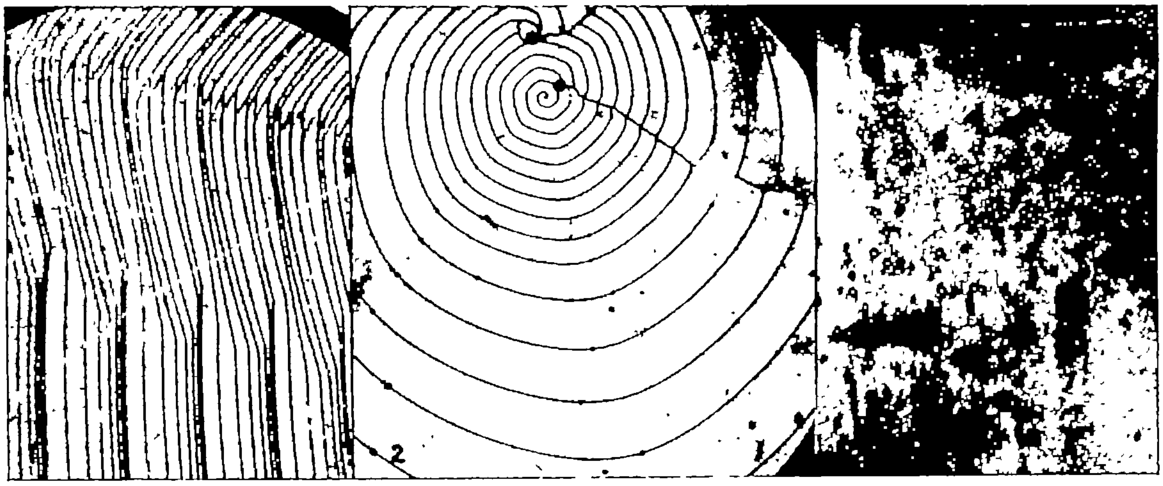

Fig. 2 shows a spiral in which spots are seen just on the edges of the steps. Their size generally increases as we go away from the centre.

Fig. 3 shows a number of hexagonal spirals originating from screw dislocations, the point of emergence of which is marked by a somewhat hexagonal spot. A large number of similar spots with no spirals attached to them are also seen. These are sometimes linearly arranged. At the Bristol Summer School (1951), where some of these pictures were presented, it was suggested by Dr. F. C. Frank that these may be the ends of edge dislocations.

I wish to express my thanks to Prof. S. Tolansky for his interest, and to the British Council for the award of a scholarship.

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Relationship Between the Extinction Coefficient and the Particle Size

THE experimental determination of the relationship between the extinction coefficient and the particle size for spherical bodies having diameters less than about 50 microns is of considerable theoretical interest in the verification of certain aspects of the vector theory applicable to the problem, and also of practical importance in the application of the photo-extinction method of powder-size analysis.

For these reasons the relationship has received considerable theoretical and experimental investigation; but, even so, a study of the literature shows that the available data are conflicting.

Further examination of the problem, however, shows that the deviations occurring between the results of the different experimental determinations are probably due to errors arising from the following causes: (1) the suspensions tested are usually composed of ground mineral powders, and so the particles are, in general, not truly spherical; (2) the samples tested are usually sized for diameter by levigation and, owing to the limitations of the method, the size limits are often indefinite; (3) complete elimination of fine material from the sample is difficult, and even traces of residue introduce considerable error; (4) the calculated size characteristics of samples of particles, of size less than say 5 μ, are often unreliable due to errors introduced by Brownian movement and thermal currents in the fluid in which the samples are separated; (5) aggregation of the particles in the suspension occurring during the normal photo-extinction test is undetected, and it is probable that errors of unknown magnitude, arising from this cause, are frequently included.

In the present investigation these sources of error are either eliminated or the magnitude of their effect determined and an appropriate correction applied to the results.

For particles of size up to about 25 μ diameter, spheres of fused powdered glass and of polystyrene are used. The preparation of glass spheres of size greater than about this figure is not practicable so, in order to extend the size-range, a desert sand and a silica sand are used. The particles of these sands approximate closely to spherical, but a small correction for the deviation from sphericity is made upon the basis of the shape factors suggested by Heywood[1].

The glass and sand powders are sized within reasonably close nominal limits of size by repeated levigation, these fractions then being submitted to sedimentation in a photo-extinction apparatus which has been described elsewhere[2], and a curve of ln I_0/I plotted against the corresponding Stokes's diameter obtained—I_0 and I being the incident and emergent light intensities respectively.

From this curve is calculated the mean size and the size limits of the sample, and also the increment of ln I_0/I due to the material in this size-range. Furthermore, the approximate weight of the material, mainly of size less than about 2 μ, not removed by levigation, is computed from the curve and an appropriate correction to the concentration of the suspension determined.

The substitution of these corrected values in the equation of light transmission through a suspension of particles,

$$\ln I_0/I = 1\cdot5 \frac{Cl}{\rho d} K_e$$

llows the calculation of the corresponding extinction oefficient, K_e.

The extinction coefficient for the plastic spheres is etermined without recourse to corrections, the iameter as obtained from an electron photomicrograph being used.

It seems probable that by these means the rrors enumerated above are almost completely liminated.

The relationship of extinction coefficient and particle size as obtained from the present experiments s shown by the relevant points on the appended graph, and it will be seen that, in the range where he results for the different materials overlap, the oints applicable to desert sand agree well with hose for the glass spheres, and those for silica and agree well with those for desert sand; thus onfirming the accuracy of the correction for nonphericity.

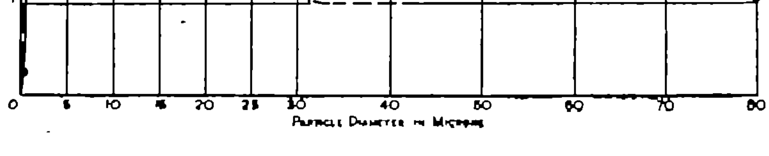
The full line on the graph is considered to be the best line through these points; this line being drawn, or materials less than 10 μ in diameter, to correspond with the theoretical curve suggested by Stratton and Houghton[3], since there is considerable evidence of the validity of the results of these workers for this range, and also the experimental points fall well upon uch a curve.

The broken curve shows a portion of the solution uggested by Stratton and Houghton, and for diameters greater than about 17 μ an extension to he solution of Stratton and Houghton suggested, on heoretical grounds, by Brillouin[4].

Within the range 1–2 μ, the experimental data are canty, but it is interesting to note that two points determined by Vouk[5] fall well upon the curve of Stratton. These points, which do not fall on the curve deduced by Vouk and which appear to have received no mention in his thesis, give further confirmation to the curve of Stratton and Houghton for this range.

From these results it appears that the theoretical xtension of the curve of Stratton and Houghton, deduced by Brillouin, is of the form obtained by experiment, and hence that Brillouin's interpretation of the terms in the vector equations is correct.

The agreement between the theoretical and the xperimental results also supports the view that the full curve of the graph may be used with confidence in the determination of the size characteristics of fine powders by the photo-extinction method; the procedure for the application of such a curve to this problem has been given in detail elsewhere[6].



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Improving the Performance of a Littrow-type Infra-Red Spectrometer

IN a recent communication in *Nature*, A. Walsh[1] suggested a means of improving the performance of a commercial infra-red spectrometer by adding extra plane mirrors so that the radiation traverses the prism four times instead of twice, and then chopping the partly dispersed radiation so that only the wanted radiation is interrupted and consequently measured. The advantages claimed are that the instrument is in effect converted into a double-monochromator with improved resolution and complete freedom from stray light even at 15 μ.

It is the purpose of the present communication to point out that similar ideas have been suggested previously, and to describe an alternative and perhaps simpler way of applying them to existing spectrometers.

Some years ago, Dr. W. C. Price (then with Messrs. I.C.I., Ltd.) explored the possibility of increasing resolution by traversing the prism four times instead of twice, as indicated in Fig. 1. Resolution is certainly improved, but two difficulties arise: (1) normally the entrance slit is curved to give a straight spectral image on the exit slit, but two extra traversals of the prism will introduce further curvature so that either the exit slit must have curved jaws also or the entrance slit must be given still greater curvature (Walsh does not mention this point in his letter); (2) with so many traversals of the prism, stray light, already troublesome in Littrow-type instruments, is likely to be further increased.

A natural development from Dr. Price's suggestion is to use a small plane mirror close to the entrance slit to reflect the rays back through the prism; but this fails because the initial dispersion is annulled during the third and fourth traversals of the prism. This difficulty is easily overcome by using a pair of plane mirrors at right angles to return the radiation through the prism. (The guiding rule is that radiation in successive traversals must not switch from base to apex of the prism or vice versa.)

We thus arrive at the arrangement proposed by Walsh, but in our modification the plane mirrors are placed above the entrance slit instead of alongside (Fig. 2). This arrangement is generally more easily applied to an existing

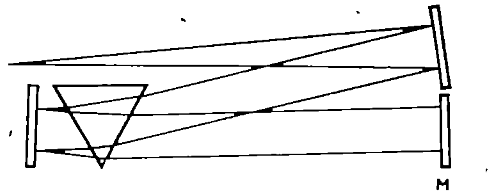

Fig. 1. Littrow system with additional plane mirror *M*, as used by Dr. W. C. Price

spectrometer and has the advantage that the small angle off-axis in a vertical plane (about 1° in the *S*3 spectrometer) tends to reduce the curvature of image already mentioned. In practice, it is unnecessary to make any alteration to the slits, which is a point of some practical importance.

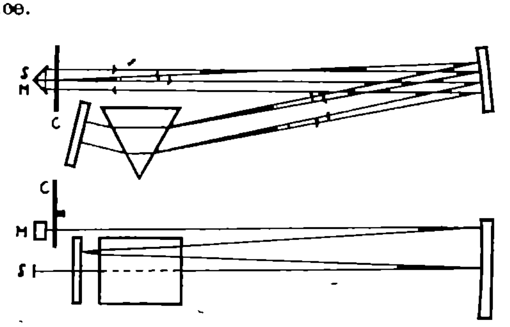

Fig. 2. Plan and elevation illustrating a simple method of converting a single- to a double-monochromator. *S* is the entrance (and exit) slit and *M* a pair of plane mirrors mounted at right angles to each other

The elimination of stray light by chopping after initial dispersion has already been described[2]. In our arrangement the chopper *C* is placed at the position shown in Fig. 2. If the primary spectrum is imagined spread out horizontally across the pair of mirrors, only a small band of wave-lengths will be intercepted by them. If stray light of some other wave-length happens also to fall on these mirrors, it will, of course, be interrupted, but will be separated from the wanted radiation during the further traversals of the prism.

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[1] Walsh, A., *Nature*, 167, 810 (1951).

[2] *Perkin-Elmer Instrument News*, 1, No. 4, 3 (1950).

The Xi-Phase and a New Sigma Phase

Six phases with structures isomorphous with the iron – chromium sigma phase have been reported in binary alloys of the transition elements of the first long period[1–3]. In addition, Goldschmidt[4] has shown that the phase FeMo, stable between 1,180° and 1,540° C., has the same structure. In the binary system cobalt – molybdenum, a similar phase Co$_2$Mo$_3$ exists between 1,250° and 1,620° C.[5]; recent work in this Laboratory has shown that Co$_2$Mo$_3$ has a sigma-phase structure. The interplanar spacings of the alloy containing 61 atomic per cent molybdenum are very similar to those of the alloy with 50 atomic per cent FeMo given by Goldschmidt, except that they are slightly smaller, as might be expected when the slightly smaller cobalt atom replaces iron. Multiplying the Co$_2$Mo$_3$ *d*-values by 0·981 gives values which agree well with those for FeCr given by Goldschmidt[4].

As in the iron – molybdenum system, the cobalt – molybdenum sigma-phase has only a limited temperature-range and decomposes peritectoidally to form the xi-phase Co$_7$Mo$_6$, which has a rhombohedral structure stable over a wide range of temperature. It is of interest to compare the occurrence of the sigma- and xi-phase in the binary systems of iron and cobalt with chromium, molybdenum and tungsten respectively. Where the second element is in the same period the only intermediate phase is sigma, which has a wide stability range. With molybdenum both iron and cobalt form a sigma-phase, though this has only a restricted stability-range and decomposes to the xi-phase. In the case of tungsten, the xi-phase only is found. The reason for this transition does not appear to be predominantly a size effect, as there is little difference in the atom sizes of molybdenum and tungsten; it is more probable that it is an electronic one. The xi-phase may thus also be an electron compound, as has been suggested by Sully[6] for the sigma-phase; as is the case with the sigma-phase, the proportions of molybdenum and tungsten are greater in the cobalt phases than in the iron ones.

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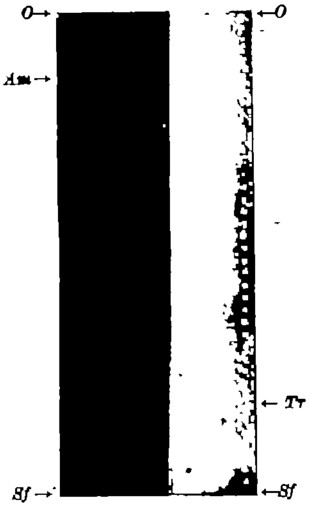
Separation of Enzymes by Paper Chromatography

In a recent publication[1] from this laboratory, a technique for the study of the chromatographic behaviour of enzymes on paper was described. The ease with which enzymes can be readily identifie on the paper chromatogram by the agar-plate metho enabled us to study the chromatographic behaviou of some of the important enzymes. In the course of preliminary experiments with amylases, phosphorylases and phosphatases from various sources we found that some enzymes did not move at al while others moved considerable distances on th paper. This observation prompted us to attemp the separation of enzymes by paper chromatography

Apart from the work of Mitchell, Gordon anc Haskins[2], who report that some separation of adenosine deaminase from amylase has been achieved b their 'chromatopile' method, no really complet separation of enzymes by paper chromatography ha been reported. In a recent note by Wallenfel and Pechmann[3], which appeared after we sen our communication[1] on the technique for the detection of enzymes on paper, the separation of th enzymes of a mould extract by a micro-electrophoreti technique was described. However, by adopting th usual paper chromatographic technique and usin aqueous acetone or sodium chloride or a suitable com



Chromatogram showing the separation of amylase from trypsin: *O*, origin; *Sf*, solvent front; *Am*, amylase; *Tr*, trypsin

ination of these two as developing solvents, we ve been successful in achieving a few good separa- ons of the individual enzymes from mixtures pre- red artificially or obtained from natural sources such mould or tissue extracts.

As a typical example of the separation that can so readily obtained by the paper chromatographic ethod, we reproduce a photograph of the separation amylase from the proteinase, trypsin, present in mmercial trypsin powder (Pfanstiehl Chemical ompany). From the photograph, it can be seen at the amylase shows little or no tendency to ove, whereas trypsin has moved quite a distance om the starting line, and a complete separation f the two enzymes is thus obtained. As it is necessary adhere to our procedure to be able to reproduce ccessfully the above separation, we are giving elow the essential features of our method.

A 2 per cent aqueous solution of commercial ypsin powder was prepared and centrifuged to move the suspended impurities. By means of a icro-pipette (11 μl.) two spots of the enzyme solution ere placed, at an interval of 4 cm., on the starting ne of the filter paper strip (Whatman No. 1, 40 × 8 n.). The chromatogram was run at low tempera- re (0–5° C.), the developing solvent being 50 per nt aqueous acetone containing 1·5 per cent sodium loride. After the solvent front had advanced a stance of 25 cm. from the starting line, the filter per strip was removed from the chromatographic amber and cut into two strips (*A* and *B*) longitudin- ly, to locate the positions of the two enzymes. The sition of the amylase on strip *A* was detected by e method previously described[1]. The elegant and mple method of Wallenfels and Pechman[3] for the tection of proteinases was used for locating the ypsin on the chromatogram. Accordingly, strip *B* s placed on the wetted gelatin side of a 35-mm. né-film strip about 12 in. long. The combination was aced in an incubator at 30° C. and water was sprayed, intervals, on to the paper to keep it moist. After out two hours, which was sufficient for the trypsin liquefy the gelatin, the paper was removed from e film strip. The position of the enzyme, trypsin, the paper is indicated by liquefaction of the latin, resulting in the formation of a clear zone.

It is interesting to note that neither aqueous acetone nor water alone is able to bring about any appreciable movement of trypsin. However, the addition of sodium chloride in concentrations as little as 0·5 per cent to the aqueous acetone or water results in the trypsin moving a considerable distance from the starting line. Further, we have observed that the use of saline solutions enhances the definition of the spots by arresting tailing.

Details of the other separations of enzymes so far achieved by us will be published elsewhere.

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Dissociation of Complex Ions in Non-Aqueous Solvents

We have developed recently[1] a method for the micro colorimetric estimation of iron as triphenylmethylarsonium hexathiocyanato ferrate III, $(Ph_3MeAs)_3(Fe(CNS)_6)$, in which this compound was extracted from aqueous solution with *o*-dichlorbenzene in the presence of about seventy equivalents of triphenylmethylarsonium thiocyanate. The orange-red solution had a sharp absorption maximum at 478 mμ (curve *A*), the same wave-length as that observed by Woods and Mellon[2] for the ammonium salt $(NH_4)_3(Fe(CNS)_6)$ in water.

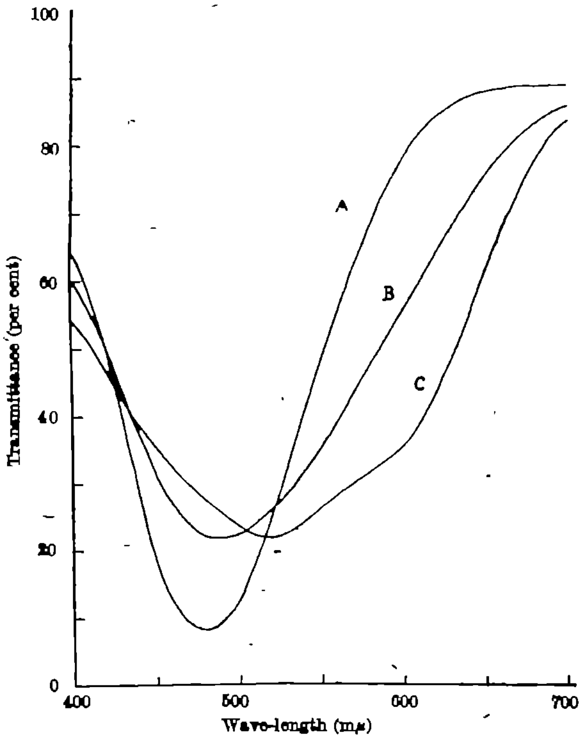
The solid, analytically pure, iron compound could be isolated as a dark red crystalline powder. In *o*-dichlorbenzene this gave a purplish-red solution, with a broad absorption maximum at 488 mμ (curve *B*). The solution became violet when warmed, and reddish when cooled in ice. When the solution was progressively diluted with the solvent and correspondingly thicker cells were used for the determination of the absorption curve, the colour also became violet, developing a sharper absorption maximum at 520 mμ, while in the most dilute solutions a new absorption maximum commenced to develop in the region of 600 mμ (curve *C*). Addition of triphenylmethylarsonium thiocyanate to the violet solutions changed the colour to orange-red. The colour changes are not due to colloidal micelles of different sizes, since a large excess of triphenylmethylarsonium perchlorate caused the violet solutions to become only slightly redder.

The various arsonium compounds used were soluble in a wide variety of non-aqueous solvents such as chloroform and ethylene dichloride in spite of the fact that they are salts. This is undoubtedly due to the large covalent moiety and the existence of ion pairs in the solution.

The colour changes are consistent with the following equilibria, in which arsonium thiocyanate is detached from the complex salt as an ion pair:

$$(Ph_3MeAs)_3(Fe(CNS)_6) \rightleftharpoons (Ph_3MeAs)CNS + (Ph_3MeAs)_2(Fe(CNS)_5) \rightleftharpoons 2(Ph_3MeAs)CNS + (Ph_3MeAs)(Fe(CNS)_4).$$

The triphenylmethylarsonium radical confers solubility in organic solvents on a great number of com-



Curve A: $(Ph_3MeAs)_3(Fe(CNS)_6)$ in o-dichlorbenzene (4·0 μgm. Fe/ml.) + 70 equivalents of $Ph_3MeAsCNS$. 0·5 cm. cell.
Curve B: $(Ph_3MeAs)_3(Fe(CNS)_6)$ in o-dichlorbenzene (4·0 μgm. Fe/ml.). 0·5 cm. cell.
Curve C: $(Ph_3MeAs)_3(Fe(CNS)_6)$ in o-dichlorbenzene (0·5 μgm. Fe/ml.). 4·0 cm. cell.

plex anions such as $FeCl_4'$, BiI_4', $Co(CNS)_4''$, and dissociation of the above type is probably a general phenomenon.

The dissociation of complex salts in water, as pointed out by Bjerrum[3], is complicated by the competition of water molecules for co-ordination positions of the metal, so that complexity constants are not measures of the affinity of the metal for a particular ligand, but of the change in free energy when a solvent molecule is replaced by the ligand. The determination of dissociation constants in solvents such as o-dichlorbenzene or carbon tetrachloride should give a very close evaluation of the true affinities of metals and ligands, as well as the energy of dissociation, since these solvent molecules can be attached by only the weakest of bonds.

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Identity of Lespedin with Kæmpferitrin

From the leaves of *Lespedeza cyrtobotrya* Miquel, a deciduous shrub of the natural family Leguminosæ, M. Hasegawa and I isolated a kæmpferol glycoside which we named lespedin[1,2], its structure being shown to be kæmpferol 3,7-dirhamnoside. It has also been isolated from *Celastrus orbiculatus* Thunberg (family Celastraceæ) by M. Kanao and M. Shimokoriyama[3]. When crystallized from water, lespedin had meltin point 195° with or without water of crystallizatio $(3\frac{1}{2}H_2O)$, whereas from ethanol it melted at 234°. I thus appeared to be different from kæmpferitrin melting point 201–203°[4].

Having learnt from Dr. E. C. Bate-Smith that th kæmpferitrin employed in his chromatographi studies was obtained from the original collection o the late Prof. A. G. Perkin (through the courtesy o Dr. E. J. Cross of the Department of Colour Chemistry University of Leeds), I sent a specimen of lespedin t Dr. Bate-Smith in order to have the mixed meltin point of the two glycosides tested. The results h has communicated to me are as follows :

	Softening point	Melting point
Kæmpferitrin	190–192°	194°
Mixture	190–194°	195°
Lespedin	190–194°	195°

Rf values in butanol – acetic acid – water (4 : 1 : 5) and phenol water are for both 0·71. The colours given in ultra-violet light and i ammonia are also identical.

I am satisfied that the identity of lespedin wit kæmpferitrin has been thus established, and the nam 'lespedin' becomes, therefore, redundant.

I wish to thank Dr. T. Swain, who carried out th determinations, and Dr. E. C. Bate-Smith, both o the Low Temperature Research Station, Cambridge for their kindness.

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Cholinesterase Activity in the Secretions o the Pancreas of the Dog and Parotid of the Pig

It has been recognized for some time that th pancreas of the dog contains large amounts (pseudo-cholinesterase[1], and the parotid gland of th pig is known to have a much higher cholinesteras activity than other digestive glands in this species Gmsberg *et al.*[2], using a biological method, found the dog's pancreatic juice possessed at least fifteen time the enzyme activity of the blood, but this observation does not so far seem to have been confirmed.

In view of this work and other experiments whic will be reported separately, dog's pancreatic juic secreted in response to different stimuli, was examined for the presence of pseudo-cholinesterase. Th animals were anæsthetized with chloralose before cannulation of the accessory pancreatic duct. Extract of the mucosa of the small intestine and pilocarpin were injected intravenously to stimulate secretior Pseudo-cholinesterase in the juice and in wate homogenates of the gland was estimated manometrically at pH 7·4 with 0·06 *M* acetylcholin perchlorate (B.D.H.) as the substrate. The unit o cholinesterase is defined as the amount of enzym which liberated 1 μl. carbon dioxide/min.

PSEUDO-CHOLINESTERASE ACTIVITY OF DOG'S PANCREATIC JUICE AND PANCREAS

Exp.	Pancreatic juice secreted in response to:			Pancreas (units/gm.)
	Pilocarpine (units/ml.)	Secretin preparation (units/ml.)	Vagal stimulation during secretin flow (units/ml.)	
I	3,240 3,120	420 500	—	1,450
II	1,380 1,450	1,080	1250	2,000
III	2,700 2,870	765 960	1470 1870	2,570

The activity of the pseudo-cholinesterase in the pancreatic secretion of three dogs is shown in the accompanying table.

The results indicate that pseudo-cholinesterase can be present in high concentration in the pancreatic juice of the dog, and in these experiments the amounts appeared to vary according to the stimulus employed, in a manner similar to that of the other enzymes of the juice. In two of the experiments the activity of the secretion was greater than that of the gland, which was removed at the end of the experiment.

Parotid saliva was obtained from two pigs anæsthetized with chloralose, and from two after decerebration under ethyl chloride and ether anæsthesia. Difficulty was experienced in estimating the cholinesterase activity in a satisfactory manner; but it was clear that acetylcholine was hydrolysed at a high rate by the parotid saliva (saliva 30–640 units/ml.; gland 410–670 units/gm.; serum 10 units/ml.).

These preliminary experiments confirm that cholinesterases may be secreted actively by glands[4]. It is not yet possible to assess the significance of their presence in the secretions of digestive glands; but they may have some useful function in the lumen of the gut.

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Stimulation of Bile Secretion in Chick Embryos by Cortisone

In some preliminary experiments it was observed that the administration of cortisone to twelve-day old chick embryos caused their gall bladders to become distended and bile to flow prematurely into their intestines. Accordingly a substantial experiment was performed to confirm or deny these preliminary findings, and since there are certain difficulties associated with obtaining either rapid or complete absorption of substances injected into chick embryos, comparatively large doses of cortisone were employed. A dose of 5 mgm. of cortisone ('Cortone acetate') was given to each of sixty White Leghorn chick embryos on the twelfth day of incubation, either by injecting it into the yolk or on to the chorioallantoic membrane. For controls, seventy-five embryos were similarly injected with the same volume of normal saline. The eggs were harvested on the fifteenth day of incubation. The diameters and the lengths of the gall bladders were measured with calipers and their volumes were determined by assuming them to be cylinders. Observations were made in each instance on whether or not bile had reached the intestine to colour it green.

Forty of the sixty embryos receiving cortisone had larger gall bladders than the largest encountered in the control series. The average calculated volume of gall bladders in the cortisone group was 21·1 c.mm. and that of those in the control series 6·9 c.mm. In twenty-eight of the cortisone-treated embryos, bile had reached the intestine to colour it green; this had not occurred in any of the control embryos.

The finding that cortisone can stimulate bile secretion raises the interesting question of how this effect is exerted. With regard to the possibility of the injected cortisone contributing to the formation of bile salts, which in turn produce the effect observed, it should be noted that in our experience the injection of sodium dehydrocholate into twelve-day old chick embryos also stimulates bile secretion; hence the liver at this stage of development is competent to respond to a bile salt stimulus. But since Paschkis, Cantarow, Walkling, Pearlman, Rakoff and Boyle[1] have shown that carbohydrate-active oxysteroids can be recovered from the bile of dogs given adrenal cortical extracts, the possibility of cortisone being excreted as such into bile and, in being excreted, directly stimulating the flow of the medium in which it is contained, should also be considered.

We wish to acknowledge financial assistance from the National Cancer Institute of Canada and the Foster Bequest Fund of the University of Toronto.

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Antivitamin D Factor

Rickets, attended by a reduction in gain of weight, has been frequently reported in weaned lambs grazing on green oat plants and other green feeds during the winter in the South Island of New Zealand[1,2]. The effect is not confined to green feeds grown in this country, since Ewer has demonstrated a rachitogenic effect of green oats grown in England[3].

Previous work in New Zealand[2,4,5] has shown that there is adequate calcium and phosphorus in the rickets-producing plants and that supplementary feeding of calcium and/or phosphorus does not prevent the disease. Rickets was prevented and normal growth-rate restored by a single massive dose of 'Calciferol' (1,000,000 i.u.) given at the commencement of green feed grazing[5], but not by weekly doses of cod liver oil which provided an average of 300 i.u. of vitamin D a day, which is approximately twice the normal daily requirement of young sheep[6]. It was therefore postulated that a rachitogenic factor was present in the green feeds on which ovine rickets occurs. Further support for this hypothesis has been obtained from a recent investigation[7] which suggested that the incidence of solar ultra-violet radiation on sheep grazing green oats was at least as great in an area where rickets occurred as in one where no rickets developed.

A laboratory study was undertaken at this Research Station to investigate the nature and occurrence of the rachitogenic factor in green oats. The white rat was employed as the test animal, and it was kept under the same regime as that developed by Hume *et al.*[8] for the biological assay of vitamin D. By measuring the influence of oat extracts on the ash content of rat bones, the existence of an anti-vitamin D factor has been firmly established. Some of the results are outlined in the accompanying tables.

Table 1 indicates the rachitogenic properties of a chloroform-extract of dried young green oats when given to rats in dilute solution in olive oil. The results summarized in Table 2 indicate the pronounced effect of the oat extract in depressing the bone ash response to vitamin D.

Table 1 (12 rats per group)

Group	Daily dose	Average % ash in dry fat-free femur
1	0·3 gm. olive oil	31·2
2	0·3 gm. solution *X**	27·8

* *X* is a 1 in 30 dilution of the oat extract in olive oil.

Table 2. (7 rats per group)

Group	Daily dose	Average % ash in dry fat-free femur
1	0·3 gm. olive oil containing 0·1 i.u. vitamin D	34·6
2	0·3 gm. solution *X* containing 0·1 i.u. vitamin D	30·1
3	0·3 gm. olive oil containing 0·2 i.u. vitamin D	38·3
4	0·3 gm. solution *X* containing 0·2 i.u. vitamin D	33·1
5	0·3 gm. olive oil containing 0·3 i.u. vitamin D	40·9
6	0·3 gm. solution *X* containing 0·3 i.u. vitamin D	37·0
7	0·3 gm. solution *X* containing 0·4 i.u. vitamin D	38·2

That these results were not due to any factor associated with the oat extract which might reduce the amount of vitamin D absorbed from the gut was demonstrated in another experiment by administering the vitamin subcutaneously and solution *X* orally (Table 3). In each of the four weeks of the trial period, each rat received a subcutaneous dose of 0·1 gm. olive oil containing 2·0 i.u. vitamin D.

Table 3. (7 rats per group)

Group	Daily dose *per os*	Average % ash in dry fat-free femur
1	0·3 gm. olive oil	34·2
2	0·3 gm. solution *X*	27·3

Similar results have been obtained with extracts of young Italian ryegrass, a feed on which winter-grazed hoggets often develop the disease.

Some preliminary work on permanent pasture, on which feed the development of ovine rickets has not so far been reported, has demonstrated that it contains both vitamin D and the antivitamin D factor. Rats on the standard rachitogenic ration developed more severe rickets when dosed with an extract of the young green leaves; but the opposite effect—an increase in the degree of bone calcification—resulted from dosing with an extract of the brown dead leaves. Such dead matter often makes up a considerable proportion of a sample of well-established pasture. The net result of the two effects observed when an extract of the whole pasture sample was given to rats was an increase in bone calcification. That this extract also contained the antivitamin D factor was demonstrated by the fact that a measured amount of vitamin D added to it did not increase the extent of bone calcification by the expected amount. Whether both vitamin D and the antivitamin D factor exist together in varying proportions in both the green and dead material has yet to be determined.

Further studies on the distribution and physiological action of the antivitamin D factor are being made, and work is progressing towards its isolation.

From this investigation, it is apparent that for many materials of plant origin the biologically determined assay figures for vitamin D should be accepted with some reserve, until the physiological action and distribution of the antivitamin D factor has been more fully investigated.

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A Further Example of *Kidd* (Jk^a) Hæmagglutinin

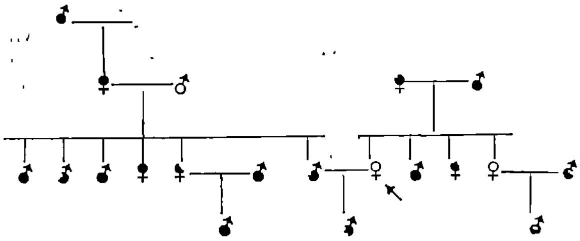
RECENTLY Allen, Diamond and Niedziela[1] reported a previously unidentified blood-group antibody which they termed anti-*Kidd*, or anti-Jk^a. Samples of the serum were most generously sent us by Dr. Allen and Dr. R. R. Race. With these we have identified an antibody of apparently identical specificity.

This antibody was found in the serum of a woman, Mrs. McGimpsey (*McGi*), who is *Rh*-negative, and whose blood was being examined for antibodies as a routine measure during her first pregnancy. She has never had a transfusion. She gave birth to a normal boy on May 17, 1951. On May 29 a direct Coombs test on his blood was negative.

A sample of Mrs. McGimpsey's serum, drawn on February 14 and tested by both the capillary method for saline antibodies and the test-tube for albumen antibodies, did not agglutinate either of two test cells, one being *O*, *MS*, *CDe.cDE*, *Kk*, *Lu*(*a*−), *Jk*(*a*+); the other, *O*, *Ms*, $C^wDe.CDe$, *kk*, *Lu*(*a*−), *Jk*(*a*+). A specimen drawn on April 26 agglutinated both test cells in saline in the capillary, with a doubtful reaction in albumen in the test-tube. It agglutinated eight other *Kidd*-positive cells and did not agglutinate 8 *Kidd*-negatives. This appears adequate proof of its specificity.

The inheritance of the factor defined by the serum *McGi* was investigated in some of the members of the family, as set out in the diagram. Identical reactions were given by anti-*Kidd* and anti-*McGi*.

Inheritance of Jk^a in Family *McGi*



$Jk(a+)$ ♂ ♀; $Jk(a-)$ ♂ ♀; Propositus ↖

Of 146 pregnancy and premarital bloods of groups O and A, 77·4 per cent (113) were agglutinated by *McGi*. Allen *et al.*[1] reported the antigen Jk^a to be "present in the red cells of about 77 per cent of Americans".

Our serum reacts both at room temperature and at 37° C., but better at the latter, by both the capillary method and the test-tube method for saline antibodies.

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Temperature Characteristics of the Microflora of Central African Soils

The importance of a knowledge of the effect of temperature on the metabolic activities of the soil microflora can scarcely be questioned, especially in the case of tropical soils. Furthermore, the temperature characteristic of the metabolic activities calculated by the Arrhenius's law:

$$V = \exp(-\mu/RT),$$

where V is the rate of the process, R the gas constant and T the absolute temperature, may be considered as the activation energy of the slowest or 'pacemaking' process in the chain of enzymatic mechanisms[1]. In this case it would be possible to use this method as a kinetic analysis of the slowest enzymatic processes in the metabolism of the soil microflora.

The experimental results presented here report our preliminary findings regarding the order of magnitude of the activation energy calculated from the rate of oxygen uptake at different temperatures. The measurements of oxygen uptake were always made on soils immediately after they had been brought to the laboratory, that is, less than three hours after sampling. Sampling was carried out with a cylindrical soil auger to the depth of 10 cm. About twenty samples were mixed in the field and the composite sample was brought to the laboratory.

The rate of oxygen uptake at temperatures between 28° and 38° was determined on 50-gm. portions of soil (passing a 4-mm. sieve and retained by 1-mm.) with the differential manometer as modified by Lees[2]. Triplicate determinations were made for each temperature. The rate of oxygen uptake of soils recently taken from the field was reasonably constant during the first 30 hr. We have used this value as a measure of the metabolic activity of soil microflora.

TEMPERATURE CHARACTERISTICS AND RATE OF OXYGEN UPTAKE OF CENTRAL AFRICAN SOILS

Soil No.	Oxygen uptake (µl. per hr. per gm. of soil at 28° C.)	Temperature characteristic (µ) cal.
1	5·0	7,500
2	4·0	10,000
3	3·2	7,500
4	2·7	7,000
5	1·1	16,000
6	0·6	16,000

(1) Forest soil under *Cynometra alexandri* Harms; (2) old rubber plantation; (3) forest soil from glade, under second growth; (4) old pasture of *Panicum maximum* and *Digitaria* (soil 1 to 4 on Yangambi reddish-yellow latosol); (5) colluvial sandy soil under young (5–7 years) second-growth forest; (6) the same, four months after felling and burning forest.

The accompanying table presents the observed values for the rate of oxygen uptake at 28° C. and temperature characteristics calculated from the rates at temperatures between 28° and 38° C. The order of magnitude of the values determined for these temperature characteristics agrees well with those given by Crozier for various biological reactions.

It will also be observed that µ values for soil microflora are quite close to the corresponding figures in biological reactions, namely, 16,000, 11,000 and 8,000 cal.

It may be of interest to note that the very sandy soils studied here showed constantly a higher value of µ than the less sandy soils in the same region. Together with other factors, a more pronounced influence of temperature on the microflora of sandy soils might explain the greater difficulty in maintaining the soil organic matter content in light-textured tropical soils.

Work is now in progress on the analysis of the 'pacemaking' process in the metabolic activities of the soil microflora through selective poisoning of characteristic enzymatic systems.

H. Laudelout
J. Meyer

Division d'Agrologie,
Institut National pour l'Étude
Agronomique du Congo Belge,
Yangambi, Belgian Congo.
June 15.

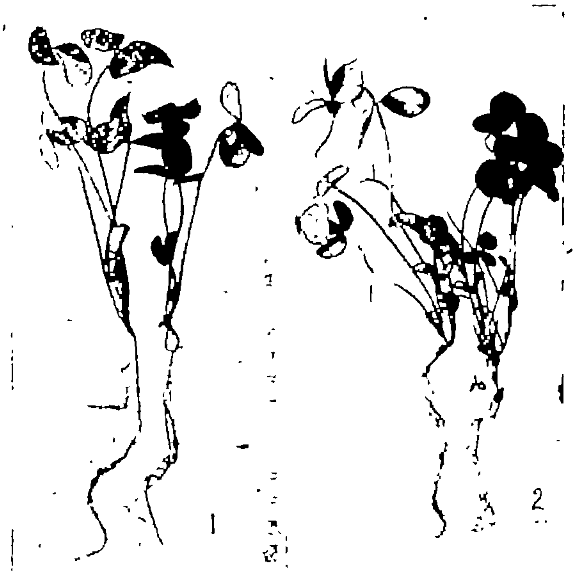
[1] Crozier, W. J., *J. Gen. Physiol.*, 7, 189 (1924).
[2] Lees, H., *Plant and Soil*, 1, 123 (1949).

Acid Tolerance in Plants

The failure of certain plant species to thrive on acid soils has been ascribed to an intolerance of the acid conditions.

A number of tree species, such as ash and *Pinus halepensis*, which are usually associated in Nature with alkaline soils, have been the subject of experiments designed to throw light on this supposition. In one such experiment, carried out in pot cultures and in the field, seeds of these trees were sown in the acid soil of Wareham Heath and in this same soil to which compost had been added. The Wareham soil had a pH value of 4–4·5; the compost used had an acid reaction, and the pH value of the soil remained virtually unaltered after addition of the compost. The resulting growth in the untreated Wareham soil was extremely poor, whereas in the composted soil it was excellent, notwithstanding that the reaction of the rooting medium was but little more than pH 4.

The behaviour of a number of agricultural crop plants was also studied, for example, red clover,



Red clover (*Trifolium pratense*) 9 weeks from sowing: (1) soil reaction, *p*H 7; (2) soil reaction, *p*H 4

alsike clover, buckwheat, lucerne, wheat. All these showed good growth under compost treatment in the soil of low *p*H value, quite comparable with that in a compost-treated neutral soil (see accompanying illustration).

From such results it would appear that the limiting factor for growth is not the low *p*H of the soil, since the inhibition to growth can be removed with negligible change in the soil reaction. Addition of a suitable compost is only one way of bringing this about; modification of the soil environment in other ways not involving raising the *p*H may be equally effective when they can be employed, among them establishment of a mycorrhizal relationship previously lacking.

W. Neilson Jones
Ida Levisohn

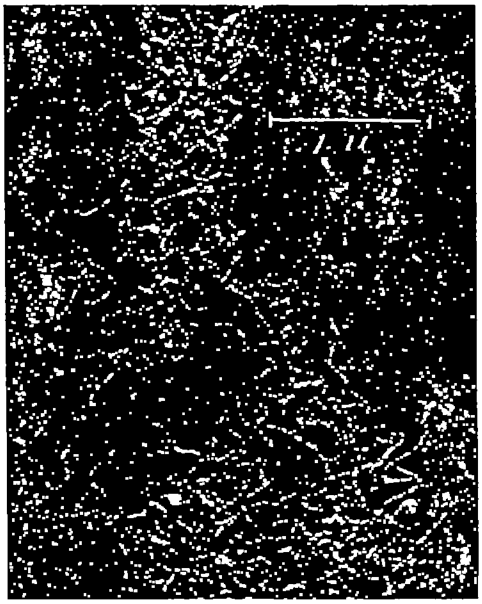
Bedford College,
University of London.
Sept. 27.

Formation of Silk Fibre by the Silkworm

The silk-producing apparatus of the common silkworm provides a convenient system for the study of several aspects of the synthesis of fibrous proteins. It is particularly useful for the investigation of the transformation from the soluble precursor protein of the gland into the solid, insoluble, fibrous fibroin. The precursor, which may be called 'fibroinogen', accumulates in solution in the silk gland and is converted into the fibre by the disturbances produced during spinning. Certain structural problems have recently been studied by Kratky, Schauenstein and Sekora[1,2], who have described an X-ray pattern characteristic of the soluble precursor, which appears to differ from the well-known pattern of silk fibre. Similar observations have been made by us.

The fibroinogen can be extracted from the silk gland by water and forms at first a slightly turbid solution, which exhibits the usual reactions of soluble proteins[3]. On standing for a few hours, the turbidity increases and the protein separates as a fibrous precipitate. X-ray patterns of the precipitate were found to be similar to those of the ground-up silk fibre (silk 2 according to Kratky *et al.*[1]) and distinct from the carefully dried gland (silk 1)[1]. It appears, then, that the change into the fibrous form can proceed spontaneously in dilute solution without the participation of mechanical stress.

The formation of the fibrous precipitate has been further studied by means of electron microscopy. Examination of the freshly prepared extract dried on collodion films revealed no significant structure, but the aged solution yielded fields, such as that shown in the accompanying electron-micrograph, in which the predominant component is a fine fibril about 100 A. in diameter and up to 3,500 A. in length. The soluble precursor of fibroin thus exhibits the property, already made familiar by electron microscopical studies of fibrin[4] and actin[5,6], of forming fibrils spontaneously in solution.



Since silk fibre is not usually thought to be an aggregation of fine fibrils, a further electron microscopic study was made of fibre spun in the normal way. Natural silk was disintegrated by prolonged tryptic digestion and the fine fibrillar fragments examined electron microscopically. These fragments were found to consist of fine fibrils of a similar diameter to, but greater length than, those shown in the electron-micrograph, and aligned parallel to the length of the fibre, demonstrating that, in the fibre spun in the normal way, there occurs a morphological feature intermediate in size between the molecular level and the whole fibre. Zahn[7] has reported similar observations, and the large spacings found by means of X-rays[8] also point to the existence of large structural elements.

The formation of silk fibre by the extrusion of the viscous contents of the gland or by the stretching of the gland appears closely analogous to the process of making artificial fibres, and suggests that the polypeptide chains of the soluble corpuscular molecule unfold and from this state are drawn into parallel strands by stretching[9]. On the other hand, the spontaneous appearance of fibrils in solution seems more simply explained as being due to an unsymmetrical aggregation of the particles of the soluble form without the occurrence of unfolding. There is evidence that this is the case with actin and fibrin. This theory, which may be referred to as 'the linear aggregation theory', could also account for the existence of discrete fibrils and the large lateral spacings.

Since the formation of an unsymmetrical aggregate may prove the characteristic step in fibre building, the conditions of its formation and other aspects of the theory are being investigated. The initiation of such aggregation may rest with purely colloidal forces, as will be shown in future publications from this laboratory. Afterwards, in the linear aggregate, short-range forces could ensure the orientation of the component molecules (or complexes) and thus lead to a fibril oriented at the molecular level, as is required to account for the fibre-type X-ray pattern. The mechanical stresses set up during spinning probably merely orient the preformed fibrils. Further research is necessary to elucidate the nature of the modification in small-scale molecular structure which also seems to accompany fibril formation.

E. H. Mercer

Chemical Physics Section,
Division of Industrial Chemistry,
Commonwealth Scientific and
Industrial Research Organization,
Melbourne.

July 11.

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[1] Kratky, Schauenstein and Sekora, *Nature*, 165, 319 (1950).
[2] Kratky, Schauenstein and Sekora, *Nature*, 165, 527 (1950).
[3] Foa, *Koll. Z.*, 10, 7 (1912).
[4] Hawn and Porter, *J. Exp. Med.*, 86, 285 (1947).
[5] Jakus and Hall, *J. Biol. Chem.*, 167, 705 (1947).
[6] Rozsa, Szent-Györgyi and Wyckoff, *Biochem. et Biophys. Acta*, 3, 561 (1949).
[7] Zahn, *Koll. Z.*, 112, 91 (1949).
[8] Meyer, "Natural and Synthetic High Polymers", 453 (Interscience Pub., 1942).

Effect of Hosts on the Egg Coloration of the Parasite *Bracon gelechiæ* Ashmead (Braconidæ)

Salt[1] has reviewed the literature on the effect of hosts upon their insect parasites. Knight[2] found that a carotinoid pigment of the bug *Perillus* was obtained from its prey, the potato beetle (*Leptinotarsa decemlineata*). Toumanoff[3] discovered that in *Dixippus morosus* the pigmentation may be transmitted by the female to the eggs and so to the offspring. I have not come across any record of the effect of hosts upon the pigmentation of the eggs of the parasite.

Bracon (*Microbracon*) *gelechiæ* Ashm. is an ectoparasite of the larva of the potato tuber moth, *Gnorimoschema operculella* Zell. In my laboratory experiments I found the Braconid to be polyphagous, parasitizing caterpillars of various moths, for example, the Pyralids *Scirpophaga nivella* F., *Argyria sticticraspis* Hamp. and *Chilo zonellus* S., and the Noctuids *Plusia orichalcea* F., *Sesamia inferens* W. and *Earias insulana* B. The parasite was reared on the caterpillars of each of these hosts up to the fifth generation. Except in the eggs of the parasite reared on *P. orichalcea* and *E. insulana*, no marked change in the pigmentation of the egg of the parasite was observed. The eggs laid by the females of the second generation reared on the above two species showed a slight tinge of yellow pigmentation; the pigmentation of the eggs produced by the females of each subsequent generation gradually increases, and ultimately the eggs produced by the females of the fifth generation thus reared are distinctly yellow in colour. This coloration is more intense in the eggs of the females of the fifth generation reared on *Earias insulana*. It is interesting to note that the coloration of the cocoons of the parasites of the fifth generation is yellow. It is worth mention also that when the adult Braconids thus obtained from coloured eggs are again reared on the natural host, *G. operculella*, it is found that the yellow pigmentation is markedly present in the eggs laid by the females of the next generation; but the yellow pigmentation of the eggs laid by the females of each of the subsequent generation decreases in stages. Up to the fourth generation the pigmentation, though insignificant, still persists, and is at last lost in the eggs laid by the females of the fifth generation. The normal white colour of the eggs is thus restored.

In the present case, therefore, the coloration of the eggs of the parasite is clearly a character which is induced by the host, through an article of food, and hence an important factor is environment.

G. C. Sen Gupta

Entomological Section,
Department of Agriculture,
Orissa, Cuttack,
India.

May 28.

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[1] Salt, G., *Biol. Rev.*, 16, 239 (1941).
[2] Knight, H., *Ann. Ent. Soc. Amer.*, 17, 258 (1924).
[3] Toumanoff, K., *C.R. Soc. Biol., Paris*, 98, 198 (1928).

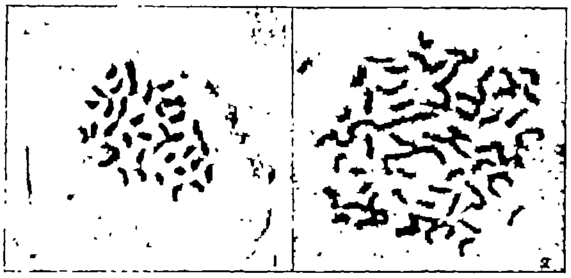
Chromosome Numbers of *Cerastium* Species

Since my publication of chromosome counts of *Cerastium* species in 1950[1], five further counts have been made, two of British material, *C. arvense* L. and *C. viscosum* L., and three of Continental material, *C. dichotomum* L., *C. tomentosum* L., and *C. alpinum* L. The results for these species are shown in the accompanying table.

Species	2n	Original source of material
C. arvense L	72	Isle of Man
C. viscosum L.	72	Malham Tarn, Yorkshire
C dichotomum L.	38	Not known. Seed obtained from Botanika Zahrada University Karlovy, Prague
C. tomentosum L.	72	Not known. Cultivated garden plant
C alpinum L.	c. 144	Abisko, Sweden

The counts for the British material, *C. viscosum* L. and *C. arvense* L., both $2n = 72$, agree with counts made by Rohweder[2], who used Continental material, though I have also counted $2n = 38$ for *C. arvense* L. collected in the Alps[1].

Of the Continental material, *C. dichotomum* L., $2n = 38$ (Fig. 1), has not previously been counted. *C. tomentosum* L., $2n = 72$ (Fig. 2), has also been counted by Rohweder[2], who, however, obtained $2n = 38$. It would appear that this species, like *C. arvense* L., is a complex one containing plants with at least two different chromosome numbers, namely, $2n = 38$ and $2n = 72$. It is hoped that crossing experiments will help to elucidate these two species.



Somatic metaphase plate of (1) *C. dichotomum* L., showing 38 chromosomes; (2) *C. tomentosum* L., showing 72 chromosomes. × 1,500

The count of $2n = 144$ for *C. alpinum* L. is only an approximation, as an accurate count has not yet been possible. The number certainly exceeded $2n = 108$ and $2n = 72$, which I[1], and other workers[2-5], have previously recorded for *C. alpinum* L. It would appear that this species contains a polyploid series, $2n = 72$, $2n = 108$, $2n = 144$.

Olive E. Brett

Department of Botany,
Queen Mary College,
University of London, E.1.
June 23.

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[1] Brett, O. E., *Nature*, 166, 446 (1950).

[2] Rohweder, H., *Beih. Bot. Centralblatt*, 59B (1939).

[3] Böcher, T. W., *Svensk. Bot. Tid.*, 32 (1938).

[4] Love, A., and Love, D., *Arkiv för Bot.*, 31 (1944).

[5] Love, A., and Love, D., Dept. Agric. Rep., Reykjavik, Series B, No. 3 (1948).

Statistical Methods in Anthropology

There has been a lively discussion, in *Nature*[1] and elsewhere[2], on the classification of recent fossil finds in South Africa. Prof. S. Zuckerman has rightly stressed the need for basing such decisions on statistical tests. But his findings have been at odds with those based on classical comparisons; so that anthropologists must now be in doubt whether their science has, indeed, anything to learn from statistics.

This unhappy result can be traced to the piecemeal tests which have hitherto been used. A bone or a tooth is a unit; it is not a discrete assembly of independent measurements. To compare its single variates one by one, as Ashton and Zuckerman have done[3], is both inconclusive and misleading. Inconclusive, because nothing is decided when it is shown that, say, the height of an incisor lies in the range of heights of gorilla incisors, and the breadth lies in the range of breadths of chimpanzee incisors—a state of affairs which may well be characteristic of a species different from both; and misleading, because tests based on dimensions which are correlated are themselves not independent, and little is gained by accumulating them.

The right statistical method must treat the set of variates as a single coherent matrix; and this is, in fact, the technique of multivariate analysis. Consider, for example, four measurements (in millimetres) of a lower milk canine: x_1 the height, x_2 the maximum anterior–posterior length of the upper half, x_3 the maximum breadth of the upper half, and x_4 the maximum anterior–posterior length at the level of the basal cingulum. Also consider the problem, in the first place, of discriminating between two species—say, chimpanzee and man. Then the measurements should be combined in a single discriminating function,

$$X = a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4, \qquad (1)$$

where the constants a_1, a_2, a_3, a_4 are to be calculated from the averages, the variations, and the correlations, of the measurements within both species.

The discriminant we obtain in this way, using the measurements of forty human and forty-four chimpanzee milk canines, is

$$X = x_1 - 7 \cdot 49x_2 + 2 \cdot 34x_3 + 4 \cdot 70x_4, \qquad (2)$$

and this has on the average the value

$$X = +\ 17 \cdot 6 \text{ for the chimpanzee,}$$

and has the average value

$$X = -\ 5 \cdot 0 \text{ for man.}$$

The standard deviation of X is $2 \cdot 45$; so that the range of X, taken at $2\frac{1}{2}$ times the standard deviation, is $6 \cdot 1$ on either side of the average.

In order to classify a tooth, which is supposed to be either a human or chimpanzee lower milk canine, x_1, x_2, x_3, x_4 are measured in millimetres, and the measurements inserted in the discriminant function (2) above. If the result lies between $+23 \cdot 7$ and $+11 \cdot 5$ the tooth is chimpanzee; if between $+1 \cdot 1$ and $-11 \cdot 1$ it is human. For all the eighty-four teeth the measurements of which we have had, this test is decisive. The supposition that a tooth belongs to one of these two groups is at least strengthened by the fact that its value of X falls into one of the two ranges.

As an application, we have calculated the value of the discriminant function given by (2) for the Kromdraai and the Taungs milk canines found in South Africa. The values are $-2 \cdot 6$ and $-7 \cdot 9$ respectively. They demonstrate conclusively that these teeth do not belong to the chimpanzee group. More than this, they fall precisely in the human range. It would be wrong on this ground alone to conclude positively that they are human teeth; for the measurements might, for example, be matched on an object which turns out to be a pebble or a fake. But within the limits of the present comparison, the statistical evidence is that these teeth belong to the human family.

These methods of discrimination need not be confined to a choice between two alternatives. The technique of multivariate analysis makes it possible to construct functions to discriminate at one time between a number of species, and we hope elsewhere to construct such functions for human, chimpanzee, gorilla and orang-utan teeth. These functions can, we believe, have an important place in biological classification, for which indeed they were first designed. They show that the methods of modern statistics are not alien to anthropology, but are capable of assessing a fossil or a limb as a unit, and not as a haphazard jumble of piecemeal measurements.

J. Bronowski
W. M. Long

Cleeve Hill,
Cheltenham.
Aug. 31.

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[1] Zuckerman, S., *Nature*, 165, 652; 166, 158, 953 (1950). Le Gros Clark, W. E., *Nature*, 166, 893; 166, 791 (1950).

[2] Le Gros Clark, W. E., *Man*, 51, 18 (1951). Zuckerman, S., *Man*, 51, 20 (1951).

[3] Ashton, E. H., and Zuckerman, S., *Phil. Trans. Roy. Soc.*, B, 234, 471 and 485 (1950); *Man*, 51, 23 (1951).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 5

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. W. V. Lewis: "Glacier Investigation by Tunnelling".

University of London (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Prof. W. J. M. Mackenzie: "Science in the Study of Administration".*

Society of Engineers (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. L. H. J. Hersch: "Oilfield Operations".

Society of Chemical Industry (joint meeting of the Food, Agriculture and Microbiology Groups and the London Section, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. H. R. Dawson: "The Cultivation and Propagation of Baker's Yeast".

Pharmaceutical Society (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Mr. H. G. Rolfe: "Pharmaceutical Industry in America".

Tuesday, November 6

Chadwick Public Lecture (in the Sir Edward Meyerstein Lecture Theatre, Westminster Medical School, 17 Horseferry Road, London, S.W.1), at 2.30 p.m.—Dr. A. T. Doig: "The Principles of Prevention of Industrial Diseases".*

Society of Chemical Industry, Crop Production Panel of the Agriculture Group (in the Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S.W.7), at 2.30 p.m.—Symposium on "The Selective Toxicity of 2-4, D and MCPA in Wheat, Oats and Barley".

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5 p.m.—Prof. J. M. Mackintosh: "Trends of Opinion about the Public Health, 1901–1951, 1, The New Age" (Heath Clark Lecture).* (Further Lectures on November 8, 13, 15 and 19.)

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. D. M. Newitt, F.R.S., and Mr. M. Coleman: "The Mechanism of the Drying of Solids with Special Reference to China Clay".

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Measurements Involved in the Testing of Protective Equipment" (to be opened by Mr. H. S. Petch).

Royal Anthropological Institute (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Huxley Memorial Lecture.

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Dr. H. E. Rose: "The Measurement of Particle Size in Very Fine Powders".* (Further Lectures on November 13, 20 and 27.)

Sheffield Metallurgical Association (at the Grand Hotel, Sheffield), at 7 p.m.—Mr. A. A. Smales: "Radio Chemistry as an Aid to the Analytical Chemist".

Wednesday, November 7

Association of Applied Biologists (in the Mining Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 11 a.m.—Discussion on "Photography in Applied Biology".*

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Society of Public Analysts and Other Analytical Chemists (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

Thursday, November 8

Royal Society (at Burlington House, Piccadilly, London, W.1), 4.30 p.m.—Sir Charles Ellis, F.R.S.: "Science in the Coal Industry".

Mineralogical Society (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. T. Kilvington, Mr. F. J. M. Laver and Mr. H. Stanesby: "The London–Birmingham Television-Cable System".

Textile Institute, Yorkshire Section (joint meeting with the West Riding Section of the Society of Dyers and Colourists, at the Great Northern Victoria Hotel, Bradford) at 7.15 p.m.—Dr. F. Happey: "Synthetic and Natural Polypeptides".

University of London (at Wye College, Wye, Kent), at 8.15 p.m.—Dr. H. P. Donald: "Facts and Fallacies in Livestock Breeding".*

Friday, November 9

Royal Sanitary Institute (in the Guildhall, Cambridge), at 10 a.m.—Papers on "Three Approaches to Man's Welfare" (Mr. D. W. Bottom: "Improving the Environment"; Dr. C. G. Eastwood: "Caring for Body and Mind"; Prof. A. Leslie Banks: "Research and the Wider Issues").

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

University of London (at Charing Cross Hospital Medical School, Chandos Street, London, W.C.2), at 5 p.m.—Prof. E. Wolff: "Sex Differentiation in Vertebrates".*

Institution of Mechanical Engineers (joint meeting with the Hydraulics Group, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. G. A. Wauchope and Mr. H. P. Humphreys: "The Design of Large Pumping Installations for Low and Medium Heads".

North-East Coast Institution of Engineers and Shipbuilders (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.15 p.m.—Prof. J. F. Baker: "Shortcomings of Structural Analysis" (Andrew Laing Lecture).

Institute of Economic Engineering (at the George Hotel, Church Lane, Kingsbury, London, N.W.9), at 7 p.m.—Mr. Winston Rodgers: "Pre-determined Motion Times".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. C. D. Darlington, F.R.S.: "The Two Theories of Heredity".

Saturday, November 10

Biochemical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11.15 a.m.—Symposium on "Metabolism and Function of Nervous Tissue".

British Psychological Society (in the Eugenics Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. H. A. Innes: "Fundamental Research in Human Relations".

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Sir Harry Lindsay: "The Museum and Education".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant (with a degree in engineering or equivalent qualification) in the Department of Mechanical and Civil Engineering—The Registrar, Technical College, Infirmary Road, Chesterfield, Derbyshire (November 10).

Assistant (Grade B) for Mechanical Engineering at the Swansea Technical College—The Director of Education, Education Department, The Guildhall, Swansea (November 10).

Assistant (Grade B) in Inorganic Chemistry at the Constantine Technical College—The Director of Education, Education Offices, Woodlands Road, Middlesbrough (November 10).

Assistant Experimental Officers (with a degree in engineering or physics, or equivalent) in the Horticultural Department—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds (November 10).

Demonstrator in Chemistry—The Registrar, Technical College, Sunderland (November 10).

Head of the Department of Metallurgy, a Senior Lecturer in Metallurgy, and a Lecturer in the Department of Engineering, County Technical College, Wednesbury—The Director of Education, Department F.E., County Education Offices, Stafford (November 10).

Lecturer in Electronics and Telecommunications, and a Teacher of Mathematics, at the Coventry Technical College—The Director of Education, Council House, Coventry (November 10).

Lecturer in Mechanical Engineering, and an Assistant Lecturer (Grade A) in Mechanical Engineering, at the South Shields Marine and Technical College—The Director of Education, Town Hall, South Shields (November 10).

Principal of the Bury Technical Institute—The Director of Education, Education Offices, Bury (November 10).

Scientific Officer (Ref. R/A) for research and development work on mechanical engineering problems, a Senior Scientific Officer (Ref. R/O1) for development to prototype stage of mechanical mechanisms of an original nature, a Scientific Officer (Ref. R/C2) for work on combustion and heat transfer problems, and a Scientific Officer (Ref. A/T2) to work on engineering problems—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds, quoting the appropriate Ref. No. (November 10).

Teacher (honours graduate in chemistry) in Chemistry—The Principal, Harris Institute, Preston (November 10).

Research Assistant in the Department of Geography, to assist in a project of research in agricultural geography—The Secretary, University College, Gower Street, London, W.C.1 (November 12).

Physicist or Physical Chemist (Scientist II) to take part in laboratory scale investigations into crushing, screening and briquetting of coal, at the Central Research Establishment, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/384 (November 14).

Research Officer (with honours degree in physics or physical chemistry) to carry out work on physical properties of gelatin gels and solutions—The Director, British Gelatine and Glue Research Association, 2a Dalmeny Road, London, N.7 (November 14).

Engineer and Manager of the Water Company—The Engineer and Manager, Gas and Water Company, Hartlepool, endorsed 'Engineer and Manager' (November 15).

Lecturer in Mechanical Engineering—The Registrar, King's College, Newcastle-upon-Tyne (November 17).

Assistant Lecturer in Geology (with qualifications in palæontology)—The Registrars, The University, Manchester (November 24).

Postgraduate Studentship in Physics—The Registrar, University College, Leicester (November 24).

Head of the Physics Department at the Radiotherapy Centre—The Secretary, War Memorial Hospital, Scunthorpe, Lincs. (November 26).

Research Officer (Physicist) in the Division of Food Preservation and Transport, Sydney—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3609 (November 24).

WATER ENGINEER AND MANAGER OF THE LEICESTER WATER UNDERTAKING—The Town Clerk, Town Hall, Leicester, endorsed 'Water Engineer' (November 24).

ASSISTANT DIRECTOR PUBLIC HEALTH BACTERIOLOGICAL LABORATORY (University of Melbourne)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 30).

HUGH WOOD MEMORIAL FELLOWSHIP IN MINING—The Registrar, The University, Leeds 2 (November 30).

LECTURERS (2, specialists in medical protozoology and medical entomology) IN PARASITOLOGY at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (November 30).

PROFESSOR OF PHILOSOPHY at the University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 30).

SENIOR LECTURER IN SOCIOLOGY AND SOCIAL WORK at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 30).

LECTURER IN MINING SUBJECTS, and a LECTURER IN SCIENCE, at the Wrexham Technical College—The Director of Education, Education Offices, Ruthin, Denbighshire (November 30)

RESEARCH ASSISTANT IN NUMERICAL ANALYSIS in the Department of Applied Mathematics—The Registrar, The University, Liverpool (December 1).

SENIOR LECTURER IN PHYSICAL CHEMISTRY in the University of Tasmania and Hobart Technical College—The Agent-General for Tasmania, 457 Strand, London, W.C.2, or the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Hobart, December 1).

STATISTICIANS (5, main grade) in the Civil Service—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 4093/51 (December 6).

RESEARCH ASSISTANT (graduate in physics) for laboratory work connected with Papermaking in the Department of Textile Chemistry—The Registrar, College of Technology, Manchester 1 (December 12).

PROFESSIONAL ENGINEERS in many Departments of the Civil Service for a wide variety of engineering duties—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Street, London, W.1, quoting S.86/51 (December 31)

REGIUS PROFESSOR OF CIVIL ENGINEERING AND MECHANICS in the University of Glasgow—The Private Secretary to the Secretary of State for Scotland, St Andrew's House, Edinburgh 1 (December 31).

CHIEF SOIL CONSERVATOR, and SOIL CONSERVATORS or JUNIOR SOIL CONSERVATORS, to the Otago Catchment Board—The Secretary, Otago Catchment Board, P.O. Box 858, Dunedin, New Zealand (January 18).

LECTURER IN PIGMENTS in the Department of Colour Chemistry and Dyeing—The Registrar, The University, Leeds 2 (January 19).

H.M. INSPECTORS—The SECRETARY (Inspectors' Section), Ministry of Education, Curzon Street, London, W.1 (January 31).

POSTGRADUATE FELLOWSHIPS (34) for research in pure chemistry and physics tenable in the National Research Council Laboratories at Ottawa, and POSTGRADUATE FELLOWSHIPS (5) in biochemistry, microbiology and related fields tenable in the Prairie Regional Laboratory at the University of Saskatchewan, Saskatoon—The Secretary, Laboratories Awards Committee, National Research Council, Ottawa, Canada, or The Chief Scientific Liaison Officer, National Research Council of Canada, Africa House, Kingsway, London, W.C.2 (Ottawa, February 15).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, The University, Nottingham.

CHEMICAL ENGINEER for investigations on various aspects of whiting manufacture, including drying processes, classification of powders by wet and dry processes, and general handling of suspensions and powders—The Director of Research, Research Council of the British Whiting Federation, 245 Ampthill Road, Bedford.

CHEMIST, general or analytical (with a good honours degree in chemistry, a sound knowledge of analytical chemistry and research and administrative experience), a RUBBER TECHNOLOGIST (with a wide experience in rubber technology and some experience of research and development work), and a COLLOID CHEMIST (with a good honours degree and research experience in surface or colloid chemistry) to undertake fundamental research on natural latex, at the Rubber Research Institute of Malaya, Kuala Lumpur—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, South Kensington, London, S.W.7.

CHEMIST at Risley, to advise plant design engineers on the metallurgical aspect of their work, etc., and a CHEMIST at Springfields Factory, Salwick, Preston, to supervise the work of a team engaged on the development of powder metallurgy processes—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for.

CHEMISTS (Principal Scientific Officer grade) (with a first- or second-class honours degree or equivalent in chemistry, with many years responsible research experience in modern methods of analysis of inorganic materials, including microchemical methods) at a Ministry of Supply research and development establishment near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.640/51A.

CHEMISTS (Scientific Officer grade) at the Ministry of Supply factory at Capenhurst, Chester, for research into the detailed behaviour of inorganic systems and their surfaces (the work may involve electronic diffraction and X-Ray techniques as well as conventional chemical qualification)—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

CURATOR (with an honours degree in archæology, with some anthropological training) IN THE DEPARTMENT OF MUSEUMS, Malaya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. No. 2744C/1/51.

ENGINEER (with degree or equivalent in engineering) to assist in development work connected with concrete vibrators, etc., at research laboratories of the Cement and Concrete Association, Wexham Springs, Slough—The Secretary, British Cast Concrete Federation, 17 Amherst Road, Ealing, London, W.13.

EXECUTIVE ENGINEER IN THE PUBLIC WORKS DEPARTMENT, Northern Rhodesia, for general civil engineering duties—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27322/115.

EXPERIMENTAL OFFICER at Springfields Factory, Salwick, Preston, to assist in large-scale development work on processes or reduction of metals and treatment of residues—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

EXPERIMENTAL OFFICERS at the Atomic Research Establishment, Harwell, for work in Physics, Electronics and Scientific Computing (Ref. A.309/51A/BA), and Chemistry (other than Organic Chemistry), Chemical Engineering and Metallurgy (Ref. F.777/51A/BA)—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

GRADUATE IN PHYSICS (with a bias towards engineering) to undertake research work in the unexplored field of glasshouse heating and ventilation—The Head of the Garden Research Department, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts.

HEAD OF THE CHEMICAL ENGINEERING SECTION, and a PLANT PHYSIOLOGIST to direct and undertake fundamental biochemical investigations with a view to the ultimate development of mass culture techniques for the lesser known marine algæ of potential industrial value—The Secretary, Institute of Seaweed Research, Inveresk, Midlothian.

PHYSICIST to carry out research on the performance of photographic lenses—(Applications), Technical Optics Section, Physics Department, Imperial College of Science and Technology, South Kensington, London, S.W.7.

PHYSICIST, and a PHYSICAL CHEMIST (with first- or second-class honours degree; some postgraduate experience is desirable)—The Director, British Paper and Board Industry Research Association, St. Winifred's Laboratories, Welcomes Road, Kenley, Surrey.

RESEARCH ASSISTANT (graduate in chemistry) IN THE DEPARTMENT OF CHEMICAL ENGINEERING AND APPLIED CHEMISTRY, to carry out investigations on ignition and flame propagation in gases—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7.

SENIOR PLANT PATHOLOGIST (Senior Principal Scientific Officer) at the West African Cocoa Research Institute, Gold Coast—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

SENIOR PRINCIPAL SCIENTIFIC OFFICER (veterinary research) to undertake direction of protozoological, epidemiological and trypanosomiasis research, a SENIOR SCIENTIFIC OFFICER (veterinary research) to undertake research in animal trypanosomiasis, a SCIENTIFIC OFFICER (veterinary research) to undertake research in animal trypanosomiasis, a PROTOZOOLOGIST to undertake studies of tyrpanosomes and trypanosomiasis, and MEDICAL RESEARCH OFFICERS (2) for research into human trypanosomiasis and epidemiology, at the Central Trypanosomiasis Institute, Sukulu, Uganda—The Under-Secretary of State, Research Department, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

TEACHER (professorial grade) OF PHARMACOLOGY at the Lady Hardinge Medical College, New Delhi—The Secretary (Division 5A), Ministry of Health, Savile Row, London, W.1.

REPORTS and other PUBLICATIONS

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Air Ministry: Meteorological Office. Professional Notes No. 103: Stratus Cloud near the East Coast of Great Britain. By G. A. Bull. (M.O. 524c.) Pp. 16. 6d. net. Professional Notes No. 104: Meteorological Aspects of Turbulence affecting Aircraft at High Altitude. By J. K. Bannon. (M.O. 524d.) Pp. 16. 6d. net. (London: H.M. Stationery Office, 1951.) [228

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INTERNATIONAL INSTITUTIONS

IN a book published a few months ago*, Mr. T. Besterman makes a praiseworthy attempt to set forth the activities of the United Nations Educational, Scientific and Cultural Organization and the ideas behind them. In a series of readable chapters he indicates how the Organization is working in the fields of education, science, the social sciences and humanities, and the conditions which determine its success or failure, and what has already been achieved in regard to reconstruction, mass-information and the exchange of persons. He establishes very clearly that there is room for such an Organization in the world to-day; but though in his final chapter his criticisms and conclusions deal with some important factors in Unesco's development, he does not quite succeed in grappling with some of the essential issues. His book, for all its merits, leaves the impression of over-optimism and of a head a little too much in the air.

A striking corrective to this little book and a wholesome stimulus to constructive thinking about the real and wider issues is a report which has been issued, partly under the imprimatur of Unesco itself and partly under that of the International Institute of Administrative Sciences, Brussels. Entitled "National Administration and International Organization"†, this report describes an inquiry conducted jointly by the two bodies with the view of improving international co-operation and the operation of the United Nations, the Specialized Agencies and similar bodies. It is open to criticism in that the inquiry was limited in scope and not sufficiently representative. The fourteen governments selected for the inquiry, although varying in size and responsibilities, are politically and culturally too homogeneous. The difficulties in the way of international collaboration and the conditions essential to make any body like Unesco effective would have been even more apparent had the Middle East, Far Eastern and backward countries been included. Outside Europe and America, India is the only country represented, and, in spite of the cultural diversity, its system of government is also founded on democratic principles.

Whether in India and in some of the other countries the conditions exist under which democratic principles can be served and a democracy function is another question, and this survey shows very clearly what an important bearing it has on international organization and co-operation. There cannot be, as this study shows, any standard pattern for administering the relations of national governments with international institutions: political traditions, the structure of organization, national resources and national interests vary too widely, though it is true that every government has something to learn from the administrative experience of other governments, particularly where their situations are comparable. Disregarding considerations of national policy, however, the study emphasizes that the level of international administration, in a society of co-operating sovereign States, can rise no higher than the level of national administration in those States. Deficiencies in national administration, whether they are due to personal failures or to the inherent unsuitability of the national organization to its social and economic conditions, are at once reflected on the international plane.

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* Unesco: Peace in the Minds of Men. By Theodore Besterman. Pp. xi+134+12 plates. (London: Methuen and Co., Ltd., 1951.) 10s. 6d. net.

† National Administration and International Organization. a Comparative Survey of Fourteen Countries. Report of an Inquiry conducted jointly by the International Institute of Administrative Sciences and Unesco. Pp. 78. (Paris: Unesco; London: H.M. Stationery Office, 1951.) 150 francs; 8s.; 50 cents.

This is a point which is commonly overlooked in discussing international organization and plans for international co-operation, for example, in regard to technical assistance to the under-developed areas. It is brought out as strongly by this inquiry as in Mr. Besterman's book, and it is worth noting that it was equally emphasized by Dr. Herbert Greene and other speakers at the discussion, at the British Association meeting in Edinburgh last August, on surveys of under-developed areas. It provides the main reason for the concern of the scientific or technical expert with the subject of this inquiry and with the theme of Mr. Besterman's book.

The two main difficulties in international collaboration which are brought out by these publications are, first, the tendency of numerous governments to express different views in different places on related international problems; and secondly, the failure of all too many governments to discharge promptly and effectively their substantive obligations as participants in a co-operative international system. The first not only creates confusion but may also affect the soundness of the plans which are formulated. The second, however, could make the formulation and execution of plans a complete waste of time. It is the growing disregard for international obligations and the unilateral repudiation of negotiated agreements that is the most disturbing feature of to-day. If it is unchecked, it can halt all schemes for economic and technical assistance to backward countries. Technicians and scientific advisers cannot work confidently and effectively apart from some rule of law and guarantee of stability, nor indeed will it be possible to recruit them for such work. If they cannot be recruited, then the programme stops. In this connexion, the challenge which present events in Persia and Egypt thus presents to international institutions does not appear to have received the attention it demands.

The inquiry carried out by Unesco and the International Institute of Administrative Sciences, moreover, brings out that while the major responsibility for consistent, prompt and effective observance of international obligations by national governments rests with these governments themselves, such matters are no longer the affair of Foreign Offices and professional diplomats alone. A wide range of government departments and of technical and professional advisers may be involved, and what was once regarded as a matter of foreign relations is not easily distinguished from domestic affairs. For a government to pursue a reasonably stable and consistent course in its foreign relations, close and continuous liaison between the legislative and the executive is essential. Similarly, in democratic countries—and elsewhere—governments are now obliged to heed demands emanating from public opinion and from a variety of interested groups which find expression in various ways. As a corollary, the ethical standards of a government in its international relations are unlikely to be much above that of the standards of the community it governs.

It is this point, rather than the minor suggestions which are made in this report for improving administrative organization and methods of organization, that deserves attention at the moment. It is not suggested that any of the fourteen reporting countries covered by the inquiry was satisfied with the existing state of affairs, or that further improvements might not result from greater attention to the recruitment, selection and training of staff. This also is secondary, and though Mr. Besterman, too, directs attention to the unfortunate consequences of excessive turnover of staff and to the difficulties which can arise once any considerations other than that of professional competence enter into the selection of staff for a post, the dominant factor in efficient working and in securing an efficient international secretariat is the standard of co-operation and interest shown by the participating countries. Deficiencies in that respect cannot be offset by any scale of salaries designed to compensate for genuine expatriation and the speculative character of such employment. Indeed, it should be remembered that too lavish an endowment of such posts with diplomatic and taxation privileges may fail to attract staff of the integrity desired and also provoke criticism which may militate against co-operation. The personal character which is as essential as administrative ability for such posts will not be forthcoming, whatever the terms of remuneration, unless the work is manifestly seen to be worth while and enjoys the respect of professional bodies as well as of governments.

To strike the right balance here is admittedly not easy. Whether or not this is a contributory factor, Unesco at least scarcely seems to enjoy the standing among professional associations that many of its activities would warrant. Mr. Besterman's little book, by contributing to a wider understanding of what Unesco is doing, should in a modest way assist in increasing that repute. By and large, so far as science is concerned, Unesco's reputation and influence must depend on the extent to which the value of its projects becomes known to the scientific world through its links with the international unions and other professional bodies. In Great Britain the newsprint position is a severe handicap in making the work of Unesco better known, but even so the position is unlikely to be remedied by the circulation of Unesco's own publications. Indeed, on Mr. Besterman's own showing, contraction might be a wiser policy than expansion here, if appropriate arrangements could be made with existing publishing bodies.

For all the valuable work that Unesco has undoubtedly done in its five years or so to meet some of the world's needs in the field of education, culture and learning, and to strengthen some of the international bodies already working in those fields, it is difficult to regard the immediate situation with confidence, still less optimism. As Sir John Maud recently pointed out, Unesco itself has now established a growing number of personal and professional relations between the men who are chiefly responsible for educational and scientific progress in their own countries. Outside Unesco, the programme of technical assistance to the backward areas would seem to offer a most encouraging vista of international co-operation and understanding.

All this, however, is overshadowed by the failure of member States of the United Nations to keep faith and to honour obligations into which they have entered. The very facts, on which this inquiry into national administration and international organization rightly insists, that distinct boundaries between domestic and international problems no longer exist, and that the conduct of foreign affairs must be regarded as an inseparable part of the larger problem of organization for the conduct of national affairs as a whole, make it essential that there should be some common standards of value among the participants in any form of international organization. Without such standards, misunderstandings, frustrations and acerbity, leading ultimately to anarchy, are inevitable.

It cannot be too strongly insisted that good faith and the observance of negotiated agreements and obligations are a *sine qua non*, and in their absence minor improvements in administrative procedure are irrelevant. In the limited sphere of Unesco, the irresponsible disregard of obligations which Mr. Besterman notes is made more invidious by the fact that rather more than half Unesco's income comes from the United States and the United Kingdom; of the other members, only France and China contribute even 7 per cent. In spite of this, all members have equal voting rights. Mr. Besterman rightly points out that reconsideration of this egalitarian principle is unavoidable if certain nations and groups of nations continue to manifest the irresponsibility in voting and in observing obligations which have marked recent years. In view, moreover, of what is happening in the wider context of the United Nations, it may well be asked if the time has not already come for the United Kingdom to consider whether it can continue its own contribution to such organizations on the present scale, or whether it should not concentrate the resources it can spare for the furtherance of international understanding in more limited organizations where there exists a standard of goodwill and honesty of purpose which make effective co-operation possible.

The latest annual report of the Secretary-General of the United Nations points to the need for realistic thinking here. One of the functions of the United Nations is to provide a common ground on which antagonists can meet to resolve their differences. It was proposed as an organization affording each nation a forum in which it could argue its case as an equal. Only the conduct of the members of the Organization can show that Mr. Trygve Lie is right in maintaining that the Organization's function as a forum need not frustrate its function as policeman, and the evidence since his report was written is very much the other way. If the Security Council and other organs of the United Nations continue to condone the flouting of international agreements and of the authority of international institutions by governments pledged by their membership of the United Nations to observe a code of good behaviour, it may well be asked whether it is worth persisting in membership. Whatever the immediate outcome of the recent unilateral repudiation of agreements in the Near East, fresh thought must be given by Great Britain to the implications of such incidents before the country is committed to further large obligations in any international organization where there can no longer be presupposed the essential basis of good faith and respect for such obligations by all contracting parties.

ANTHROPOLOGY AND SOCIAL STUDIES

The Foundations of Social Anthropology

By Prof. S. F. Nadel. Pp. xi+426. (London: Cohen and West, Ltd., 1951.) 25*s.* net.

Society

An Introductory Analysis. By Prof. R. M. MacIver and Prof. Charles H. Page. Pp. xix+698. (London: Macmillan and Co., Ltd., 1950.) 25*s.* net.

SOCIOLOGY and social anthropology are closely allied subjects. Apart from this, there is no real reason for comparing these two books. Profs. R. M. MacIver and Charles H. Page have produced a summary of present sociological knowledge. They progress from one aspect to the next, until the whole panorama of their subject is displayed. The book has the merits of all good encyclopædic work, and will be invaluable as a bibliography and as a teacher's book of reference. At the same time, it inevitably carries the flatness and finality of a text-book.

Prof. S. F. Nadel, on the other hand, has written, not a summary of anthropological knowledge, but an inquiry into the nature of sociological knowledge. As he says, social anthropologists have had a tendency to apologize about their subject. The societies they study have often no written records, the language may never have been studied, and the environment and customs are strange; in face of these difficulties, their techniques are necessarily 'tentative' and their concepts 'fluid'. For these reasons he has undertaken now a book about method, rather than one about results (with which he considers anthropologists have hitherto been too exclusively concerned). His training in logic qualifies him well for a work which aims at defining the place of anthropology among the sciences, by linking the 'study of man' with the whole universe of scientific knowledge.

Prof. Nadel considers that such a wealth of ethnographical data has been assembled in the past three decades that an "era of systematization" is now due. These data he speaks of as raw material awaiting the "fuller synthesis" which will "lead to valid generalizations on primitive culture and society". His view that the time for such a synthesis is near is shared by others who also exhibit his interest in methodology, but its truth may be questioned.

Even after studying his argument one is forced to doubt whether the ethnographer's material, however systematized, is yet capable of yielding a single valid generalization. It is to be hoped that at some later stage he will himself publish much more fully the results of his own valuable research among tribes in Nigeria and the Sudan. Only a few anthropologists have justified the claim that Prof. Nadel makes for their research, as distinct from traditional sociology, that it is both more intensive and comprehensive. Few have remained sufficiently long in any single society to produce a study that goes beyond the broad outlines which give a misleading impression of sameness from one society to another. The few who have achieved the highest standards unfortunately stand alone as experts on widely separated regions. In short, comparative work within a given region on the basis of modern intensive study has scarcely begun.

Prof. Nadel rightly claims that its subject-matter provides for social anthropology data which differ from those of sociology; instead of considering class-structure or heredity and environment, it is faced with problems of taboo, clan exogamy or totemism. But original data have not, in fact, produced new sociological theories. A personal interest in methodology may have tempted him to hope that systematization will one day yield generalizations about society, but one may equally well argue against him that in sociology the process has worked usually in the opposite direction. The fact-collecting and systematization directed by the Victorian anthropologists were stimulated by hypotheses about social evolution and cultural diffusion. Similarly, in the United States to-day a vast amount of research has been undertaken to test current theories about the relation between culture and personality. In this subject, at least, it seems that theories produce facts and not vice versa.

Since the 1920's, when Malinowski raised the standard of field-work, and Prof. A. R. Radcliffe-Browne set a sociological scaffolding around ethnology, the stimulus they gave to social anthropology has to some extent evaporated. The history of philosophy shows that a branch of learning develops a dominant preoccupation with methodology only in its relatively sterile periods, and certainly many exponents of social anthropology seem deeply concerned with its status and methods. It must be admitted that no major speculative theory has appeared which compares with those which inspired the Victorian anthropologists.

As a minor criticism of the scope of Prof. Nadel's work, it may be remarked that a book of this size gives unduly little space to the serious problem of how there can be reliable knowledge of social phenomena for an outside observer whose language and categories of thought belong to an alien culture. This is only sketchily touched upon in a dozen pages on "Observation and Description".

In certain branches of sociology the need for the stimulus of sweeping sociological theories does not seem to be felt. The impetus of most of its research derives ultimately from the moral conscience, the concern to remedy pressing social evils. The relation between academic knowledge and social reform is generally close. Anthropologists, on the other hand, find it difficult, though some try strenuously, to justify their work on strictly practical grounds. The scope and character of their studies in alien societies make them, indeed, more wary than enthusiastic for social change. If it is called into play at all, their moral conscience tends to find itself opposing schemes for social advance.

The book by Profs. MacIver and Page, in spite of proper magisterial detachment, reflects in its subject-matter the characteristic preoccupation with social problems. It is divided into three parts. After only a few pages of definition, the first plunges into the relations between the individual and society, co-operation and conflict, society and environment, and then on to social control and the problem of moral liberty. Part 2 covers the major forms of social structure, and Part 3 social change. The book is admirable as a summary, but is not intended as a criticism of current trends of thought. It is in the nature of a good text-book to draw on pre-suppositions which are already a little out of date, and this one is faithful in reflecting the prejudice and weakness as well as the strength of contemporary sociology. This is particularly noticeable in the unconscious bias against religious organization in the section on conflict between religion and morals, which is more significant in view of the later chapter on "Evolution of the Church as a Social Form". This section is based on assumptions which have been challenged by important modern publications on primitive religion and magic.

MARY DOUGLAS

COLLOID SCIENCE

Colloid Science

Edited by Prof. H. R. Kruyt. Vol. 2: Reversible Systems. Pp. xix+753. (Amsterdam and New York: Elsevier Publishing Co., Ltd.; London: Cleaver-Hume Press, Ltd., 1949.) 77*s.* 6*d.*

IT must be said first that this is not a text-book on colloids; rather it is a record of the work of the Dutch school under the distinguished leadership of Prof. H. R. Kruyt, and the volume suffers from the limitations thereby imposed. This factor will probably be unimportant in Volume 1; but in the present volume it is serious.

The writers, faced by the almost insurmountable difficulties of finding a logical order of dealing with colloids and their properties, have chosen the thermodynamic classification into reversible and irreversible. Volume 2 deals with the former, which includes macromolecules and association micellar colloids. Macromolecules receive 211 pages, gels and solid macromolecules 193, while coacervation with related topics occupies 248. Micellar colloids are compressed into 37 pages, of which about half is taken up by coacervation. Thus 40 per cent of the book is of little interest to the majority of colloid chemists. It is stated in the introduction that the work on coacervation is included because of its inaccessibility to English and American readers; it should, however, have been published as a separate monograph. It seems most unfortunate that the name 'coacervation' has been extended to the clear case of macromolecule-solvent systems separating into two layers without clear proof that Bungenburg de Jong's 'coacervation' is the same phenomenon. In this book, the two cases are discussed in separate sections.

The book is a collective work to which the contributors are: R. Houwink, J. J. Hermans, P. H. Hermans, J. Overbeck, Bungenburg de Jong and H. L. Booy. The editing is very good; in this subject, in which basic ideas and nomenclature current in the literature are often far from clear, as in the word 'colloid' itself, or even grossly misleading as 'emulsoid', the need for clear definition is paramount. This has been achieved in the book under review, though how far it is due to editing and how far to clear thinking by the Dutch workers over a number of years cannot be said ; whichever it is, the credit is due to Prof. Kruyt. It should be read word by word more than once. Its particular merits are that it stimulates and disciplines. It is suitable for advanced students and research workers interested in colloids, and should find a place wherever colloids are studied seriously.

It will be most interesting to see in Volume 1 how the authors deal with irreversible colloids, for which the thermodynamic approach to stability is so much less useful than the kinetic. There is a real danger to-day that research workers dealing with macromolecular colloids may be lamentably ignorant of the other types. This is due in part to the common habit of young workers of regarding investigations more than about ten years old as obsolete ; and in part to nomenclature and the need for revision of the treatment of the classical colloids. It is as well to remember that there is one basic and fundamental property only common to all types, namely, the large size of the free kinetic unit of the solute. Can one imagine a book on ordinary solutions which did not mention the colligative properties ? We must recognize that although many of the properties, especially their commercially useful ones, depend upon the interaction between particles, the single molecule, whatever its size, still remains the fundamental chemical unit, and it can still be studied only in ideal solution, that is, at a dilution such that mutual interaction effects are reduced to zero. There is nothing new in this situation : exactly the same applies to metals. The confusion really arises from the word 'colloid'. Is there such a thing, or are there only colloidal solutions ? The answer is, of course, that the colloidal state is a state of dispersion, and that there is therefore no such thing as a 'colloid'.

A. S. C. LAWRENCE

FREE-LIVING NEMATODES

Soil and Freshwater Nematodes

A Monograph. By Dr. T. Goodey. Pp. xxvi+390. (London : Methuen and Co., Ltd. ; New York : John Wiley and Sons, Inc., 1951.) 45*s*. net.

THIS monograph by Dr. Goodey will be welcomed not only by specialists but also by the general zoologist. To the latter the nematodes are a somewhat troublesome group : they are superficially so similar, there are so many of them, they are so widespread and the relevant literature scattered. Dr. Goodey previously published a useful volume on the nematodes parasitic on plants which gave access to these forms ; but there are still a large number commonly found living free in the soil and in fresh water. It is to these that the present book is devoted. Many of the plant parasites are also to be found in the soil and so are included, but only as soil inhabitants, since details concerning their relationship with the host plant are to be found in the other volume.

The systematic arrangement to a considerable extent follows that of Chitwood and Chitwood, starting with the two main sub-classes Phasmidia and Aphasmidia. This division rests, in the main, on the presence or absence or reduction of the curious, paired, possibly sensory organs, termed phasmids, situated in the lateral areas of the caudal region. The introduction includes a useful section on the technique of handling nematodes and an account of their structure sufficient to follow the systematic definitions that follow. A uniform treatment is adopted throughout and the descending classificatory groups are clearly defined down to genera. For each genus, in addition to the definition, there is a more detailed description of one species, accompanied by diagrams sufficient for accurate diagnosis. The species generally chosen is the genotype ; but, where this is unsuitable, for example, if it is marine, another typical, more accessible species is described.

The illustrations are comprised in 190 figures in the text, but as each figure contains three, four or five diagrams a very large amount of information is conveyed. Most of these line block illustrations are excellent, but a few suggest they have been reproduced from worn or inadequately inked blocks. In the review copy Figs. 53 and 98 are examples. The treatment does not extend to descriptions of species, but under each genus is a list of the recognized species accompanied by a brief reference to the original description. As a number of species in a genus may be large—*Dorylaimus* contains 195 species and ten additional varieties—treatment of the individual species would require a number of volumes the size of the present one and would prove too unwieldy and expensive to have a wide appeal. At the conclusion of the account of each genus is a paragraph on its bionomics, and in looking through these the reader is at once struck by the large gaps in many genera. In some genera, as in *Aphelenchoides*, where a good deal is known, a letter after the specific name indicates whether it is an obligate plant parasite, saprophagous, connected with insects or predatory. Thus a great deal of information is conveyed in a concise manner.

In fact, to the reviewer, conciseness is the most outstanding feature of this book ; indeed, it is remarkable how much information is contained within its 390 pages. The last part of the book, apart from an adequate index, is a list of references. Here again this is a selective bibliography, and the further references that can be obtained easily from Stiles and Hassall's catalogue or the *Zoological Record* are not included unless for a special purpose.

The author is to be congratulated on producing a volume that, like its predecessor, will be an essential to all interested, however remotely, in the field it covers.

C. H. O'DONOGHUE

RECENT DEVELOPMENTS IN METAL PHYSICS

Progress in Metal Physics, 2

Edited by Dr. Bruce Chalmers. Pp. viii+213+23 plates. (London : Butterworths Scientific Publications, Ltd., 1950.) 45*s*.

THE appearance of the second volume of this series is most welcome, and all interested in the science of metals will find much of value. In the reviewer's opinion the editor has been wise in refusing to make the book a report on the progress in any one period, and in again presenting a series of self-contained articles most of which can be read with profit by an honours graduate in metallurgy, physics or chemistry with no specialized knowledge of the subjects concerned. The standard of writing varies, and some articles would have profited if the authors had submitted their manuscripts for criticism, not only by experts in the subject but also by the general reader for whom the book is intended.

The first paper, by H. Lipson, on "Order–Disorder Changes in Alloys", is a model of its kind, beautifully written and illustrated, and arranged so that the reader's attention is continually directed to the important points. The next review, by I. I. Betcherman on "Rate Processes in Physical Metallurgy", is less satisfactory. It covers a wide range, but some of the writing is too superficial to be of real value, while the description of the work of Frederickson and Eyring is confusing; there are also several misleading legends to the figures. The third paper, by W. Boas and J. K. Mackenzie on "Anisotropy in Metals", is excellent, and the description of a wide range of properties should be most stimulating to those who are prepared to cope with the rather formal introduction to the ideas of the mathematics of the vector–vector relations. The paper by H. G. Warrington, on "Developments in Magnesium Alloys", seems rather out of place, since much of it is concerned with technology rather than with fundamental metal physics. The atomic radii given on p. 137 are not the quantities usually known by this name, and it is strange to find no reference to the work of G. V. Raynor on magnesium alloys.

The last fifty pages are devoted to a symposium on polygonization, introduced by a paper by R. W. Cahn on "Internal Strains and Recrystallization". This is stimulating and suggestive, but in some parts it is rather premature and, as in the later papers, the description suffers from the fact that the author accepts the dislocation hypothesis so completely that what are really interpretations in terms of the hypothesis sometimes appear as statements of fact. It must not be forgotten that, however great the promise of the hypothesis, it is supported by little direct experimental evidence, and has led to the prediction of relatively few facts before their discovery. The paper by A. Guinier and J. Tennevin, on "Polygonization", is interesting and beautifully written, while the final contribution, by C. Crussard, F. Aubertin, B. Jaoul and G. Wyon, describes "Polygonization in Strongly Deformed Metals". The volume thus covers a wide range and should be read by all concerned with the physics of metals.

W. Hume-Rothery

CANCER FOR THE LAYMAN

Cancer

Where we Stand. By Prof. Sidney Russ. Pp. xv+192+16 plates. (London, New York and Toronto: Oxford University Press, 1950.) 10*s*. 6*d*. net.

We are all interested in the subject of cancer. There are few whose families and friends have not included someone who has died of cancer. Malignant disease has a terrible reputation. Nevertheless, a substantial proportion of people suffering from many types of cancer have been completely cured by means of surgery or radiotherapy or by the combined use of both these methods of treatment. Most intelligent people know that with early diagnosis and prompt surgical treatment, many forms of cancer can be successfully eradicated. Few, however, appreciate the achievements of radiotherapy. The statistics published during the past few years show that for new cases of cancer of all types treated by radiation, and excluding the almost completely curable basal cell carcinoma, the corrected survival-rate is almost exactly one-third after five years and one-quarter after ten years. For similar cases treated twenty-five years ago, the five-year survival-rate was about one-eighth. It seems reasonable to assume that one of the most important factors responsible for this improvement has been the application of physics to radiotherapy.

Prof. Sidney Russ is one of the leaders of the group of British physicists who have contributed so much to these applications of physics to the treatment of cancer. It is evident that for many years he has thought about the problem of cancer from many angles. The study of cancer is still outside the main stream of biological teaching, and it is difficult for the intelligent layman to acquire an objective elementary knowledge of this field. With a sense of duty, Prof. Russ has attempted the almost impossible task of writing a simple and accurate account of the present position with regard to the scientific study and medical diagnosis and treatment of cancer. In my opinion he has succeeded admirably.

The book starts with an account of the nature of cancer and theories of its origin. The second chapter is a useful discussion of the prevalence of cancer and of the public attitude to malignant disease. The results of the surgical and radiological treatment of cancer are set out clearly in a later chapter. I think that the best part of the book is the discussion of the results of treatment and the logical insistence on early diagnosis and prompt treatment with a minimum of delay.

A great deal of information about radiological physics and many biological subjects such as cancer throughout the animal kingdom and occupational cancer are skilfully introduced. The chapter entitled "Historical Notes on Cancer and its Treatment" is interesting and should convince anyone of the folly of reliance upon treatment by quacks. Appendix 3, at the end of the book, includes a very simple statement of what should be known about cancer, with much good advice.

The chapter on research in cancer, together with the short chapter on palliative chemotherapy, introduces the general reader to some of the important lines of thought in these fields.

The last chapter is entitled "Cancer in the Future". In it, Prof. Russ puts forward a number of suggestions for the advancement of the treatment of cancer, with which I think there is general agreement. I would like to suggest that the knowledge that present methods of treatment are much more effective than is commonly realized should encourage people to seek medical advice without delay. It is, of course, essential that greater hospital facilities for the diagnosis and treatment of patients with cancer should be provided in order to utilize more fully for the benefit of the individual patients the best methods of treatment available at the present time.

Of the suggestions made by Prof. Russ for the further encouragement of experimental cancer research, I think that special mention should be made of the need for greater inducement to research workers outside the purely medical sciences to participate in this field.

This little book is well produced and has interesting illustrations. A number of references are given in the text. I should like to suggest that, in a subsequent edition, a limited bibliography would add to its value.

J. S. Mitchell

Biology of *Drosophila*

Edited by M. Demerec. Pp. x+632. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 80*s*. net.

A BOOK with this title ought to be a summary of the behaviour, feeding, mating and larval habits of all the numerous species of *Drosophila*, seen in relation to insect life as a whole, and to the special roles of this genus as an introduced pest into temperate climates and as a laboratory animal. This one is not. Only the last chapter, "Collection and Laboratory Culture" by Warren P. Spencer, concerns the insect as a whole, and contains much practical advice to all who need to trap flies and rear them in the laboratory. The other six chapters, "Normal Spermatogenesis" by Kenneth W. Cooper, "Early Embryology" by B. P. Sonnenblick, "Histogenesis, Organogenesis and Differentiation in the Embryo" by D. F. Poulson, "Postembryonic Development" by Dietrich Bodenstein, "External Morphology of the Adult" by G. F. Ferris and "Internal Anatomy and Histology" by Albert Miller, deal only with bits of the animal, and of course refer almost exclusively to *D. melanogaster*.

The real purpose of this symposium is to provide a handbook of what is considered 'normal' in the morphology, histology, embryology and post-embryonic development of *D. melanogaster*, a standard of reference by which the vast amount of experimental work on this fly can be assessed. Deciding what is 'normal' is necessarily a strongly subjective process; but the work is extremely well documented and includes some references up to 1947. The numerous illustrations, including many excellent photomicrographs, are very clearly lettered, and the account of post-embryonic development includes a chronological table of events as they take place in the 'normal' fly at 25° C. G. F. Ferris's section on external morphology presents a personal point of view that diverges considerably from generally accepted views, especially in trying to avoid such apparent discontinuities as exist between the mouth-hooks of the larva and the mouthparts of the imago.

The geneticist, the embryologist and the insect morphologist will all find this symposium a valuable guide into collateral fields of study, while the general entomologist, and especially the dipterist, will welcome such an exhaustive study of one species. It is a pity about the title. H. Oldroyd

Introduction to Electron Optics

The Production, Propagation and Focusing of Electron Beams. By V. E. Cosslett. Second edition. Pp. xvi+294+8 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1950.) 27*s*. 6*d*. net.

THE second edition of Dr. Cosslett's well-known book is a photographic reprint from the first edition, with some mis-statements and misprints corrected. The text thus differs little from the original, but a series of notes on more recent work has been added, as well as some numerical examples on the more theoretical chapters. The first edition appeared before many of the advances made during the Second World War were made public. It is therefore regrettable that the final third of the book, dealing with applications of electron optics in research and industry, has not been rewritten to include the progress made in electron microscopy, particle acceleration and the generation and amplification of centimetre waves. However, the book is written mainly for students and those commencing research work, and it must be judged in this light. The first edition was always highly regarded as being an excellent introductory text, and the new edition should maintain this good reputation.

Orkney

By Hugh Marwick. (County Books Series.) Pp. viii+287+49 plates. (London: Robert Hale, Ltd., 1951.) 15*s*. net.

NO part of Scotland is richer in prehistoric remains than the islands of the Orkney group. Both habitations and burial places are numerous, and all seem to begin in Neolithic times. These matters are described and discussed in this book, and well illustrated by photographic plates. But the volume is not only archæological. All aspects of the islands are treated, though the natural history perhaps has least notice. There are, however, other books on these aspects. Agriculture gets adequate notice. The islanders depend almost wholly on this for their prosperity, their exports being eggs and cattle, and some lobsters. There are no industries, though the manufacture of tweed is beginning. Population has been falling for the past hundred years, and only twenty-seven of the sixty islands have any inhabitants; and several have only one farm or a lighthouse. The book has an adequate map.

The Land of Britain

Its Use and Misuse. By L. Dudley Stamp. Second edition. Pp. viii+507. (London, New York and Toronto: Longmans, Green and Co., Ltd., in conjunction with Geographical Publications, Ltd., 1950.) 45*s*. net.

THIS valuable book, first published in 1948, has now been re-issued in what the publishers describe as a second edition; little if any change, however, seems to have been made in the text. The bibliography is unaltered and stops at 1946, although some valuable reports and books published since that date might well have found a place. Also there still remain the puzzling discrepancies between the official statistics of land utilization in England and Wales as published by the Ministry of Agriculture and those as quoted on p. 481: up to 1939 the figures agree with those of the Ministry, but for 1940–46 they do not, and no explanation is given. Also the figures stop at 1946, but the later ones, which are very interesting, are available. A completed table brought up to date would have been very helpful; in no other readily accessible volume are these important statistics assembled on one page as they are here.

The need for a re-issue shows how widely the book has been appreciated. Nowhere else can the student find so full and authoritative an account of the land of Britain or so good a summary of the labours of the devoted band of workers who carried out the classical Land Utilization Survey on which it is based.

The original Survey was carried out in 1931 and 1932, and, since then, British agriculture has undergone profound changes. Would it be possible to repeat the Survey now that twenty years have elapsed, so as to have a full record of these changes? The information would be invaluable for those whose task it is to direct the new agriculture, and there still remain a sufficient number of the old workers to ensure that the results would be comparable with those of the 1931 Survey. E. John Russell

AGRICULTURAL RESEARCH IN THE GROUNDNUT SCHEME, 1947–51*

By Dr. A. H. BUNTING

Recently Chief Scientific Officer of the Overseas Food Corporation

THE Overseas Food Corporation has recently decided, following the curtailment of the scope of its operations in Tanganyika, to reduce the scale and to revise the organization of its agricultural research services. As a preliminary to this reorganization the post of chief scientific officer has been abolished, and steps are under consideration by which part of the work formerly conducted by the Corporation may be transferred to other agencies. It seems appropriate at this juncture to record in outline the objects and the results of the work up to the present time.

The Scientific Department of the Corporation was founded by my appointment as chief scientific officer on January 30, 1947. Its task has been to assemble the technical knowledge necessary for the successful establishment of systems of mechanized crop production in the Corporation's areas of Tanganyika. To carry out this task the Department has developed a considerable organization for field investigations and for supporting laboratory work.

The European research staff in the crop season of 1950–51, including agricultural trainees attached to the Department, numbered thirty-eight, of whom eighteen were academically qualified. This staff, aided by African assistants trained in the Department, operated three fully mechanized experimental stations, ranging in size from 800 to 1,000 acres, at Kongwa, Urambo and Namanga, near Nachingwea, in the Central, Western and Southern Provinces of Tanganyika respectively. The headquarters of the Department, including the statistical and chemical laboratories, are at Kongwa.

Questions arising from the work of the Department which require a more fundamental attack have been passed, wherever possible, to the East African Agriculture and Forestry Research Organization for study. Collaboration has also been developed with the official agricultural and related technical services in Tanganyika, and in practically all other territories of tropical Africa, in Australia, in the United States and in many other countries, and notable help has been received from university departments and official and commercial research organizations in the United Kingdom. The chief scientific officer was a member of the East African delegation to the African Regional Scientific Conference in Johannesburg in October 1949.

The research programme has been based on a broad general exploration and assessment of the edaphic, environmental and biological factors operative in the three regions. This has included the assembly of meteorological data, with special reference to rainfall in the Kongwa area, the generalized pedological study of soils, particularly in the Kongwa and Southern Province areas, and extensive botanical and entomological collections of species of economic interest.

Soil Studies

A fairly clear qualitative idea has been gained of the fertilizer needs of crops on the more important soil types of the three areas. In general, it has been established that it is necessary to use phosphate for all crops, with nitrogen, usually as a top dressing, for sorghum, maize and other non-legumes. The quantitative study of fertilizer needs has more recently received closer attention, and it is clear that on some soils, at least, about 0·2 cwt. P_2O_5 per acre is sufficient to give an economically satisfactory response, although the economically optimal levels of application have not yet been precisely determined. Residual effects of phosphatic and organic manures, which have been found in field experiments, are now receiving closer attention, and work has begun on the effect of grasses on the soil nitrogen cycle (including the removal of nitrogen by leaching), with special reference to the possible role of grass courses in the conservation of soil nitrogen. In collaboration with members of the staffs of the Empire Cotton Growing Corporation and of the Tanganyika Department of Agriculture an initial examination has recently been completed which strongly suggests that *Tridax repens*, a common weed at Ukiriguru, in the Lake province of Tanganyika, plays an important part in the mobilization of soil phosphate. In 1951, an experiment on the nutrition of tobacco showed that quality in Virginia flue-cured tobacco at Urambo is dominated by the balance of nitrogen and potash. This result may have a profound effect on the future of tobacco production in Tanganyika, since it appears to be possible, by the correct use of fertilizers, to produce a tobacco free from the 'tang' which has been so characteristic and adverse a feature of Tanganyika tobacco in the past.

Crop Research

A systematic programme of crop introduction, from tropical and subtropical countries in all continents, has provided much valuable material, most of which was new to Tanganyika and in many cases to East Africa as a whole. The groundnut collection includes about 250 varieties, from which new, long-season types with seed dormancy are being developed to facilitate groundnut production in wetter areas, where harvesting of short-season types has at present frequently to be undertaken before the end of the rains, and to aid in the fight against the rosette virus disease of the crop (see below). The sorghum collection contains more than 160 varieties and has been the basis for all commercial production of this crop by the Corporation so far. The ideal type of sorghum for mechanized production in Tanganyika appears to be a stout-stemmed, rust-resistant dwarf, with a well-exserted head of shallu type, small glumes and a light-coloured giant grain of the Kafaru or Kaura type, developing a horny peripheral layer at maturity as a protection against storage pests.

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* Based on an address to the Fifth Annual Conference of the Scientific Department, Overseas Food Corporation, held at Kongwa, Tanganyika, August 18–20.

All the necessary characters for such a variety are represented in the sorghum collection.

Safflower was introduced to East Africa, probably for the first time, by the Corporation, and may yet become a useful combine crop for the drier areas. It may even find a place as a late-planted crop in the wetter areas on suitable sites, extending the peak periods of planting and harvesting.

The soya bean collection contains about seventy varieties. Certain of these have transformed the prospects of this crop in Tanganyika, as a result of the recognition of the limiting effect of equatorial day-lengths on growth and yield in all varieties of soya in use in East Africa hitherto. The standard South African, Rhodesian and American types of soya bean, when exposed to equatorial day-lengths, receive the flowering stimulus at a very early stage and give small plants and poor yields. For success in Tanganyika, especially in mechanized production, a soya variety must be sufficiently tolerant of short days to produce considerable vegetative growth before accepting the flowering stimulus. Six such varieties obtained from equatorial or subequatorial territories are now in the possession of the Department. Four of them, in a formal trial at Urambo in 1950–51, yielded 1,500–1,600 lb. per acre, against 100–900 lb. for the other types tested.

Much attention has been given to maize and also to minor crops, and particular interest is attached to recent work at Urambo on the mechanized production of paddy rice, and to the pilot scale development of Turkish tobacco production at Kongwa.

The agronomic programme has led to elementary investigations in crop physiology at points of economic importance. Studies of root distribution in soils and subsoils have added to the understanding of crop behaviour at Kongwa and Urambo. In 1950 a preliminary investigation, using the techniques of growth analysis, was carried out on the development of the groundnut crop. It showed, *inter alia*, that in the short-season variety, Natal Common, about one-third of the final yield of kernels is laid down in the last fortnight of the life of the crop. This result has been confirmed in 1951 by harvesting experiments.

Soil Management

In the field of soil management, a study has been made over three seasons of moisture relationships in Kongwa soils. This has shown that while no moisture accumulates at Kongwa under continuous cropping, considerable reserves can be built up by bare fallowing in a dry farming rotation. The gypsum-block technique is being used in these investigations to follow variations in the amount and distribution of available soil moisture. At the same time field experiments have indicated the very considerable advantages to be expected from bare fallowing: in the case of groundnuts 300 lb. additional kernels per acre have been obtained as a result of bare fallowing, the yield being raised from 700 to 1,000 lb. per acre. The crucial importance of weed control, particularly in the earlier stages of the life of crops, has also been shown at Kongwa.

A simple ridge and furrow system of ploughing, set out on the contour, has been evolved at Urambo as an addition to normal soil conservation practice, in an attempt to control surface wash and to reduce ponding and excess moisture in seed beds. Experience in the abnormally wet season of 1950–51 at Urambo has been very encouraging, and the method is now under trial in French West Africa as well as in Tanganyika.

It has been demonstrated that the avoidance of soil compaction, which was once regarded in some circles as a major and practically insoluble problem, is entirely a question of intelligent soil management.

On general matters of cropping technique, much has been learnt about seed dressings, seed-bed preparation, sowing rates and methods, time and method of harvesting and related matters. A few long-term experiments, and several two-year trials, have been devoted to the examination of crop sequences and rotations.

Plant Protection

The Department's pathologists and entomologists have maintained continuous surveys of crop diseases and pests. All actual or potential biological enemies so far encountered have been identified, with the aid of workers in Britain and elsewhere, and a working knowledge of the bionomics of the more important organisms, leading already in a few cases to methods of control, has been obtained. Crown rot of groundnuts has so far received more attention than any other disease, because of the fear that it might be cumulative. This has not proved to be the case. Advances have been made towards the control of *Sclerotium* foot rot and *Cercospora* leaf spot of groundnuts. In the entomological field *Calidea dregei* has for the first time been followed through its annual cycle and the study of its control by means of insecticides has begun. Stem borers of sorghum and maize represent a most serious problem: their biology at Kongwa is now fairly well understood; but their control is difficult and would seem to require attention on an East African scale. Studies of the pollination of sunflowers have confirmed the view that the natural populations of pollinators are inadequate for large-scale production of the crop, and have increased our knowledge of the behaviour of wild bees in Tanganyika.

The outstanding piece of work in the plant protection field has been the study of the rosette disease of groundnuts and its aphid vector, *Aphis craccivora*. An adequate picture of the field biology has been obtained, and has led in one direction to the successful trial of systemic insecticides for the control of the disease, and, in another, to the study of the possibilities of a new and important means of biological control based on the provision of alternate hosts for the predators of the vector. The demonstration that dry-season volunteer groundnuts can carry rosette disease and its vector over into the new season has been followed by the discovery that certain long-season varieties exhibit marked seed dormancy, which delays the appearance of volunteers for many months and so automatically provides a close season to prevent the carry-over of the disease. More recent work suggests that some of these long-season types are, in addition, resistant to some forms at least of rosette disease.

Scarcely less important has been the demonstration that benzene hexachloride, placed near the seed at planting time at the rate of about 4 oz. gamma-isomer per acre, can control the attack of termites on the standing crops as they approach maturity several months later. The biological staff have also given major help in such matters as seed selection, storage of agricultural products and the control of termites in buildings.

The attention of the Department has been so largely concentrated on field work that the laboratory side has seemed to occupy a second place. For a long time there were no laboratory facilities at all, yet valuable studies were carried out using portable or improvised equipment. For two years the headquarters laboratories were housed in tents; but on August 20, 1951, the Kongwa chemical laboratory, a well-equipped establishment of modern design, was formally opened after having been in use with temporary fittings for eighteen months. The remaining laboratories at Kongwa have been housed in converted accommodation for the same period. At all times, however, the Department has had a reliable routine laboratory service. The chemical staff have analysed many thousands of soils and of crop samples, and their work has also extended to the analysis of fertilizers, studies of the effect of shipment and storage on produce, work on the contamination of crops and analyses arising from pedological problems. Much help has been given to other departments of the Corporation, and the Scientific Department was responsible for the chemical aspects of the recent experiments at Kongwa on the artificial precipitation of rainfall.

The statistical section has been responsible for the design and analysis of more than seven hundred field experiments of modern design, ranging in size from 16 to 300 plots, and has had considerable responsibilities in the planning of programmes and in the evaluation and reporting of results. In addition to papers which have appeared in the specialist and technical Press, the Department has issued annual reports for 1947–48, 1948–49 and 1949–50, which have been summarized in the annual reports of the Corporation published by H.M. Stationery Office. The full data on which these reports have been based may be obtained in mimeographed form from the Scientific Department, Overseas Food Corporation, Kongwa, Tanganyika.

EIGHTH INTERNATIONAL CONGRESS OF REFRIGERATION

THE Institut International du Froid (I.I.F.), which has its headquarters in Paris, normally arranges for an international congress to be held every four years in one of its member countries. The intervention of the war years, however, broke the continuity of its meetings and no congress had been possible since that held in the Hague in 1936. For this reason the recent Congress, held at Church House, Westminster, during August 28–September 10, had more than usual significance, and the field of activity to be reviewed was particularly wide.

The presidency of the Congress was shared by the Right Hon. Viscount Bruce, of Melbourne, and Prof. W. J. De Haas, of Leyden. The Institute of Refrigeration in Great Britain undertook the arrangement of all meetings and functions. The attendance was approximately seven hundred, of which the proportion of overseas visitors was more than two to one. Thirty countries were represented.

The work of the Congress was divided among seven commissions, the subjects of which ranged from low-temperature physics and the low-temperature industry through all branches of refrigeration, including purely biological problems associated with the storage of food and other perishable materials, to problems of statistics and education in refrigeration.

In the meetings of Commission I, no attempt was made to embrace the general field of low-temperature physics, since by agreement this was delegated to the Oxford Low Temperature Conference held a few days previously (p. 807). One session was devoted to the subject of hydrogen and helium liquefaction. This meeting directed attention to the present situation, where there are now scores of laboratories throughout the world equipped to produce liquid hydrogen or helium. In the case of helium liquefaction, while many laboratories use the Simon direct-expansion type of liquefier, a description was given of a small completely automatic helium liquefier, employing a Collins expansion engine, which is now produced commercially in the United States. Dr. A. Wexler, of the Westinghouse Research Laboratories, Pittsburgh, also described a type of small metal Dewar vessel for liquid helium which has an evaporation loss of only one per cent per day. The vessels are shielded by liquid nitrogen boiling under atmospheric pressure. He suggested that larger vessels for storing liquid helium for as long as a year could readily be constructed.

A further session, devoted to thermodynamics, heard reports on the construction of thermodynamic charts for pure substances both by the Kamerlingh Onnes Laboratory, Leyden, and by the Heat Division of the Mechanical Engineering Research Organization (Department of Scientific and Industrial Research). So far, at Leyden, eleven diagrams have been completed and made available for the common industrial gases and helium; while the British body has also completed preliminary surveys for air, carbon dioxide, acetylene, propane and ammonia.

A paper by Prof. Jiro Oishi, of Japan, described a new experimental procedure for determining the absolute temperature of the ice point by the isotherm method. Two advantages were claimed: first, the elimination of dead-space errors, and, secondly, greater reliability of the results since the measurements can be confirmed by the use of at least six different gases in the thermometer. The mean value of the ice point determined by these experiments is 273·15, compared to the mean value of 273·155 obtained from the experimental results of all workers since 1929. Considering both sets of data and the absolute accuracy of the method, he proposed 273·15 to be the best value now available.

Measurements of heat transfer were reported by many authors both to Commissions I and II, the range of temperatures extending from normal refrigeration temperatures down to that of liquid hydrogen. New values for the thermal conductivity of liquid nitrogen were given by Prof. H. L. Johnstone, Ohio State University, while Prof. L. Weil, of Grenoble, gave values for the rate of heat transfer to boiling liquid hydrogen.

The greatly increased importance and activity of the low-temperature industry both in Great Britain and abroad was evidenced by the fact that no fewer than twelve papers were given on subjects connected with industrial gas separation and liquefaction. Many of these were concerned with plant for separating air into its constituents, from the scale of small transportable units mounted on trailers to single industrial units for producing 1,000 tons of oxygen a day. The increasing use of argon-arc welding for fabricating aluminium and alloy steels focused attention on methods of extracting this gas from the atmosphere. The separation of ethylene from coke oven gas and from the gases obtained by the cracking of oil is another field in which low-temperature gas separation is now widely practised.

A further contribution to this session was an account of the work pioneered by Sir Alfred Egerton at the Imperial College of Science and Technology, London, into the utilization of liquid methane. Trials with motor vehicles adapted for running on liquid methane, carried in a vacuum-jacketed tank, have now totalled about 25,000 miles, of which the greater part has been made with buses in full passenger service. It is considered that sufficient knowledge now exists for the use of liquid methane as an automotive fuel to be considered for certain types of vehicles where methane is available. The use of stored liquid methane to meet peak loads at gas works was also discussed.

Commission III of the Congress was concerned with fundamental biochemical and biophysical studies related to refrigeration. Dr. P. Becquerel reported on experiments in which dehydrated organisms such as Protozoa, seeds, and spores of bacteria and fungi were mixed with iron alum powder and cooled by the magnetic method to within 0·2° C. of absolute zero. All the organisms frozen in this way recovered their full vital activity when thawed. It is thus shown that by the action of dehydration, vacuum, and extremely low temperatures it is possible to suppress the colloidal state of protoplasm necessary for biological changes without affecting its power to recover.

In organisms having a higher water content, the chance of survival decreases, although it was shown by Dr. L. Geneves in experiments in which microscope observations were made of cooling thin sections from the roots of the chicory plant that the disturbance of the cell structure by cooling was often reversible on thawing. Similar work was reported by Miss I. Modlibowska, East Malling Research Station, who directed attention to the causes of frost injury to fruit trees, relating it to the water content of the affected cells. The effect of low temperatures on the survival of animal cells was discussed by Dr. L. Bucciante. The usefulness of these researches was instanced by the present use of the low-temperature preservation of animal spermatozoa and of insulin in frozen pancreatic glands.

A novel approach to these problems described by Dr. W. H. Cook, National Research Council of Canada, involves the study of freezing processes in artificial cells constructed from 'Cellophane' or rubber. Films produced from these materials exhibit high resistance to penetration by ice crystals.

The effect of low temperatures on enzyme activity was discussed by Prof. M. A. Joslyn (California) and others. While this field is still only partially explored, it appears that the concentration of the substrate by freezing of some of the water may protect the enzyme and allow the continuance of its activity at lower temperatures than would otherwise be possible.

A further biological problem which arises in refrigerated food storage is the shrinkage and loss of weight of meat and fish which can occur on thawing, due to the extrusion of fluids from muscle. In this field a most valuable paper was presented by J. R. Bendall (Department of Scientific and Industrial Research) and Dr. B. B. Marsh, of New Zealand. They have been able to relate the shortening of muscle fibres and the consequent extrusion of liquid to the decline in the concentration of adenosine triphosphate in the muscle. The reversibility of the process has been demonstrated, and also its dependence on the pH value.

The present state of gas storage for apple and pears was outlined by Dr. C. West, of the Low Temperature Research Station, Cambridge. Wide experience has now been gained in the optimum refrigeration temperature and composition of atmosphere required for different varieties, and the importance of this method is such that it already provides storage for 80,000 tons of fruit in Great Britain alone. Other speakers reported its use overseas.

The work of other commissions covered the purely technical and engineering questions involved in the design of refrigerating machines and insulated chambers of all types. Facilities were also provided for members of the Congress to visit research laboratories and industrial installations in many parts of England and Scotland.

The occasion of the Congress was made the opportunity for drawing up and sanctioning extensive measures for the reorganization of the International Institute of Refrigeration under its new director, M. C. David. It is a matter of the greatest satisfaction to scientific men and refrigeration engineers in Great Britain that Dr. Ezer Griffiths was elected as the new president of the General Conference of the International Institute of Refrigeration; he is succeeded in his post as head of the Technical Board of the Institute by Prof. C. J. Gorter, of the University of Leyden.

G. G. Haselden

LOW-TEMPERATURE PHYSICS

THE conference on low-temperature physics, held at Oxford during August 22–28, constituted the second meeting of the Commission for Very Low Temperatures of the Union de Physique Pure et Appliquée, the first having been held at the Massachusetts Institute of Technology in 1949; and at the same time it formed part of the first post-war meeting of the Institut International du Froid, which has a Commission primarily interested in the pure physics of low temperatures. A conference on the technical and industrial aspects was held in London (p. 806) immediately after that at Oxford. Visitors were invited to the Royal Society Mond Laboratory at Cambridge on August 21.

A feature of the Oxford conference was the presence of a large number of younger research workers who, the organizing committee felt, had in general insufficient opportunities of attending international meetings of this kind. They were able to be there through the generosity of the Royal Society and a number of industrial organizations, the contributions of which substantially augmented the grant made by the Union de Physique from Unesco funds. The presence of a large number of delegates from the United States was ensured through the continued support of the Office of Naval Research.

Except for three introductory papers, contributions were limited in duration to ten, fifteen or twenty minutes. The total number was about a hundred and ten. A reporting system similar to that of the Harwell conference on nuclear physics (1950) was used, with the aid of fifty of the junior research workers, to make the report available in a few weeks.

In the following account, papers are grouped under the same four headings as at the conference.

Thermal Properties

A noticeable feature of this section was the general attempt to measure quantities such as specific heat, thermal conductivity and electrical conductivity over a continuous temperature range, where previously considerable gaps had existed. A number of workers have pushed these measurements below 1° K., and some private discussion took place on the temperature scale in this region. Discrepancies still exist between different laboratories even above 0·2° K.; below this temperature the discrepancies become considerable, but, until the problem of heat transfer to and from the paramagnetic salts used as cooling agent is solved, this does not seriously affect work except on the properties of the salts themselves.

Work on the specific heat anomaly in solid deuterium was reported by H. L. Johnston, and in solid hydrogen by R. W. Hill. It seems probable that the origin of the anomaly is splitting of the rotational degeneracy by the crystal field. Hill also reported that pure germanium shows no anomaly, and E. Estermann showed that the anomaly previously found is connected with the presence of impurity. Measurements on neptunium and thorium oxides (NpO_2 and ThO_2) (E. F. Westrum) showed that the anomaly in the former is magnetic in origin, like that of uranium oxide (UO_2).

Work on solid helium at high temperatures was concerned with the possibility of a critical point in the solid–fluid equilibrium. J. S. Dugdale reported that entropy measurements give no indication of approach to such a point, and that two phases have been found in the solid state, with a latent heat of transition. F. E. Simon suggested that these represent close-packed hexagonal and cubic states. The melting curve below 4° K. has been further investigated by C. A. Swenson. The melting curve of the light isotope, helium-3 (B. M. Abraham), has been measured between 1·5 and 0·16° K. Above 0·5° K. the melting pressure is $p = 26·8 + 13·1\ T^2$ atmospheres, while below it approaches a constant value of 29·3 atmospheres; this may be due to a transition in the liquid, or to the experimental difficulty of lack of heat contact with the paramagnetic cooling salt.

R. Berman reported that work on the thermal conductivity of dielectrics gives general confirmation of theory. The maximum in the thermal conductivity occurs at about a twentieth of the Debye temperature and amounts to 60 watts/cm. for sapphire. Work on solid helium (J. Wilks) is of interest because of its large change of density under pressure. The low thermal resistance of some crystals raises the possibility of observing 'second' sound in them. Work on the thermal conductivity of metals at Oxford and Ohio State University is concerned with the question of the minimum which, according to E. H. Sondheimer, is a rigorous consequence of the Bloch–Nordheim theory.

A considerable amount of work was reported on the electrical resistance of both pure metals and alloys, partly directed towards the discovery of suitable secondary thermometers and partly for comparison with theory. Hitherto, it has been generally accepted that the resistance reaches a constant value at low temperatures, but a number of metals show a minimum of resistance. E. Mendoza has investigated specimens of silver, gold and copper below 1° K. and finds a sharp increase in the resistance at the lowest temperatures. There seems to be no explanation for this at present.

Liquid Helium

In an introductory lecture, F. London surveyed the present position in the theory of liquid helium. Further work has revealed some of the limitations of the two-fluid model, though there is no doubt that this is basically correct. These limitations are connected with the existence of a limiting velocity in the rate of transfer, and the presence of dissipative forces at high rates of transfer. A more fundamental difficulty is the lack of a satisfactory molecular theory, although considerable progress has been made in the molecular theory of ordinary liquids. The fact that the light isotope, helium-3, shows no superfluid characteristics down to 0·25° K. suggests that the nature of the statistics, Bose–Einstein or Fermi–Dirac, must play an important part.

Measurements on liquid helium at Cambridge were reviewed by K. R. Atkins. Below 1·6° K. the velocity of 'first' sound approaches asymptotically the value 237 ± 2 m./sec., while previously the velocity of 'second' sound has been found to tend towards 152 ± 5 m./sec. at 0·2° K. The ratio of these velocities departs slightly from the simple Landau theory value of $\sqrt{3}$, but this may be due to dispersion.

Experiments on the flow of liquid helium II were mainly concerned with evaluating the nature of the frictional forces. The theory of Gorter and Mellink postulates a frictional force proportional to the cube of the difference of the velocities of the normal and superfluid. Measurements at Leyden, described by P. Winkel, have been designed to determine the proportionality constant and its variation with temperature; it seems possible that some interaction between the superfluid and the walls may have been present. Such an effect is suggested also by experiments of B. S. Chandrasekhar and K. Mendelssohn. Work at Cambridge, including a modified form of the Andronikashvili experiment, suggests that frictional terms involving only the velocities of the individual components may be present. R. Bowers discussed experiments in which the pressure at an intermediate point in the flow was measured, which indicated that frictional terms may only be required to explain flow above a certain critical rate.

Measurements down to 0·25° K. on the specific heat of liquid helium were described by H. C. Kramers. Above 0·7° K. the specific heat diminishes with a power of the temperature between 6 and 7, in agreement with previous work, but then changes rather abruptly to follow a third-power law at lower temperatures, with an absolute magnitude not in serious disagreement with that predicted by the theory of Landau.

A number of papers were presented on measurements of dilute solutions of helium-3 in helium-4. J. G. Daunt and C. V. Heer showed that a quasi-gaseous model of a Bose–Einstein liquid can be used to explain the properties of such solutions, without assuming that helium-3 dissolves only in the normal component of the fluid, as has been suggested by K. W. Taconis.

An interesting experiment of a novel kind was discussed by J. R. Pellam. He showed that a Rayleigh disk can be used for investigating 'second' sound; the use of a disk permeable only to the superfluid will give results on the densities of the normal and superfluid components, the entropy and the specific heat.

Papers on theoretical aspects ranged from the viscosity of gaseous helium-3 and helium-4 (J. H. de Boer) to the hydrodynamics of superfluids (I. Prigogine); the resurgence of physics in Japan was emphasized by a number of papers, read by M. Kotani.

Superconductivity

The session opened with a review by H. Frohlich of his new theory of superconductivity. The problem of finding an interaction mechanism leading to a new electronic state different from the usual state by a small enough energy has been solved, but it has not yet been possible to show that this will lead to superconductivity. The interaction is between the electrons and lattice vibrations through spontaneous emission and absorption. This differs from that in electromagnetic theory in that the velocity of the particles (electrons) is much greater than that of the waves (phonons). The interaction depends on the ionic mass, and so gives rise to the isotope effect; on the simple theory the transition temperature should vary with the inverse one-half power of the isotopic mass. A new fundamental length of the order of 10^{-6} cm. appears, which may be connected with long-range order effects. M. R. Schafroth described an attempt to show that the theory leads to the London equations, but A. B. Pippard suggested that the true equations might be integral equations with the Meissner effect not implicit but imposed as a condition of the solution. On the experimental side, Pippard pointed out that the sharpness of the transition temperature with a mixture of isotopes implies that groups of at least two thousand atoms be involved simultaneously to avoid a spread due to random variations in the isotopic distribution, while groups of 10^{10} atoms are required to avoid a spread due to temperature fluctuations. This, and the smallness of variations in the penetration depth with magnetic field at constant temperature, suggest that the interactions have a range of the order of 10^{-4} cm. This range might be affected by impurities.

Experimental work on the isotope effect was reported by E. Maxwell, who finds that in tin the transition temperature varies with the power $(-0{\cdot}486 \pm 0{\cdot}031)$ of the isotopic mass, while in lead the power is $-0{\cdot}73$ (Mrs. M. Olsen-Baer). A striking result in work on thin films by R. Hilsch is that bismuth condensed from the vapour at 4·2° K. is superconducting, but, after annealing at room temperature, it is not. Among many other papers on superconductivity, mention should be made of a superconducting galvanometer (F. T. Pullan), with a voltage sensitivity of 10^{-12} volt. It is being used to measure the thermoelectric e.m.f. around a tin–lead circuit the junctions of which differ in temperature by only 0·01°. Experimental and theoretical work on the de Haas–van Alphen effect was reported from Cambridge.

Magnetism

In a review of recent advances in paramagnetism, B. Bleaney showed how the use of paramagnetic resonance has made possible the investigation of the behaviour of the ionic energy levels in a magnetic field in a detail which could not be achieved by previous methods. This is particularly valuable in the study of hyperfine structure, since in dilute salts the position of levels as close as 0 001° K. can be determined. This has made possible the analysis of the degree of nuclear alignment by methods such as have been suggested by Gorter and Rose. The information obtained has given impetus to new theoretical work: in the iron group, by Abraham and Pryce, and in the rare earths, by Elliott and Stevens. In the latter case, the use of a crystalline electric field of axial rather than cubic symmetry accords well with the experimental results on the ethyl sulphates. A. H. Cooke described the paramagnetic properties of cerium ethylsulphate, the high anisotropy and low susceptibility of which normal to the crystal axis suggest its use for measurements below 1° K. A magnetic field could then be applied normal to the axis without producing appreciable heating of the salt.

A concentrated attack on the antiferromagnetic state below 4·5° K. in copper chloride was reported from Leyden, measurements having been made on the susceptibility, the paramagnetic resonance spectrum and the nuclear resonance spectrum in a single crystal. The behaviour of the magnetization is in accordance with the theory of Néel, and the effective moment of the cupric ion can be calculated from the nuclear resonance spectrum.

Further measurements on remanence, hysteresis and similar effects in paramagnetic salts at temperatures of the order of 0·01° K. were described by D. de Klerk and M. J. Steenland. It seems that the behaviour observed resembles that of more concentrated salts at higher temperature, being antiferromagnetic in nature. Lack of dependence on the Curie point on shape suggests that it is due to exchange forces rather than magnetic dipole–dipole forces.

After a review of possible experiments with oriented nuclei by M. H. L. Pryce, C. J. Gorter gave a short account of work at Leyden. This has included experiments with gamma-ray emission and the absorption of unpolarized neutrons; one somewhat doubtful positive result has been obtained, the rest being negative. J. M. Daniels reported on work in progress at Oxford.

Two-stage demagnetization experiments using a superconducting wire as a heat-switch were described by J. Hatton. With a starting field of only 9 kilogauss, a temperature of 0·0011° K. has been reached, and the sample remained below 0·01° K. for forty minutes. B. V. Rollin showed that nuclear resonance experiments on a natural crystal of beryl have confirmed the value of 3/2 for the nuclear spin of beryllium-9 from observation of the quadrupole splitting, and a previously unobserved line has been ascribed to silicon-29, with a gyromagnetic ratio of 1·11.

B. Bleaney

R. Bowers

OBITUARY

Prof. F. W. Oliver, F.R.S.

Francis Wall Oliver was born on May 10, 1864, at Richmond, Surrey. On the paternal side he came of a Northumbrian Quaker stock; his great-grandfather, Daniel Oliver (1771–1848), was well known as a preacher among Friends in the North of England. Though F. W. Oliver did not remain a member of the Society, certain traits in his character, such as his unyielding individualism, may perhaps be associated with his Quaker origin. His father—the third Oliver in direct succession to bear the name of Daniel—was keeper of the Herbarium at Kew during 1858–90, and, concurrently, professor of botany at University College, London, during 1860–88. His official house on Kew Green, where F. W. Oliver was brought up, had been occupied previously by Sir Joseph Hooker. Frank's childhood memories included meetings with botanists whom few now living can recall, such as M. J. Berkeley (1803–89) and Asa Gray (1810–88). In 1871, when he was seven years old, George Bentham (1800–84) gave him the book by Edward Lear which contains the "Nonsense Botany", with its deliciously absurd pictures, closely resembling those in certain medieval manuscript herbals.

Frank Oliver was sent to Friends' schools at Kendal and York, and then, after a period at University College, London, to Trinity College, Cambridge. In those days the best training in research was to be had in Germany, and in 1885 and 1886 his initiation took place under Strasburger and under Pfeffer. Daniel Oliver retired from the professorship at University College in 1888, and F. W. Oliver, though only twenty-four, succeeded him as head of the Department. In this capacity he revealed a breadth of sympathy, which enabled him to draw out the individuality of his pupils, while he also had so wide a range of knowledge that it was possible for him to meet and help each student, wherever his chosen ground might lie. The catholicity of his interest would be difficult to parallel in these days of specialization. He once described how he had, in youth, worked through a whole century of the botanical volumes of the *Annales des sciences naturelles*, adding, as a final comment—"and great fun it was". In his personality, however, it was not the purely intellectual aspect of things that was in the ascendant. His physical hardihood, and the determined keenness of his face —he characterized a certain silhouette of himself as "the old hawk"—marked him as a man in whom thought was the handmaid to action. Among his students half a century ago, it was said that F. W. Oliver was born to be a naval officer rather than a professor. There was a prophetic touch in this dictum, in view of the subsequent naval careers of his two sons—Vice-Admiral Sir Geoffrey Oliver, commander-in-chief, East Indies Station, and Captain (E) P. D. Oliver, R.N. Their father's love for an adventurous outdoor life was fostered in childhood by a glorious year of running wild in Jersey, where his grandparents lived. Later on, it found its outlet in mountaineering. This passion dated from his school days in Westmorland; it was shared by his wife, whom he first met when they were both waiting at Zermatt to climb the Matterhorn. The mountain fervour eventually had to give way to an absorbed pre-occupation with coastal regions, the ecology of which came to play a leading part in his departmental programme.

In the latter part of the nineteenth century, university botany had become predominantly an affair of the laboratory and botanic garden, and there was little organized field-work for students. Oliver once wrote that, in the eighteen-eighties, the 'country' was regarded primarily as a source of 'material' for the stocking of laboratory shelves. It was not, indeed, until early in the present century, when ecology had begun to breathe fresh life into outdoor botany, that an attempt was made from University College to carry out a systematized survey of the vegetation of an individual locality. The pioneer effort took the form of an expedition to the Norfolk Broads in 1903. After this tentative experience, Oliver chose the Bouche d'Erquy, on the north coast of Brittany, twenty-five miles west of St. Malo, as an ecological centre for his Department; the visits paid to it covered the period 1904–9. The primary object of the first year's work was to map and level the physical features and plant-associations, as a basis for further research. In later years a variety of experimental and ecological techniques was employed (*New Phyt.*, 3, 1904, and later years). A. G. (now Sir Arthur) Tansley, who has since been so largely responsible for the development of ecology in Great Britain, had much to do with the initiation of the Erquy studies. Another ecologist, closely associated with Oliver's vegetation surveys, was E. J. (now Sir Edward) Salisbury, who eventually succeeded him in his professorship. From 1910 onwards, Oliver's ecological activities were transferred to Blakeney Point in Norfolk—an area which has since come under the control of the National Trust (*Trans. Norfolk and Norwich Nat. Soc.*, 9, 1909–14, and later years). Many of the Blakeney observations find a place in Tansley's work, "The British Islands and their Vegetation" (1939; ed. 2, 1949).

It was not in Oliver's nature to confine himself to the ivory tower of academic botany; he was constantly trying to apply his ecological experience to the needs of man. Evidence of this will be found in two team-work books which he edited—"The Exploitation of Plants" (1917) and "Life and its Maintenance" (1919). Both of these were based on public lectures at University College, dealing with problems the urgency of which emphasized itself during the First World War. Oliver's contribution to the first volume was on the reclamation of waste lands, while, in the second volume, he discussed the use of certain grasses as substitute raw material for paper. In another book, "Tidal Lands" (1918), he collaborated with A. E. Carey, a maritime engineer, in a study of the maintenance of coastal and riparian areas. In this work he describes the part played by plants in fixing dunes, and in reclaiming shingle beaches and salt marshes. He lays special stress upon *Spartina Townsendii*, the grass that he called "a Gift from Heaven", on account of its mysterious origin, and its almost miraculous power of transforming salt marsh mud into land suitable for reclamation. In the autumn of 1950, at the age of eighty-six, he re-visited the Dutch *Spartina* fields, to study the progress they had made since the first batch of cuttings was sent to Holland more than twenty-five years before.

The special courses of lectures, often by outside men of science, which were a feature of F. W. Oliver's Department, and to which I have alluded in connexion with the economic aspect of his work, also gave the opportunity for dealing with other topics not included in examination syllabuses, such as the history of botany. Oliver had inherited and extended his father's collection of old herbals and of the work of botanical draughtsmen, and his interest in the subject found expression in organizing courses on the historical aspect of plant delineation, and of botanical study in Great Britain. Some of these lectures were incorporated in a book which he edited, "Makers of British Botany" (1913).

F. W. Oliver's own personal research had its focal centre in palæobotany. His friend, D. H. Scott, inspired him with fervour for the subject, and his early enthusiasm was closely linked with a course of lectures which Scott gave at University College in 1896, and which were afterwards published as "Studies in Fossil Botany". Oliver specialized in the complex seeds of Carboniferous plants, and examined modern gymnosperms, such as *Torreya*, to find material in which to trace the phylogenetic history of seed structures. Coal Measure seeds are commonly seen only in detachment from the parent plant, so that, in the early days of these studies, their attribution was conjectural. In looking through the Williamson Collection of sections of Carboniferous plants at the British Museum in 1902, Oliver noticed certain anatomical features which practically proved that the fossil seed, known as *Lagenostoma lomaxi*, belonged to the fern-like plant, *Lyginodendron oldhamium* (now called *Lyginopteris*). He reported what he had seen to Dr. Scott, and asked him to collaborate in an account of this identification. Such a suggestion was natural, since the Williamson Collection was, in a moral sense, Scott's property; in order that it might belong to the nation, he had bought it when the opportunity arose, the British Museum repaying the debt by instalments. Scott, however, held very decidedly that the epoch-making *Lagenostoma* discovery should be published by Oliver independently; but Oliver remained determined that it should be joint work, and he finally prevailed upon Scott to agree. The collaboration was complete; Oliver has assessed their contributions as being "50/50 both in the descriptive and theoretical parts". In their memoir, "On the Structure of the Palæozoic Seed *Lagenostoma Lomaxi*, with a Statement of the Evidence upon which it is referred to *Lyginodendron*" (*Phil. Trans. Roy. Soc.*, Ser. B, 197, 193; 1904), the name Pteridospermeæ was proposed for fern-like plants bearing seeds; Oliver and his pupils afterwards investigated other members of the group. Scott always accorded the fullest recognition to Oliver's primary part in unravelling the *Lagenostoma* secret; this became strikingly evident when the Pteridosperm nature of *Lyginopteris* was clinched, once and for all, at the Cambridge meeting of the International Botanical Congress in 1930. At this meeting well-preserved impressions of *Sphenopteris hœnighausi* (the foliage of *Lyginopteris oldhamia*) actually bearing cupules and seeds were exhibited by W. J. Jongmans. At the end of the paper, Scott, who was presiding, left the chair, and disappeared quietly from the room, thus compelling Oliver "to take the 'curtain' alone". (See notices of D. H. Scott by A. C. Seward in "Obit. Not. Fellows Roy. Soc.", 205; 1934, and by F. W. Oliver, *Ann. Bot.*, 49, 823; 1935.) In 1905, the year following the appearance of the *Lagenostoma* paper, Oliver was elected to the Royal Society, and in 1925 the Linnean Medal was awarded to him.

The year 1929 was a turning point in Oliver's career. His marriage in 1896 to Mildred Alice Thompson had given him a home atmosphere of rare and delightful quality, in which all his activities could expand and flourish. The only shadow was the distressing illness of their third child, Faith, who was partially paralysed, and for twenty years required ceaseless care, which Mrs. Oliver gave with unstinted devotion. This invalid daughter died in 1929, and her parents were then free to embark on an entirely different mode of life. Later in that year, Oliver, being then sixty-five, retired from University College, though pressed to continue for a further period. 'Fougasse' marked the occasion by an admirable cartoon, depicting F. W. Oliver soaring into the air, pipe in mouth, from the top of the portico steps of the College, his discarded cap and gown in flight behind him. The drawing was inscribed: "The Boy—What will he become?"—a query which was answered by his appointment in the same year to the professorship of botany in the Fouad I University, Cairo, a post which he held for five years. For the first three winters, Mrs. Oliver was able to be with him at Heliopolis; a vivid picture of their cosmopolitan life there is given in her "Letters from Egypt", printed after her death in 1932.

Even after Oliver had retired from this second professorship, he remained in Egypt, which became more exclusively his home than he had anticipated, since the War put a stop to his annual visits to England. For fifteen years he lived in a house he had built at Burg-el-'Arab in the Western Desert, thirty miles west of Alexandria. There was no irksomeness for him in the remoteness and isolation of his chosen spot; ennui was not within his experience. Many years ago, when he lay ill in a nursing home in the dreary precincts of Fitzroy Square, he replied to a visitor, who had ventured to condole with him on the tedium of this imprisonment: "*Nothing* is boring". Indeed, in Egypt, under the stimulating influence of surroundings not staled by custom, his interests took on a renewed lease of life. One of his special concerns, European coastal problems, suggested lines of approach to certain urgent Egyptian questions. In 1941 he published, under the auspices of the Egyptian Ministry of Agriculture, a paper on "The Sand-Dune Menace", in which he urged long-term planning for the stabilization of wandering dunes. In other articles he dealt with desert duststorms (*Geog. J.*, 106, 26; 1945; 108, 221; 1946). He continued, as ever, to view all manifestations of life with the eye of an artist-naturalist, whether he was describing lyrically the "chromatic symphony" of the Maryut flowers, or with equal pleasure observing a garden plant of *Agave americana*, with a flowering shoot more than 27 ft. high, raining nectar in a wind from its myriad perianth cups, each the size of a small liqueur glass. Again, as occasion served, he recorded the ways of ants, hornets, snails, sparrows, or the larvæ of a psychid moth; or he assembled, for packing material, the resilient balls of *Posidonia* fibres, which the sea cast up in their hundreds; or he collected on his rambles, with discriminating zest, handles of amphoræ, believed to have been imported from the Greek islands in Ptolemaic times, some "still carrying their impressed trade-marks—fresh and bright as the day they left the kiln".

In 1950, after twenty-one years in Egypt, Oliver concluded negotiations for the transfer of his property to the Farouk I University, Alexandria, for use as a field station. He then returned to England, and reinstated himself in his former home, Ballard's Barn, Limpsfield Common. Here the end came with complete suddenness on September 14, 1951.

Throughout his life, Oliver never ceased to observe and to record. Less than a month before he died he sent to me specimens and notes relating to a mutant form of *Salvia horminum*, which had appeared this summer in his garden. To the last he defied time, and looked forward to the enjoyment of yet more flowering seasons; in his eighty-eighth year he declared his intention of planting "3 Magnolias together in an appropriate border".

AGNES ARBER

NEWS and VIEWS

Forestry in the University of Edinburgh : Prof. M. L. Anderson

Dr. M. L. Anderson has been appointed to the chair of forestry in the University of Edinburgh recently vacated by Prof. E. P. Stebbing. Dr. Anderson, who already holds a doctorate of the University, brings to his new post a wide experience of British forestry, having served first in the Forestry Commission, both as a district officer and as a research officer, and then in Eire, where he was director of forestry for the period 1940–46 and had to deal with the practical and administrative problems connected with the severe war-time shortage of timber and fuel. In December 1946 he joined the Imperial Forestry Institute at Oxford, where he was responsible for instruction and research in forestry mensuration and British forestry practice. Dr. Anderson has a wide reputation as a sylviculturist with special knowledge of the native hardwoods of Britain, particularly the oaks, to which he has devoted a great deal of out-door and literary research ; his most recent publication is a very detailed study of the status of the sessile oak in the New Forest, and his alleged partiality for this species has long been the subject of friendly chaff. Another pronounced preference shown in his work and writings is for an uneven-aged structure of woods and group regeneration, and he has done much to collect experimental data bearing on the matter. His recent publication on the choice of species in relation to site factors is an important contribution to the literature of the subject and reveals a wide knowledge of this leading aspect of the vast afforestation task in Great Britain. His translation of Tamm's work on "Northern Coniferous Forest Soils" illustrates another task he has frequently undertaken, that of making available to the English-speaking forester the published material and views of leading foreign workers on subjects of importance to Great Britain. Dr. Anderson is one of the few British foresters for whom Swedish, and even Russian, present no serious difficulty. As a contribution towards the investigation of another of the major current forestry problems in Britain, during his time at Oxford Dr. Anderson undertook a study of the relation between the State and private forestry in the Western democracies. Dr. Anderson's appointment at Edinburgh is a very appropriate recognition of the large share he has taken in the advancement of knowledge and thought in the field of forestry, and the effects on the coming generation of his teaching and his example in his new post are likely to be far-reaching.

Education in the University of Edinburgh : Sir Godfrey Thomson

Sir Godfrey Thomson, who retired this year from the chair of education in the University of Edinburgh and from the directorship of Moray House Training College, has made a distinctive contribution to the theory and practice of mental testing. On the theoretical side, he has been a critic of the bold generalizations of Spearman and others, and his work on sampling and the influence of selection upon the factors in a correlational matrix stresses the need for caution in this field. On the practical side, Sir Godfrey has made Moray House the major British centre for the provision of intelligence tests in schools. He has also been concerned with population trends and a possible decline in our national intelligence. His Galton Lecture in 1946 dealt with this topic. He was chairman of the committee which carried out the Scottish Mental Survey of 1947, and is continuing his researches on the data which that survey provided. Sir Godfrey has also achieved notable success as a teacher, and the contribution made to educational and psychological research by his pupils is very great. There are at present no less than ten professors of education or psychology who have studied under him.

Prof. J. G. Pilley

Prof. John G. Pilley, who succeeds Sir Godfrey Thomson, is a Londoner who graduated in natural science in the University of Oxford in 1922. After three years as a research physicist, he became a university lecturer in education at Liverpool for a year and then, from 1926, at Bristol. In 1937 he went to the United States by invitation of the Rockefeller Trustees and Columbia University to study the teaching in American schools and to help in formulating proposals for the reform of the teaching of science. On the outbreak of the Second World War he was prevailed upon to take charge of the Department of Education at Wellesley College, Massachusetts, the post he now relinquishes. Though a man of science, and a successful teacher of science, it is in the philosophy of education that Prof. Pilley's interest is centred. He stands by the values embodied in the educational tradition of classical liberalism against every form of facile modernism. He has made his mark in America as a vigorous critic of the tendency to make education 'scientific', holding that this means, in effect, to anchor it to values that are shiftingly pragmatic, and often ephemeral. His published writings, though slight as yet and mostly topical, have a quality and direction which suggest that he has an important contribution to make to educational theory ; perhaps, in particular, to the solution of that most urgent contemporary problem, the effective integration of science in the theory and practice of a liberal education.

F. M. Balfour (1851–82)

Born in Edinburgh a century ago, on November 10, 1851, Francis Maitland Balfour, a younger brother of the statesman Arthur James Balfour, was one of the most distinguished of British zoologists and embryologists of his time. At the age of twenty-two he did original work at Cambridge on obscure points in the development of the chick, and at the Zoological Station in Naples, under Anton Dohrn, he elucidated the embryonic history of the Elasmobranchs, which was then little understood. This latter research, published in the *Quarterly Journal of Microscopical Science* (1873–75), won him a fellowship of Trinity College, Cambridge, and a lectureship on animal morphology in the University. His classical "Treatise on Comparative Embryology" (two vols., 1880–81), a masterly digest of the previous knowledge on the subject and embodying his own original contributions, was instantly recognized by his fellow scientific workers. In the graphic words of his teacher, Michael Foster, it "brushed away many cobwebs and mooted points with a firm but courteous sweep", and it laid the foundation of the modern study of descriptive embryology. Balfour's numerous honours included the fellowship of the Royal Society in 1878, one of the Society's Royal Medals three years later, and the professorship of animal morphology in the University of Cambridge, which was created for him in 1882. For several years he was one of the editors of the *Quarterly Journal of Microscopical Science*. In the summer of 1882 Balfour went to Switzerland to recuperate from an attack of typhoid fever. He and his guide were killed, probably on July 19, while attempting to climb a virgin peak on Mont Blanc. His tragic death at the early age of thirty-one robbed the world of science of one of its most imaginative, original, attractive and promising workers.

Institute of Navigation : Medal Awards for 1951

The Gold Medal for 1950–51 of the Institute of Navigation has been awarded to H. C. Pritchard for valuable contributions to navigation made over a number of years in the field of airborne navigation equipment. In 1939 Mr. Pritchard formed the Navigation Section at the Royal Aircraft Establishment, and it was in a large measure due to his personal guidance that practical solutions were found to many of the air navigator's problems. Mr. Pritchard's team successfully developed the distant-reading and gyro-magnetic compasses, the air mileage unit, air position and ground position indicators, the drift recorder, the astrograph and the astro-compass. Later during the War, Mr. Pritchard was given responsibility for the formation of an experimental unit to deal with problems of blind approach and landing, and important advances were made in the art of all-weather flying.

Bronze Medals, for the best paper to be published in any year in the Institute's *Journal*, have been awarded to R. F. Hansford (development of ship-borne navigational radar), C. S. Durst and N. E. Davis (jet streams and their importance to air navigation), and Captain F. J. Wylie, R.N. (ret.) (radar and the rule of the road at sea).

Lord Cherwell, P.C., F.R.S. : Paymaster-General

On July 5 in the House of Lords, Lord Cherwell made a vigorous attack on the way in which research on, and development of, atomic energy was being conducted in Great Britain. Lord Cherwell has now been appointed to the office of Paymaster-General in the new Government headed by Mr. Winston Churchill, and has been made responsible for the supervision of research and production in connexion with atomic energy, and also for the Prime Minister's statistical branch. It is worth recalling some of the points made by Lord Cherwell in the House of Lords debate. He referred to the impending retirement of Lord Portal from the post of director of atomic energy, and urged a complete change of organization. Civil Service methods, he said, were inadequate for the task, and the scientific men and engineers required were not forthcoming because they hesitated to commit themselves in a service where their work would always be subject to Civil Service administration. He asked for the transfer of work on atomic energy from the Ministry of Supply, which hitherto has been responsible for it, "to a special organization under the direct control of the head of the Government". His present appointment suggests that Lord Cherwell will now be able to put his views into practice, though such drastic changes in the control of a large body of scientific workers and others must clearly take a little time. Since he has a seat in the Cabinet and he is to have an office at 11 Downing Street, he will have easy access to the Prime Minister. Lord Cherwell is a man of energy and determination, and can be counted upon to see that atomic energy research and development in Great Britain receive the attention so vital a subject warrants.

Rockefeller Grant for Chemistry in the University of Oxford

The Rockefeller Foundation of New York has made a grant to the University of Oxford of £10,000, to be expended over four years, for the Dyson Perrins Laboratory in aid of research in organic chemistry sponsored or directed by the Waynflete professor of chemistry, Sir Robert Robinson. The chief topics of such investigations at the present time are: (1) degradative and synthetic studies of alkaloids, plant colouring matters, and certain other natural products; (2) study of the lipins of tubercle bacilli, especially the fatty-acid constituents; (3) isolation of a differential growth-inhibiting factor present in malt and wheat-middlings; (4) synthesis of steroids other than cortisone (this latter is covered by a grant from the Nuffield Foundation); (5) general studies of organic chemical reactions.

The Battelle International Institute

The Battelle Institute, Columbus, Ohio, the well-known American industrial research foundation, proposes to establish an international industrial research institute to serve European industry, on a non-profit basis, through science and technology. The new body, to be known as the Battelle International Institute, will establish research investigations in existing research institutes of Europe and in European universities and technical schools. It will also operate its own laboratories on the Continent. As with the parent organization, financial support for these activities will be derived from industrial sponsorship, from endowment, and from income from patents owned by the Battelle Institute. It will conduct research in the fields of applied chemistry and physics, metallurgy, fuels, ceramics, electronics, theoretical and applied mechanics, the engineering sciences and agriculture. Mr. John S. Crout, for many years assistant director of the Battelle Institute, has been appointed executive director of the new Institute.

Cultural Anthropology of the Rodiyas of Ceylon

The Rodiyas of central and southern Ceylon are a primitive tribal group, fifteen hundred strong, who have become partly incorporated in Sinhalese society as a caste of drum-makers and beggars. A brief account of them by M. D. Raghavan, "Cultural Anthropology of the Rodiyas" (Ethnological Survey of Ceylon, No. 1: *Spolia Zeylanica*, 26, Pt. 1, December 1950), is the first of a series of studies of the lower castes in Sinhalese society to be undertaken as part of the Ethnological Survey of Ceylon. It describes Rodiya myths of origin; habitat and village organization; daily life, crafts and methods of begging; rites at birth, marriage and death; and peculiarities of Rodiya dialect. Suggestions are offered for Rodiya education and for their further assimilation into Buddhist society. Of interest is the Rodiya myth of descent from Navaratne Valli, a Sinhalese princess who lost her caste through eating human flesh, and the comparison drawn between this mythical ancestress and the Kerala goddess Bhagavadi.

Catalogue of Kenya Timbers

The Government of Kenya has published a "Catalogue of Kenya Timbers", prepared by S. H. Wimbush, of the Forest Department (pp. 69;

Nairobi: Government Printer, 1950; 2*s.* 6*d.*). The author gives a brief description of Kenya Colony, with an area of 219,700 sq. miles, of which only one-third has a soil and climate suitable for normal human habitation. The south-western third of the Colony is made up of the Highlands, about one-tenth of which, that is, about 6,500 sq. miles, is believed to be forest. Although the climate of the Highlands is of a tropical nature, it has widely different extremes ranging from the alpine flora of snow-capped Mount Kenya to semi-tropical rain forest in the Lake Victoria basin. There are then two main divisions of forest in the Highlands: mountain forests which are made up of rain, coniferous, bamboo, and semi-evergreen forests; and semi-tropical rain forests. In addition, there are the lowland or coast forests comprising low and rain forest, lowland dry forest and lowland savanna woodland. Brief notes on the characteristics of these forest types are followed by a few general notes on Kenya timbers. Finally, there are indexes to botanical, English and trade names, and to native names with the botanical equivalents. The main purpose of the handbook is achieved, the trees mentioned being given alphabetically with the following details: local names, distribution, frequency, the timbers and uses. Handbooks of this type are invaluable to all forest officers working in tropical areas.

Industrial Microscopy

AN exhibition of "How Industry is Using the Microscope" has been arranged by the Royal Microscopical Society (Industrial Section), to be held on November 21 in the Great Hall, British Medical Association House, Tavistock Square, London, W.C.1, by kind permission of the British Medical Association. The exhibition will be opened by Mr. A. J. Philpot, director of the British Scientific Instruments Research Association, at 2.30 p.m., and will remain open until 9.30 p.m. Some forty exhibitors are taking part, including research associations and university departments as well as the research departments of a number of industrial firms and the Department of Scientific and Industrial Research. The exhibits cover a wide range and can be classified as concerning: mining and power; metallurgy; glass and ceramics; paint; paper, rubber and fabrics (including leather); photography; food and agriculture; pharmacy; biology. The various modern forms of optical microscopy are represented in addition to electron microscopy. Apparatus and techniques of general and special application are being demonstrated as well as surface profile techniques for electron microscopy. The exhibition is well illustrated by photomicrographs and electron micrographs. It is open to all, and the catalogue of exhibits and further information can be obtained from the Assistant Secretary, Royal Microscopical Society, Tavistock House South, Tavistock Square, London, W.C.1.

Royal Society of Edinburgh: Officers

OFFICE-BEARERS and members of council of the Royal Society of Edinburgh have been elected as follows: *President*, Prof. James Kendall; *Vice-Presidents*, Prof. Arthur Holmes, Prof. W. O. Kermack, Prof. E. T. Copson, Prof. J. H. Gaddum, Sir Robert Muir and Prof. James Ritchie; *General Secretary*, Dr. J. E. Richey; *Secretaries to Ordinary Meetings*, Prof. J. Norman Davidson and Dr. John E. Mackenzie; *Treasurer*, A. W. Young; *Curator of Library and Museum*, Dr. Douglas Guthrie; *Councillors*, Prof. T. Neville George, Prof. J. W. Heslop Harrison, Dr. C. E. Lucas, Prof. M. G. Say, Prof. W. M. Smart, Prof. J. F. Allen, Prof. A. Murray Drennan, Dr. E. Wyllie Fenton, J. M. Ross, Prof. C. M. Yonge, Prof. N. Feather and Sir Godfrey Thomson.

Announcements

CAPT. CYRIL DIVER, director-general of the Nature Conservancy, is to retire next autumn. A small committee under Sir Arthur Tansley, chairman of the Conservancy, is considering the problem of finding a successor to Capt. Diver.

MR. S. S. C. MITCHELL has been appointed controller of guided weapons and electronics in the Ministry of Supply, in succession to Air Chief Marshal Sir Alec Coryton. Mr. Mitchell, who is forty-nine years of age, will be in charge of all work in research, development and production of guided weapons in Britain. He will also undertake responsibility for the direction of the Ministry of Supply's work on electronics research, development and production.

DR. A. H. BUNTING, who held until recently the post of chief scientific officer with the Overseas Food Corporation (see p. 804), and who was responsible, from the inception of the groundnut scheme in Tanganyika in 1947, for the agricultural research services there, has been appointed to the Research Division of the Sudan Ministry of Agriculture. He is to be in charge of a new research station for investigating the agricultural potentialities of the central rainlands area of the Sudan. Dr. Bunting was trained at Johannesburg and Oxford (as Rhodes Scholar for the Transvaal, 1938) and has held appointments at Rothamsted Experimental Station, and with the Human Nutrition Research Unit of the Medical Research Council.

THE Department of Scientific and Industrial Research (Charles House, 5–11 Regent Street, London, S.W.1) is holding an international symposium on the organization of scientific and industrial research, which will take place in London during November 12–15. All sessions will be held in the Council Room, Lancaster House, London, S.W.1, with the exception of the third session, on "Sponsored Research", which will be held at the National Physical Laboratory, Teddington. Representatives from the following countries will be attending the symposium: Austria, Belgium, Canada, Denmark, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Sweden, Switzerland and the United States.

THE Science Section of the Society for Cultural Relations between the Peoples of the British Commonwealth and the U.S.S.R. has arranged a meeting to be held in the Anatomy Theatre, University College, London, W.C.1, on November 16 at 7 p.m. on "Some Aspects of Biological Research in the Soviet Union, 1948–1951". The chairman is Dr. Sidnie Manton, and other speakers are: Dr. A. Morton on "The Role of Environment in Plant Development"; Dr. R. Trim on "Enzymes and the Living Cell"; Dr. D. Ross and Mr. D. Newth "On Animal Embryos and Cells"; Prof. J. D. Bernal on "Relation between Living and Non-living Matter". Tickets of admission (1*s.*; S.C.R. members 6*d.*) can be obtained from the Society, 14 Kensington Square, London, W.8. It is hoped that this meeting may lead to regular annual surveys of Russian work in specific fields.

RESEARCH AND DEVELOPMENT IN BRITISH COLONIES, 1950–51

TO those annual reports of research and development in British Colonies which were last year collected under the title "Colonial Research" there have now been added reports for 1950–51 from the Tsetse Fly and Trypanosomiasis Committee, the Colonial Fisheries Advisory Committee and the Director of the Anti-Locust Research Centre. The present omnibus volume covering 1950–51* thus includes, besides these three reports, the annual report of the Colonial Research Council, the eighth annual report of the Colonial Products Research Council, the seventh annual report of the Colonial Social Science Research Council, the sixth annual reports of the Colonial Medical Research Committee and of the Committee for Colonial Agricultural, Animal Health and Forestry Research, and the fourth annual reports of the Colonial Insecticides, Fungicides and Herbicides Committee and of the Colonial Economic Research Committee. The broad background against which all this work is carried out and a general picture of the work itself is contained in the earlier report, "The Colonial Territories (1950–51)" (see *Nature*, October 20, p. 691). The present report gives the fuller details which the scientific worker expects, together with the particulars of membership of the several councils and committees and lists of publications.

Appended to the report of the Colonial Research Council is a list of research schemes—including fifty-seven new schemes and some sixty supplementary ones made during the year—and of the grants allotted from Colonial Development and Welfare funds. The total of £2¼ millions is the highest annual figure recorded, and brings the grant for research schemes since 1940 to about £10¼ millions. After deductions for unspent balances, etc., the net expenditure and commitment on March 31, 1951, was about £9·6 millions, of which slightly more than £9·3 millions is chargeable against funds provided by the 1945 and 1950 Acts, and to this must be added some £2 millions provided by Colonial governments or industry. The actual disbursement of £1,406,651 during the year is the highest recorded, and indicates that major schemes which have been hampered in their progress by scarcity of scientific personnel, labour, building material and equipment are now getting well under way. About 31·5 per cent of the gross allocation has been for agricultural, animal health and forestry schemes, 14·4 per cent for fisheries research, 13·7 per cent for medical research, 11·9 per cent for tsetse and trypanosomiasis research, 8·4 per cent for social science and economic research, 6·3 per cent for insecticides research, 4·6 per cent for research sponsored by the Colonial Products Research Council, 3·3 per cent for anti-locust research and 5·9 per cent for miscellaneous schemes. Major schemes approved during the year were £150,000 for the establishment of the West African Trypanosomiasis Institute and its maintenance for five years; a further £134,745 for the West African Fisheries Research Institute; £135,000 capital expenditure for the establishment of the East African Medical Survey and Filariasis Research Unit; £126,048 for the East African Institute of Social Research for five years; £200,000 for the maintenance for five years of the East African Tsetse and Trypanosomiasis Research and Reclamation Organization; £280,000 for the establishment and maintenance for five years of the East African Central Trypanosomiasis Research Institute; £263,000 for the East African Veterinary Research Organization; £217,228 for the promotion of agricultural research in Northern Rhodesia; and £260,000 for the establishment of a Marine Fisheries Research Station in Singapore.

Commitments against the £13 millions for Colonial research schemes allotted from the additional funds made available by the 1950 Colonial Development and Welfare Act reached approximately £8·3 millions by the middle of 1950, and in December 1950 the Colonial Research Council recommended that the balance should be apportioned between the various fields of research as follows: general reserve, £425,000; agriculture, animal health and forestry research, £1,300,000; work sponsored by the Colonial Products Research Council, £200,000; anti-locust research, £100,000; insecticides (including fungicides and herbicides) research, £550,000; tsetse and trypanosomiasis research, £425,000; fisheries research, £475,000; medical research, £600,000; social science research, £325,000; economic research, £100,000; and miscellaneous research (including industrial and engineering), £200,000. The Council also endorsed a proposal of the Colonial Office that the various research committees and councils should be asked to make recommendations as to the most profitable use of their funds apportioned to their respective fields to meet all new money required during the next five years, including provision for the research of important schemes.

The Scientific Council for Africa South of the Sahara has now been duly established, with Dr. P. J. du Toit as chairman and Dr. E. B. Worthington as secretary-general, and held its first meeting at Nairobi during November 1950. During the year an American hydrologist and engineer were engaged to survey flood conditions on the Kafue Flats in Northern Rhodesia, and a malacologist was secured to investigate the schistosome-transmitting snails in West Africa. A fourth scientific worker has been assisting in locust research at Cambridge. A further survey was made by the African Studies Branch of the Colonial Office of racial differentiation in the laws of all the African territories, and arrangements have been made for the reproduction of a bibliography of published sources relating to land tenure in the South-East Asia and Pacific Colonial territories compiled by the Colonial Land Tenure Advisory Panel. The report of the Colonial Building Research Liaison Officer on his visit to Africa in the autumn of 1949 has been endorsed generally by the Council. The report emphasized the need for encouraging the better use and improved manufacture of local materials and more economical building design. Problems which require urgent study include the behaviour of materials in tropical climates, the development of material manufactures and methods of construction suitable for African conditions, the design of buildings for comfort in hot climates, and low-cost housing for the African urban population. Research is also needed into the penetration of moisture through building materials and the fortification of native materials to resist insect and mould attack. A manual relating to the protection of buildings and timber against termites has been published. A census was held in Bermuda during October, and in Lagos in February, 1950. Recruitment of staff for the Directorate of Colonial (Geodetic and Topographic) Surveys made progress, and field survey work was maintained mainly in Africa, where the Royal Air Force continued air-photography in East, Central and West Africa. Mapping increased and considerable progress was made in the investigation of mineral deposits. Some fifty-two additional geologists, geophysicists and chemists were appointed during the year, and the universities are now being asked to extend their interest in Colonial geological research. In meteorology the principal development has been the progress towards a West Indies Meteorological Service, covering the West Indian Colonies and the Bahamas, with its headquarters in Trinidad (see also *Nature* of November 3, p. 769); but progress has also been made in the programme of *radiosonde/* radar wind stations and the facilities they will provide for the study of upper-wind conditions. The Colonial Road Research Liaison Officer visited Kenya, Uganda, Tanganyika and Zanzibar during September–October 1950. A report on this visit will shortly be issued. This visit has led to the conclusions, among others, that the more technical road problems of East Africa are broadly similar to those of West Africa, but are aggravated by the greater prevalence of poor-quality soils and roadstones, and that research on Colonial soils and roadstones, and indigenous materials such as *karkar*, coral, soda, wood-tar, and agricultural wastes, and to determine the minimum thickness and quality of road suitable for Colonial conditions, is urgently needed.

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* Colonial Office. Colonial Research 1950–51: Reports of the Colonial Research Council, Colonial Products Research Council, Colonial Social Science Research Council, Colonial Medical Research Council, Committee for Colonial Agricultural, Animal Health and Forestry Research, Colonial Insecticides, Fungicides and Herbicides Committee, Colonial Economic Research Committee, Tsetse Fly and Trypanosomiasis Research Committee, Colonial Fisheries Advisory Committee, Director, Anti-Locust Research Centre. (Cmd. 8303.) Pp. 243. (London: H.M. Stationery Office, 1951.) 6s. 6d. net.

The report of the Colonial Products Research Council again consists of a general part and a more detailed review of some research work in progress. Much attention has been given to the fermentation of the cocoa bean, and it has been established that the predominant species of yeast in cocoa beans commercially fermented in Trinidad and Grenada is *Candida krusei* (A. Cast.) and that *Saccharomyces* species never represent a significant percentage of the total yeast microflora. The observation that the chocolate flavour develops after drying and roasting if aseptic ripe pods are left for some days in dilute solutions of either acetic acid or sodium acetate (but not citric or phosphoric acid) at 48° C. may prove of immediate industrial value. Work on the antibiotic 'comirin' is continuing, particularly with the view of utilizing it as a fungicide or in the protection of paper, canvas and paints. The Colonial Microbiological Research Institute has also investigated the red root disease of West Indian limes and the artificial cultivation of the edible mushroom, *Volvaria esculenta, Bresadola*, and at the University College of the West Indies Prof. C. H. Hassall and Miss L. Wong have shown that the antibiotic, monamycin, separated from a strain of Meredith's actinomycete, is not identical with musarin.

In the work at the University of Birmingham under Prof. M. Stacey more attention has been directed to the action of bacteria on sugar and other carbohydrates. Prof. Stacey's observation that ultrasonic sound waves can degrade the highly polymeric dextran obtained by the action of bacteria on sugar to give the blood plasma substitute previously prepared by acid hydrolysis has been applied in a completely new manufacturing process for this substance. The structures of various ethylidene derivatives of *d*-mannitol have been elucidated by G. T. Bruce, and a series of trifluoroacetyl derivatives of amino-sugars possessing unusual properties prepared by Dr. C. M. Tatlow are being further investigated. A detailed study of sugar-cane wax isolated from the filter muds of all the sugar estates in the West Indies is being made in collaboration with Prof. L. F. Wiggins, of the Imperial College of Tropical Agriculture, Trinidad, and a method for the purification of the wax is being tried on a pilot-plant scale, as is a method for the manufacture of lactic acid. A high grade of cellulose has been obtained by Prof. Stacey by the action of bacteria on sugar, molasses and effluents containing sugar. The examination of the pharmacological action on the nervous system of sugar derivatives prepared by Prof. Wiggins and his collaborators indicates that, with one exception, the seventy pyridazone derivatives screened are unlikely to be suitable for clinical trial. In Prof. Stanley Peat's laboratory at the University College of North Wales, Bangor, the complex system of enzymes involved in the metabolism of starch in the higher plants has been further studied.

Considerable progress has been made in the study of the thermal polymerization of drying oils, and the study of the component glycerides in *Stillingia* oil has been completed, as well as some further studies on deca-2 : 4-dienoic acid and its derivatives. Trials in different areas in Australia have demonstrated the marked effect of climatic conditions on sunflower seed oils, and sufficient information has now been obtained from the experimental plots to justify the Director of Agriculture, Nigeria, starting the cultivation on an area of two hundred acres of the vine, *Tetracarpidium conophorum*, the oilseeds from which provide the conophor oil in which the paint industry is interested; but although the prototype machine for decorticating candlenuts (*Aleurites triloba*) gives a satisfactory separation of shells and kernels, the latter are damaged to an extent which renders them unsuitable for export. Work has continued on plants of possible medicinal and insecticidal value: a study of the essential oil from the wood of *Brachylaena hutchinsii* has been completed, and the structure of the phenol, chlorophorin, present in *Chlorophora excelsa* wood established. Experiments on the purification of the germination factor for *Striga hermonthica* have been actively pursued at the Universities of Leeds and Cambridge. Examination of samples of the oleo-resin from *Pinus caribaea* (British Honduras) have shown that the oil of turpentine and resin are of excellent quality.

The seventh annual report of the Colonial Social Science Research Council estimates that a little more than £100,000 remains available for the next five years for new projects and contingencies in this field. While recruitment of junior research staff improved, difficulty is still being experienced in recruiting sociologists qualified to undertake field demographic studies and urban surveys, and senior men for appointments of two or more years. Special efforts have been made to associate the staff of university colleges in the Colonies with the work of the institutes of social and economic research. Besides the organization by University College, London, of anthropological investigations in the Jos

Plateau and Cross River areas, the two studies of the social structure of an Indian community in Fiji and of the development of social welfare services in Tonga (sponsored by the Research School of Pacific Studies of the Australian National University) and the social science research financed by the University of Malaya and the University College of the Gold Coast, some social science projects have been sponsored by Colonial governments without assistance from Colonial Development and Welfare funds. Research into the grammar and structure of the Somali language, for example, has been carried out by the Director of Education, Somaliland Protectorate; the Tanganyika Government has employed three sociologists, who were to investigate land usage and associated problems in the highland areas of the Northern Province, make a two-year intensive study of the Sukuma tribe, and also a study of the Makere tribe of the Southern Province. The Government of the Gold Coast has financed further research into the teaching of English and into customary land tenure in the northern territories, while the Institute for Medical Research, Malaya, has made studies into the social and economic factors in food consumption, in conjunction with clinical and dietary investigations into malnutrition. The Ethnographic Survey of Africa by the International African Institute has made considerable progress; the survey of the Northern Bantu linguistic border was nearing completion and two sections of the survey of the languages of Africa (Berber languages of North Africa and languages of West Africa) were in the press. Besides brief notes on various socio-economic, ethnographic and anthropological studies in progress in Africa, in South-East Asia and the Pacific and the Caribbean, including also some investigations on psychological testing, the report includes as appendixes reports on work of the Institute of Social and Economic Research of the University College of the West Indies, the West African Institute of Social and Economic Research, which began operations in October 1950, the East African Institute of Social Research, which started work in May 1950, and the Rhodes–Livingstone Institute; appendixes also deal with research under the auspices of the University of Malaya and with research in social sciences at the University College of the Gold Coast and in education at Singapore. The policy and proposed programme of research of the West African Institute are given in full.

All the main schemes under the Colonial Medical Research Committee continued during 1950–51; but the sixth annual report again records inadequate recruitment. Only £600,000 was available from Colonial Development and Welfare funds for continuance of these and for the initiation of new schemes up to 1956, and the programme is under review in the light of this allocation. The Filariasis Research Unit established at Mwanza, Tanganyika, has now been fully staffed and has extended its surveys of filarial infections in the area. Studies on the chemotherapy of bancroftian filariasis have confirmed the high tolerance of the African for doses of the piperazine derivative, 'Hetrazan'. Investigations on loiasis in the Cameroons continued, and in south-west Nigeria a study of the ecology of the local species of *Cyclops* (the copepod crustaceans dwelling in ponds and streams which serve as intermediate hosts to the guinea worm) and a survey of the infection in the area have been commenced. Reasonably good results were obtained in the first twelve months of an experiment in the control of malaria in four valleys in Negri Sembilan, Malaya, in which all houses in one valley were sprayed with DDT, in another with 'Gammexane', while in a third proguanil was distributed weekly to the population. Studies of the effectiveness of DDT and 'Gammexane' against Malayan mosquitoes have also been made, while in North Borneo, besides studies of the repellent effect of DDT to *A. leucosphyrus*, the entomological, spleen and parasite surveys required for the Tambunan experiment to determine whether malaria can be controlled by the localized clearing of jungle growing over *A. leucosphyrus* breeding places has continued. Malaria research in Jamaica has been directed chiefly to the study of the habits and infectivity of suspected malaria vectors, mainly *Anopheles albimanus*, and the distribution of anopheline bites among different human age-groups in relation to general problems of malaria transmission and epidemiology; in Trinidad investigations on outside-resting *A. aquasalis* were intensified, and others on the relative attraction of various animals for *aquasalis*, night activity and ecological studies of various types of breeding places were started. An investigation of the natural history of malaria in African infants in Nigeria was concluded, and comparative field trials on three groups of 245 African school-children naturally infected with *P. falciparum*, *P. malariae* and *P. ovale* showed that all malario-metrical indices decreased more rapidly in the chloroquine than in either the mepacrine or the proguanil groups.

Neither a director nor adequate scientific staff have yet been secured for the West African Virus Research Institute, Lagos, but at the East African Virus Research Institute, Entebbe, Uganda, a long-term programme of research on rickettsioses, with special emphasis on tick-typhus, has been commenced and research on the epidemiology of yellow fever has continued. Further work on the preparation of specific precipitin sera for the identification of blood-meals of insects was carried out at the Lister Institute, London, and the scrub-typhus field research unit of the Institute for Medical Research, Malaya, has completed a general survey of potential mammalian hosts and trombiculid mites, which has shown that the common giant rats (*R. sabanus*, *R. mülleri*) of the Malayan forest are the proper hosts of the vector-species group of mites, while the stream- and gulley-infesting species *R. mülleri* is the chief host of *Trombicula deliensis* itself in the forest. The Field Research Station, Fajara, Gambia, is now better placed to conduct its investigations into causes of ill-health and inefficiency among the rural African population and on measures likely to alleviate or eradicate them. In Malaya clinical trials of thiacetazone against leprosy are well advanced, and in Nigeria, following a study and assessment of the value of sulphone treatment, an attempt is being made to develop a simple, cheap and effective form of sulphone treatment suitable for wide use in such countries as Nigeria.

In the sixth annual report of the Committee for Colonial Agricultural, Animal Health and Forestry Research reference is made to the work under the East African Agriculture and Forestry Research Organization with systemic insecticides against rosette disease of groundnuts. Although initial infection was not prevented, the aphids carrying the virus were killed. Work on the sudden-death disease of clove trees has shown that the disease is due to more than one cause and in young clove trees is largely caused by a new and undescribed species of

Cryptosporella, which is also responsible for a high proportion of dieback in mature trees. Besides research on animal trypanosomiasis and particularly on 'Antrycide', research has been carried out on lapinized rinderpest virus. At the West African Cacao Research Institute, Tafo, investigations are proceeding into the diseases and pests of cacao, the agronomy of the crop, the breeding of improved types and problems of cocoa fermentation. At Rothamsted a survey of the occurrence of aluminium in the plant kingdom, including every family of flowering plant and vascular cryptogams, has shown that very strong accumulators of this element are confined to twenty, and moderately strong accumulators to twenty-eight, families.

Fuller space is given in this report to the work being undertaken by the Colonial Departments of Agriculture, Forestry and Veterinary Services, among which may be mentioned the investigations in British Guiana into the causes of loss in fertility of the 'pegasse' soils of the north-west; the study in the Gold Coast on the dieback disease of lime, and plant-breeding work in Kenya with wheat, maize, sorghum, barley and oats to produce disease-proof varieties of improved yield and commercial qualities, and in Tanganyika on coffee. The survey and collection of varieties of paddy have continued in Malaya, and the discovery in New Guinea of a tachinid parasite of the banana scab moth, *Nacoleia octasema* Meyr., offers the possibility of a biological method of controlling this pest. In Jamaica further work has been carried out on tick dip-fluids for cattle; besides cattle-management studies in Uganda, extensive field trials have been made of a copper preparation for seed disinfestation, and these have given promising results in the control of blackarm disease of cotton. Reports from the standing Sub-Committees for Cocoa Research, Soils and Stored Products Research are also included.

The fourth annual report of the Colonial Insecticides, Fungicides and Herbicides Committee, to which is appended an outline of the work of the Committee during 1947–50, emphasizes the high standard of the work of the Colonial Insecticides Research Team at Porton. The studies on aqueous suspensions of DDT particles in different size-ranges have yielded results which are important for the control of other insect pests besides adult mosquitoes, with which the work has already been done. An inverse relation has been established between particle size of insecticides and their initial contact-toxicity to mosquitoes and a similar relation between particle size and fumigant effect, and the work has been extended to include its effect on the persistence of volatile insecticides with the view of determining formulations giving the maximum initial and residual toxicity. Besides the sorption of solid insecticides by dried mud-blocks, a study has been made of the contact-toxicity to mosquitoes of deposits from aqueous suspensions of inert dusts impregnated with insecticides from other solutions. Promising results have been obtained in the incorporation of insecticides in resin surface coatings, and one containing 20 per cent DDT prevented for several months the fouling by barnacles of marine underwater wooden surfaces. At Silwood Park a detailed study was being made of the structure of insects to determine the mode of action of residual deposits, and also of the way in which insecticide particles are picked up by insects when moving over treated surfaces, while studies at Rothamsted have shown that at 110° F. DDT is rapidly lost by volatilization from crystalline deposits and that the presence of wax has little effect on the contact-toxicity of the glass plates. Final assessment of the results of the trials on the application of insecticides by aircraft against the tsetse fly is not yet possible, but under certain conditions and against certain species almost complete elimination of the tsetse population of a given area appears possible, although whether the method is economically feasible has yet to be proved. It has been necessary to abandon for the time being the project for establishing a West African Insecticide Research Unit. Final results on the treatment of African huts at Kasanje and Mbale, East Africa, for control of mosquitoes and malaria indicate that BHC applied at three-monthly intervals is the best insecticide to use.

The Colonial Economic Research Committee records in its fourth annual report that the study of the national income of Nigeria was initiated in the autumn of 1950, and a survey of the available data relating to Colonial dependence on imported foods has been completed. Arrangements were made in March 1951 for a pilot investigation of the value of sample market surveys as an aid to the promotion of industrial development in the Colonial territories. It is hoped to recruit suitable economists to undertake studies of the retail trade in Tanganyika, Nyasaland and Zanzibar and of capital investment in the Colonial territories generally.

The report of the Tsetse Fly and Trypanosomiasis Research Committee for 1950–51 is prefaced with some notes on the origin and past activities of the Committee. Its work on insecticides has now been taken over by the Colonial Insecticides, Fungicides and Herbicides Committee; and, when the Committee was reconstituted in 1949 and the directors of the East African Tsetse and Trypanosomiasis Research and Reclamation Organization and of the West African Institute for Trypanosomiasis Research were invited to join, the terms of reference were slightly amended and made to read as follows: "To consider and advise on the co-ordination of action, including research and reclamation, directed against human and animal trypanosomiasis".

Considerable progress has been made in studying the relation of the tsetse to its environment, and new techniques were being developed. Plans were being formulated for three schemes of experimental practical reclamation work, one in each of the East African Territories, and interesting results have been obtained in conjunction with the East African Veterinary Research Organization, with a programme of monthly and two-monthly prophylactic injections of 'Antrycide'. Close interest has been taken in the antimonial and arsenical compounds discovered by Dr. F. A. Friedheim for use in human trypanosomiasis, and, following satisfactory results with melarsen, further trials will be carried out.

The Colonial Fisheries Advisory Committee's report on Fisheries Research for 1950–51 refers to the almost complete lack of trained and experienced research workers which has delayed implementation of the research programme. A good supply of candidates for fisheries research studentships to be awarded in 1951 became available, however, and from 1952 the staff situation should be easing. At the Inter-territorial Fisheries Research Station at Jinja, on Lake Victoria, an intensive study of the growth of the phytoplankton has been started as well as of the identification and life-histories of snails and of their parasites, and on growth-rates and breeding of several species of fish. Research at the West African Fisheries Research Institute was about to begin.

The report of the Director of the Anti-Locust Research Centre on locust research and control for 1950–51 reviews the advisory activities of the Centre, which are chiefly connected with regional anti-locust organizations, as well as that of the Desert Locust Control Executive Committee, and with the research being carried out on the taxonomy of locusts and grasshoppers, field investigations on the behaviour of adult desert locusts and on methods of control. Extra-mural researches mostly fall in four overlapping groups: three of them, namely, those investigations in biochemistry, physiology or behaviour which relate to phase phenomena, phenomena migration or to population dynamics, are only just beginning; the fourth group relates to the destruction of locusts by insecticides and machinery. A 20 per cent solution of dinitro-*o*-cresol has proved very effective for aircraft work, but baiting remains the principal method of control.

TECHNIQUE OF ELECTRON MICROSCOPY

CONFERENCE AT ST. ANDREWS

THE Electron Microscopy Group of the Institute of Physics held a conference in St. Andrews University during June 19–21, which was attended by about eighty scientific workers On the first day three symposia were held: recent experiences in the cutting of thin sections; critical testing of instrument performance; and replica techniques. This was followed by a few short original papers. The second day was entirely devoted to the reading and discussion of papers.

M. S. C. Birbeck opened the session on section cutting by discussing modifications to be made in histological technique in order to cut sections thin enough for electron microscopy. Embedding and fixation were particularly dealt with, as it is in these preparative processes that the main difficulties now lie; the actual cutting of suitably prepared blocks is no longer a matter of special difficulty. The modified Cambridge rocking microtome will cut to 0·2 μ, and some Continental makers are producing instruments to cut even thinner sections than this.

It is desirable to embed the tissues in a harder medium than usual, and Mr. Birbeck favours 'ester wax', though Dr. C. E. Challice prefers the purer diethylene glycol distearate, and Prof. L. H. Bretschneider uses a wax mixture including carnauba wax. Fixatives which are suitable for optical preparations may fail for electron microscopy because they precipitate the protein in a fine form which shows spurious structure in the electron microscope size-range. There are exceptions, however, and the most successful fixatives for this purpose are those based on osmic acid and potassium dichromate. Altmann's mixture is specially recommended.

Dr. C. E. Challice opened the discussion and was in general agreement with Mr. Birbeck's methods, differing principally in the knife-blade he uses and in methods of removing the ester wax from the section when cut. Birbeck sublimes the wax in the electron beam itself, but Challice finds that this leaves a 'fixed' residue and prefers to warm the specimen *in vacuo* before exposing it to the beam.

Dr. J. Nuttings's paper opening the session on replica techniques was read for him by Dr. A. F. Brown. After ten years of development, the electron microscope is beginning to give results of real value to metallurgists; and this is happening, not because of special advances in technique and resolving power, but because of the accumulation of experience and data from the use of plastic replica techniques at moderate resolving power and magnification.

Comparison of dry-stripped 'Formvar' replicas with optical micrograms of the identical areas of the surface (made possible by a method developed by E. D. Hyam) show that at least in the optically resolvable range these replicas are completely reliable. Dr. G. L. J. Bailey, in discussion of this paper, expressed the opinion that the biggest problem before the electron microscopist in the metallurgical field is to persuade the classical metallurgist to accept his results; but he was able to cite instances where the electron microscope has proved trustworthy when the conventional optical methods have given misleading results.

Replica methods giving higher resolving power than the simple plastic replica are available or are being developed, but cannot compete with the speed and ease of the dry-stripped 'Formvar' process. Such are the method of polymerizing a monomer *in situ* to form an intermediate cast (in a two-stage process), and, as J. B. Le Poole mentioned, the use of an evaporated silver intermediate cast with silicon monoxide for the final replica, which is said to have a grain size of atomic dimensions and give maximum resolution. The resolution of the simple plastic replica, also, can be improved by preshadowing the metal surface; but there is sometimes difficulty in stripping the shadowing metal, and the discussion showed that the conditions under which this occurs are not understood. A paper by A. W. Agar and R. S. M. Revell, read later in the conference, discussed plastic replicas of ferrous specimens, and suggested that, though the major features are reliably pictured, some fine detail, especially on ferrite grains, is probably spurious and due to the etching process.

The basis of interpretation of replicas of some chromium–nickel steels was broadened by Dr. J. F. Brown and D. Clark, who isolated particles of sigma-phase electrolytically and investigated their crystal structure by electron diffraction (of individual particles selected from the electron microscope field). Correlation of the particle shapes with features of the replicas was possible. J. Trotter has observed two intermediate nitride phases in alpha-iron in addition to the well-known Fe_4N.

The interesting work of Drs. I. M. Dawson and V. Vand on spiral growth of crystal faces, particularly of the paraffin *n*-hexatriacontane (see *Nature*, 167, 476; 1951) was reported to the meeting, and one or two points of general interest to electron microscopists emerged. Gold-manganin is mobile in the electron beam on a paraffin surface and therefore cannot be used as a shadowing metal; palladium is satisfactory for this purpose. The graphitization of the paraffin in the beam is not instantaneous, and paraffin electron-diffraction patterns can be observed for about five minutes before they degenerate into diffuse rings. There was some discussion on the stability of these materials in the beam, and it seems that chemical structure is at least as important as melting point in determining their resistance; thus a paraffin of melting point 74° C. may be quite stable, whereas an aromatic hydrocarbon of melting point 200° C. may polymerize.

A spongy growth of silica in a furnace containing zirconium silicate bricks was shown by Mr. G. A Bassett to be in the form of long fine filaments, each of uniform diameter in the range 100–600 A. This curious form of growth appears to be associated with the vapour phase, as a similar growth of silicon filaments is observed in the action of silicon tetrachloride on zinc. In the case of the silica the X-ray picture shows the filaments to be vitreous.

S. F. Ward reported an instability of siliceous material in the electron beam, having observed that the diatom *Synedra fulgens* shrinks by 5–10 per cent in length on first exposure in the microscope, though after this it becomes stable. The striation-spacings in this diatom show a coefficient of variation of up to 9 per cent, so that if it is to be used for magnification calibration it must first be stabilized and then calibrated optically over the identical region used in the electron microscope observations.

H. L. Nixon has extended the method of concentration estimation by particle counting, first described by Williams and Backus, by using tomato bushy stunt virus instead of polystyrene latex as his standard reference particles. The sprayed droplet size is kept small so that a trace from an evaporated drop is only 2–3 μ in diameter and can be photographed entire at a sufficient magnification to enable one to distinguish bushy stunt virus from other particles in the 10–50 mμ range, while the number of bushy stunt particles can be large enough to give adequate statistical accuracy from counts of only a few traces.

Some experiences of the effect of salt in the purification of vaccinia virus were reported by Drs. C. E. Challice and A. S. McFarlane. Slow flocculation by sodium chloride of a well-washed preparation gives very clear and sharp virus particles as seen in the electron microscope, but similar treatment of less well-washed material results in a non-removable fine granular deposit becoming attached to the virus bodies.

Dr. R. Reed described some work, carried out in Prof. W. T. Astbury's laboratory at Leeds, in collaboration with Dr. L. Hoyle, on the human influenza virus. Ether treatment causes the virus bodies to break down into smaller particles, which form two groups, one showing antigenic activity and the other agglutination properties. It is suggested that the virus-replicating units may be small protein macromolecules which later aggregate to form the virus elementary bodies. Dr. Reed also mentioned work on fibrous components of the human skin, and showed slides illustrating the changes in collagen and elastic tissue in various pathological conditions. Subcutaneous lesions in rheumatoid arthritis have been examined, and the collagen shown to be partly degraded in the intermediate regions and reduced to debris in the badly diseased regions. Preliminary findings on the action of adrenotropic hormone (ACTH) and cortisone on the fibrinoid regions of the diseased tissue were also touched upon.

Work on the cell wall of *Staphylococcus aureus* by Dr. I. M. Dawson and H. Stern makes it very probable that this is of a polysaccharide rather than a protein nature. The apparent disappearance of the cell walls of the intact cells when the organisms are treated with cetyl trimethyl ammonium bromide (CTAB) is ascribed to swelling of the cytoplasm into such intimate contact with the enclosing wall that the latter is no longer separately distinguishable.

The problem of sterilization of film-covered electron microscope grids, before inoculation with slow-growing organisms, has been solved by R. W. Horne by exposing them to ultra-violet radiation; this does not damage the thin nitrocellulose or 'Formvar' film.

The stages of development of the spermatozoon of the spider beetle *Ptinus tectus* were described by Drs. J. Długosz and J. W. Harrold. The mature sperm is unusual in having neither a head nor a nucleus in the ordinary sense; it is of filamentous form, with the hereditary material distributed along the central axis.

Dr. H. J. Woods, with S. M. Mukherjee and J. Sikorski, following the work of Rånby and Ribi, have examined the products of sulphuric acid disintegration of various cellulose textile fibres and find very similar elongated tablet-shaped particles in each case, though the dimensions (20–40 A. thick by 80–160 A. wide) vary somewhat from fibre to fibre. This represents a disintegration beyond the more familiar fibrillar state. Similar tablets are obtained from mercerized materials. Films made by depositing the tablets from suspension show a preferred orientation of the 101 planes parallel to the surface, and the density of such a film is greater than that of the native cellulose of the original fibre, as would be expected if the particles represent the more highly crystalline portions of the cellulose.

The session on critical testing of instrument performance was opened with a lecture by M. E. Haine. Low resolution may often be due to some coarse and easily detected defects, like stage drift or electrostatic charges. Removal of these more obvious faults may still leave a lack of resolution, and Mr. Haine gave a list of possible causes and the means of their detection. Thus, astigmatism can be detected by observing zinc oxide crystals, or, if less prominent, by the observation of the Fresnel pattern near the focus, as used by Hillier, etc. For the most exacting requirements, the Fresnel fringe test with coherent illumination, as described by Haine and Mulvey, can be applied. Mr. Le Poole mentioned his method of locating charged-up areas by forming images of them on the observation screen. Lens current and high-tension variations can be determined from the change in the electron diffraction pattern.

Dr. H. J. Woods and J. Sikorski read a short paper on the filament life in the Metropolitan-Vickers *E.M.*3 instrument. They have found an average life of 15 working hours (at 75 kV.), but filament life appears very dependent on the experience of the operator. J. B. Le Poole and A. C. van Dorsten described a short focal-length objective. From certain theoretical considerations they have found that an objective of 0·8 mm. focal length (at 80 kV.) should be possible. Experiments with soft-iron pole-pieces have confirmed this, giving the predicted focal length. Slightly more favourable dimensions can be obtained with cobalt–iron pole-pieces. The advantage of such a short focal-length objective is its low chromatic aberration, which reduces the requirement for voltage and current stabilization.

A paper on the performance of high-voltage electron guns, as used in electron microscopes, was read by M. E. Haine and P. A. Einstein. It was shown that for a wide range of electrode geometries the theoretical limit of brightness, as predicted by D.

Langmuir, can be achieved if suitable bias-voltages for the shield electrode are chosen. The geometry of the gun is only important in determining the most economical working conditions, that is, lowest total current for maximum brightness.

Dr. G. Liebmann discussed magnetic projector lenses. The focal length of all symmetrical projector lenses can be represented by one single curve. All lenses can be operated at a point where they are free from radial distortion. Calculations agree well with Ruska's measured data. Certain results of use in practical lens design were combined by Dr. Liebmann in a design chart. Dr. C. E. Challice described a modification of the projector lens of the RCA *B*-type electron microscope, which turns the two-stage instrument in effect into a three-stage one, by replacing the standard pole-pieces of the projector lens by a double-gap pole-piece insert. In this way the usable range of magnifications can be greatly increased. A similar modification has been carried out by Dr. J. F. Brown and D. Clark on their Metropolitan-Vickers *E.M.2* instrument. They added a further excitation coil and replaced the existing pole-piece insert by a double-gap insert, adding also a diffraction diaphragm.

Dr. G. L. Rogers gave a talk on "The Elements of Diffraction Microscopy". He reviewed the principles of Gabor's proposals, and pointed out that each 'hologram' can be considered as a zone plate. Thus a definite focal length $\pm f$ can be ascribed to each hologram. f determines the image position, whereas the magnification of the 'reconstruction' follows from geometrical considerations.

D. G. DRUMMOND
G. LIEBMANN

MEDICAL EDUCATION IN TURKEY

ONE of the articles (which is written in English) by Prof. F. Nafiz Uzluk in the latest issue of *Acta Medica Turcica* describes the present state of medical education in Turkey (3, No. 1–2; June 1951).

The old medical education of the Moslem Turks living in Anatolia was based on the medical teaching methods of Jundi Shahpur, as it has been in other Moslem countries. According to this system of teaching, students were required to finish their primary and secondary education in privately owned medresses (religious schools or seminaries). After this they were sent to hospitals to get medical experience by familiarizing themselves with various diseases by the bedsides of patients. That was the general procedure to acquire both practical and theoretical knowledge in order to become a physician. At the end of his training a successful student who had proved his ability was granted a diploma.

Some individuals were fortunate enough to continue their studies in sciences other than medicine; these sciences were classified as theological, juridical or technical. If, in addition to medicine, a student could also continue his studies in one of these fields, he was granted the title of professor or judge. He also obtained the privilege of teaching in one of the medresses.

During the period of the Ottoman Empire, which lasted six hundred years, some of the Turkish physicians held offices as Kadies of Cairo or Istanbul or as military Kadies of Anatolia and Rumeli. Among them some were appointed as the grand religious leader (Sheyhulislam).

Suleyman the Magnificent, or the Law Giver, the Turkish Sultan who ruled in the sixteenth century, had built the famous mosque which was named after him with eight medresses surrounding it. One of these medresses was devoted to medical teaching, and each year eight students were awarded scholarships. In the records of a charity foundation these students are described as "danissments", a word corresponding to what is now called "assistant". In the same record are the words "muit", an Arabic word corresponding to associate professorship, and "muderris", corresponding to the full professorship of to-day.

The medical institute built by Suleyman the Magnificent lasted until 1860. Here a large number of physicians were trained and sent to many different parts of the Turkish Empire. In 1827 the Turkish Military Medical School was founded. In this institution at the beginning the teaching language was Italian, but later French was accepted in its place. This school lasted until 1909. The graduates served in the Army with appropriate ranks.

To make studies easier, in 1866 the Turkish language was accepted instead of French. In the same year another medical school was opened for civilians. These two schools continued in separate buildings until they were brought together in 1909 and a bigger institution came into being at Istanbul. The Medical Faculty of the University of Istanbul developed from this school.

Besides these schools, a surgical school was opened in Istanbul in 1831. This institution also provided many surgeons for the Turkish army and later was combined with the Military Medical School, which is still functioning.

In 1945 a new medical faculty was founded in Ankara as a part of the University. At present there are two medical faculties, one in Istanbul and the other in Ankara. The duration of studies before graduation is six years; entry is open to all without discrimination of any kind provided the candidate has reached the necessary standard of general education.

In 1951, 150 students were accepted by the medical faculty at Ankara; at present the general enrolment consists of 1,048 young men and 218 women. During 1945–50, 534 doctors graduated from the medical faculty of the University of Ankara, which thus provides an average of more than a hundred doctors a year.

At Istanbul, more than four hundred medical students graduate each year.

At present there are 7,349 medical men in Turkey. As the total population of the country is twenty-one million, 2,857 people are served by each physician. Besides the medical schools at Ankara and Istanbul there are two other advanced schools. One is the School of Dentistry, founded in 1909, and the other, the School of Pharmacology, founded in 1879. The duration of studies in these schools is four years.

In order to practise medicine and pharmacology in Turkey, a person must either graduate from one of the institutions described or from one of the well-known foreign faculties. Doctors of other nationalities are not allowed to practise medicine in Turkey, but some professors and specialists of foreign origin are given special permission; although they are not allowed to practise, they may be invited for medical consultations by Turkish medical men.

After further training a graduate of one of the medical faculties may specialize in one of the following branches: in internal diseases; surgery; neurology and psychiatry; gynæcology; pædiatrics; diseases of the ear, nose and throat; diseases of the eye; dermatology; neuropathology; urinary diseases; orthopædics; biological chemistry; pharmaceutics; microbiology; physio-therapeutics; anatomical pathology; radiology and radiotherapeutics; hygiene and medical jurisprudence. After acquiring both practical and theoretical knowledge and after passing a recognized examination he may become a specialist.

Besides this article the journal contains others in English, French and German. *Acta Medica Turcica* is owned and controlled by the Ankara University Medical Faculty and is edited by a Board appointed by the Council of the Faculty. It is devoted to the publication of original observations and investigations in various fields of medicine, and is published four times a year.

UNIVERSITIES OF GREAT BRITAIN

FINANCIAL AND POPULATION STATISTICS FOR 1949–50

THE publication entitled "Returns from Universities and University Colleges in receipt of Treasury Grant for the Academic Year 1949–50"*, issued by the University Grants Committee, is arranged in general on the same lines as in previous years, but a smaller format has been adopted. A new table gives for each university and university college comparative figures of income and expenditure in the year 1949–50 and the previous year. The chief features of the returns are the record number of students (85,421, compared with 83,690 in 1948–49), the continuing high proportion of assisted students (62,199 or 72·8 per cent, as against 61,655 or 73·7 per cent in 1948–49 and 55,539 or 70·7 per cent in 1947–48) and the increased dependence on Parliamentary grants, which represent 63·9 per cent of the recurrent income as against 59·2 per cent in 1948–49 and 57·8 per cent in 1947–48. There was again a welcome increase in the ratio of staff to students, the full-time teaching staff increasing by 540 to 7,930. The increase in staff was made up chiefly of 35 professors, 26 readers, assistant professors or independent lecturers, 126 senior lecturers and 329 lecturers.

Of the full-time students, 68,605 were reading for a first degree, 9,459 for a diploma, and 7,357, together with 4,080 of the 17,660 part-time students, were engaged in research or other advanced work; 63,157 full-time students were in England, 5,284 in Wales and 16,980 in Scotland; of these, 15,309 were at Oxford and Cambridge, 17,499 at London and 30,349 at other English universities and university colleges. Increases in numbers at the individual universities were not in general large, and there were small decreases at King's College, Newcastle upon Tyne, the Universities of Liverpool and Nottingham, Manchester College of Technology, University College of North Wales, Bangor, and the Universities of Aberdeen and Edinburgh. The proportion of full-time students residing in colleges and halls of residence was 22·8 per cent, as against 25·1 per cent in 1938–39, in spite of the substantial amount of new residential accommodation brought into use since the War, although the number in residence is greater (19,458 as against 12,555); 39·3 per cent were in lodgings and 37·9 per cent at home, the corresponding figures for 1938–39 being 33·2 and 41·7 per cent, respectively. There was a slight increase in overseas students compared with 1948–49: 3,387 full-time and 1,580 part-time students came from within the British Commonwealth, while a further 2,677 full-time and 1,316 part-time students came from foreign countries; these figures compare with 2,857 full-time and 658 part-time Commonwealth students and 2,356 full-time and 999 part-time foreign students in the last year before the War. Of the 24,331 students admitted for the first time in 1949–50 (a decrease of 495 on 1948–49), 21,574 were reading for a first degree and 2,757 for a diploma, and of those reading for a first degree 13,519 were nineteen years of age or more.

The distribution of students differed little from that in 1948–49, 43·6 per cent being in arts, 19·8 per cent in pure science, 16·6 per cent in medicine, 12·8 per cent in technology, 3·2 per cent each in agriculture and in dentistry and 0·8 per cent in veterinary science. Of the full-time advanced students, 37·7 per cent were in arts, 36·3 per cent in pure science and 12·9 per cent in technology. Only in agriculture was there a decrease in numbers (146) during the year, the increases in the remaining groups being arts 96, pure science 818, medicine 429, dentistry 177, technology 49, and veterinary science 308; 286 of these last were due to the incorporation of Glasgow Veterinary College into the University of Glasgow. Of the full-time students, 50,039 out of 66,068 men and 12,160 of 19,353 women, or 72·8 per cent of the total, were receiving assistance in the way of scholarships, exhibitions or other awards from public or private funds. The percentage for England as a whole was 76·2, for Wales 83·7 and for Scotland 56·7, compared with 76, 81·8 and 62·9 per cent, respectively, in 1948–49. For the provincial universities the figure (79·5) was intermediate between those for Oxford (82·2) and Cambridge (78·6), but higher than that in the University of London (66·9). Of the part-time advanced students, 45·1 per cent were in medicine and dentistry, 32·3 per cent in arts, 10·8 per cent in pure science and 10·8 per cent in technology.

The recurrent income of the universities and university colleges in the year under review amounted to £22,009,735, an increase of £3,853,157 on the previous year, parliamentary grants totalling £14,056,436 and representing 63·9 per cent of the total as against 59·2 per cent in 1948–49. Income from fees increased to £3,898,809, from endowments to £1,253,784 and from grants from local authorities to £1,008,128, but were only 17·7 per cent, 5·7 per cent and 4·6 per cent, respectively, of the total as compared with 20·6 per cent, 6·7 per cent and 5·0 per cent in the previous year; for England these percentages were 17·5, 5·8 and 4·8, respectively, for Wales 16·7, 2·1 and 6·9, and for Scotland 18·9, 6·3 and 3·0. The total income for English universities was £17,604,807, of which £6,348,424 was for the University of London, £2,003,845 for Cambridge, £1,566,547 for Oxford, £1,057,990 for Manchester, £940,779 for Durham and £914,963 for Birmingham. The total income for the University of Wales was £1,064,105 and for Scotland £3,340,823.

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* University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant for the Academic Year 1949–1950. (Cmd. 8307.) Pp. 38. (London: H.M. Stationery Office, 1951.) 1s. 6d. net.

Of the total expenditure of £21,799,958, an increase of £3,777,864 on the previous year, administration accounted for 8·8 per cent, departmental maintenance 68·2, maintenance of premises 10·8, and miscellaneous expenditure 10 per cent. Capital expenditure met from reserves totalled £472,327, and allocation to reserve £270,993. Departmental maintenance included salaries of teaching and research staffs and payments for superannuation, the running costs of laboratories, lecture rooms, libraries and museums, and the supply of materials, apparatus, books, specimens, etc. Salaries and superannuation amounted to £10,546,346, and departmental and laboratory maintenance £3,272,900, as compared with £8,185,763 and £2,864,845 in 1948–49. Library expenditure, which amounted to £788,402, an increase of £155,147 on the previous year, is analysed in a separate table which shows that of this total £416,604 was for salaries and wages, £182,595 on account of books and £95,867 on periodicals. These figures all show increases on those for the previous year; while the percentage of university expenditure on libraries was still only 3·7 as against 3·4 in 1948–49, eleven universities, Oxford (£25,688), Cambridge (£13,969), Manchester (£8,499), Birmingham (£7,922), Liverpool (£6,022), Glasgow (£10,924), Edinburgh (£9,671), Aberdeen (£6,320), London (£5,806), Reading (£5,068) and Leeds (£5,778), as well as the London School of Economics (£5,515) and the School of Oriental and African Studies (£5,024), spent more than £5,000 on the purchase of books. Of these, Cambridge (£9,601), Glasgow (£7,421) and Oxford (£6,683) also spent more than £5,000 on periodicals.

PERSONNEL MANAGEMENT

IN a recent broadsheet published by the Institute of Personnel Management, G. R. Moxon examines the functions of a personnel department in an industrial undertaking.

The personnel department is a division within the management structure wherein men and women are employed to help to evolve and carry out the various policies of a company in matters affecting its employees. Following current industrial practice, the work of a personnel department is described under six headings: employment, wages, joint consultation, health and safety, employee services and welfare, and education and training.

There is, however, no model or standard personnel department because industry itself is so infinitely varied. British industry is largely made up of companies employing less than a hundred persons. No specialized department is necessary for so small a unit and, in all probability, one personnel officer, responsible to the head of the business, may adequately cover the normal personnel duties arising from the employment of anything from 250 to 500 employees. From 500 to 1,000 employees, personnel problems assume greater proportions and make desirable the employment of a personnel officer. The large industrial unit, and the combine in particular, employing more than a thousand persons, has a wide variety of personnel problems which call for degrees of specialization among members of its personnel department. In those companies, whether medium-sized or large-scale, where personnel management is an accepted practice, there is general recognition that the functions of the personnel department can be grouped into the six divisions already mentioned.

Personnel policies in industrial organizations are the concern of directors or principals. It then becomes the responsibility of management to see that policies are translated into good management practices so that the spirit and intention of policy are faithfully carried out. The personnel department, where it exists in an organization, is a specialist department used for helping the directors in their policy-making and assisting management in carrying out what has been agreed.

Personnel management in Great Britain has evolved from a 'welfare' origin. In its earliest days it may have meant little more than the good intentions of an owner who put what he felt into practice by occasional acts of benevolence or generosity. Welfare officers were first employed in a few of these 'enlightened' companies until the problems of the First World War brought about a considerable increase of similar appointments. A majority of these war-time appointments were terminated with the return of peace-time competition.

It was not until the middle thirties, following upon the serious employment and social problems which followed in the wake of periods of slump and depression, that the establishment of an employment and welfare department began to interest an increasing number of managements. Progress was relatively slow since, for economic and other reasons, the majority of employers were reluctant to regard the labour problems of management as worthy of special study and attention. Personnel management grew principally in the new industries where employers were keen to attract and maintain a stable and efficient working force, as well as in the old-established companies where employers brought a human outlook to bear on matters affecting their employees.

As a result, personnel management had won a firm place in the management organization of a number of industries before the Second World War and, during the War, as the human problems of management again assumed immense proportions, the number of personnel departments increased more than four-fold. Since the War this growth has been maintained.

The problems which confront personnel managers to-day are the improvement of factory relations to the point where national aims and the common interest of management and men may be realized, provision of the right climate of incentive for harder and better work, and making the best use of individual, or group, ability. The techniques employed by personnel managers in tackling these problems are elaborated by Mr. Moxon. Yet though these techniques are the methods by which industry seeks to promote more fairness and justice in factory life and to secure more efficient production, the will to do these things, the good intentions or principles, are as fundamental and as important as they were to the early pioneers. What makes the task more formidable is the knowledge that better management practice of to-day requires a full understanding and a greater measure of support from workpeople and their union representatives, the majority of whom have long memories and are not yet convinced that job security ultimately depends on taking every opportunity to increase production, improve quality and reduce costs.

Other topics considered by Mr. Moxon in this thoughtful and carefully ordered broadsheet are the relation of the personnel to other factory departments and the way in which a personnel department might be organized.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Resistant Peripheral Membranes of the Keratin Fibres

In a number of communications, Alexander and Earland[1-3] have claimed to have isolated from wool a new morphological component, a highly resistant continuous membrane lying between the usually recognized cortex and cuticle. In collaboration with Happey[4], they have further claimed to have demonstrated that the new component is a β-type protein, that is, allied in molecular structure to stretched hair, silk, etc., and that this β-type molecular structure accounts for the stability and resistance of the membrane.

The existence of a subcuticular membrane in animal hairs was suggested by the German workers Lehmann[5,6] and Elöd and Zahn[7] several years ago. Their evidence for a subcuticular origin for the tubular residues has already been criticized and the tubes shown to be derived from the *external* layers of the scaly cuticle, that is, to be cuticular sheaths[8]. To cite merely one convincing experiment: tubes were prepared from fibres which had previously been coated superficially with a thin metal layer by evaporation *in vacuo*. The isolated tubes were found to bear the metal layer which unambiguously labelled the outside surface of the cuticle[8]. Alexander and Earland have merely provided further evidence for a general rule that when the keratin fibres are brought into solution a resistant residue remains which consists of the tubular membranes enclosing a variable quantity of fibrillar cortical fragments[10].

The reason for the separation of the tubes as coherent forms is found by electron microscopy, which shows that the walls of the tubes consist of a very thin, extremely resistant membrane reinforced to a variable degree by the adhesion of granular protein[9,11]. This thin resistant membrane can be separated in a purer condition by chlorinating wool, when the membrane is inflated as small bubbles (Allwörden sacs) and can be rubbed off in fragments by shaking in water[9,12]. This latter experiment is evidence of the external location of the new membrane, which is seen to form an epicuticle, a thin layer uniformly enveloping the fibre much as if it had been lacquered. This epicuticle is indeed a new morphological component and may be a further example of the peculiarly resistant membranes which electron microscopy has revealed in animal tissues. The epicuticle of hair appears to be chemically the most resistant component of the fibre and remains when the keratin proper is dissolved. Since a certain amount of the rest of the cuticle always adheres to it, we have the possibility of forming more robust sheaths or external casts of the scaly layer, and it is these which mistakenly have been thought to come from beneath the scales.

Some preparations of these sheaths give X-ray patterns of diffuse haloes with β-type characteristics as Happey and others have noted, but one is certainly not justified in concluding from this that the tubes are a β-protein and that wool is molecularly a polyphase structure. No β-reflexions in original wool were noted by Astbury and Woods[13], although a β-protein, had it been present to the extent of 7–10 per cent, would have been detected. It is wel known[12], however, that after certain chemical treat ments causing fibre contraction, a β-structure doe develop due to modifications in the cortex of th fibre[14]. An electron microscopic examination of th residue prepared by the method of Alexander an Earland shows, in fact, a considerable quantity c cortical material, which after the chemical treatmen it has suffered may be expected to give a β-pattern In the absence of cortical impurity the tubes giv only a most diffuse X-ray pattern from which littl can be deduced.

In view of the above criticisms, it may seem un necessary to comment on the final speculation tha the β-structure is the reason for the insolubility of th tubes. Bamford, Hanby and Happey[15] have ad vanced the hypothesis that the β-structure of certai synthetic polypeptides is the cause of the insolu bility of these compounds. There is, however, a con siderable difference between synthetic polypeptide and natural proteins, and it is surely better t consider the solubility of actual proteins havin a β-structure. We find, in fact, that these are mor easily brought into solution than wool keratin; fo example, silk in acid or cuprammonium solutio and feather in reducing solutions. The suggeste explanation is not, therefore, acceptable.

The histological structure of the tubes (epicuticl plus cuticular remnant) shows that the real reason fo the separation of the tubes as coherent forms is th insolubility of the epicuticular fraction. The com position of the epicuticle is thus the main problem and the great difficulty here is to separate it in a pur form and in quantity sufficient for analysis.

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The purpose of Dr. Mercer's communication seem to be to establish the following points: (*a*) that th material isolated by Alexander and Earland is no a subcuticular membrane; (*b*) that the β-protei contained in their material is not present in th initial fibre; and (*c*) that the insolubility of thei membranes is not connected with the β-structure.

As regards (*a*) we have no special comment although we feel that Mercer's view is probabl correct. On the other hand, Mercer's argument against the presence of 7–10 per cent of β-kerat in wool are far from convincing. It is by no mean certain that this amount of (partially disoriented β-keratin, even if it were crystalline, would be de tected by X-ray analysis. In fact, Ambrose an

Elliott[1] have shown that in the keratin of elephant hair there is about 10 per cent of the β-form; this s not visible on an X-ray photograph. On point (c), we believe that Mercer's views are unsound. While it is true that the β-protein silk may be more easily dissolved than wool keratin, this difference is not connected with the backbone configuration of the proteins, but results from the presence of cystine cross-links in the wool. Once these are broken, the resulting material dissolves readily in faintly alkaline solutions, for example, very dilute ammonia. Further, in converting the soluble α-keratin to the β-form, there is a marked decrease in solubility. Finally, ecent investigations[2] have shown that the α-form of silk fibroin is readily soluble in water whereas the β-form is insoluble.

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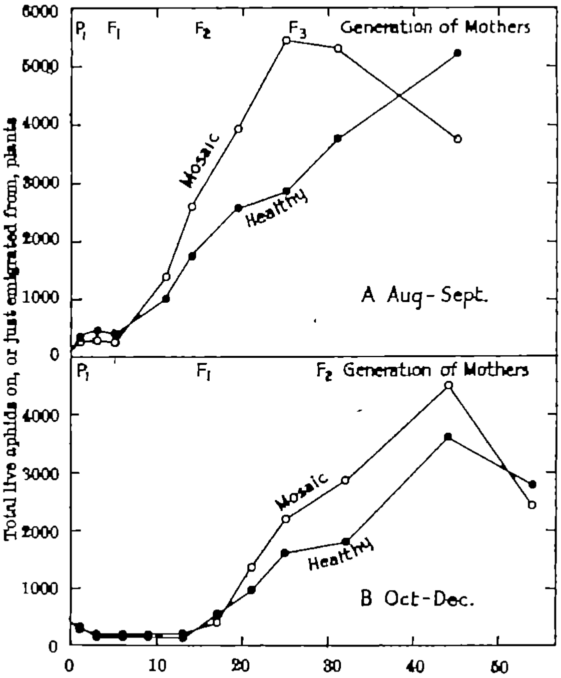
Benefits to Aphids from Feeding on Galled and Virus-infected Leaves

IT has been shown that robust green leaves which have ceased growth and not yet entered upon senescence are unsuitable, by comparison with growing or enescing leaves, for colonization by *Aphis fabae* Scopoli and *Myzus persicae* (Sulzer)[1–3]. Abnormally xtended growth or premature senescence-like hanges, or both, are characteristic of both the pseudo-galls' (curling and pocketing of leaves) and the virus diseases which plants can develop as a result of aphid attack. Experiments were therefore ndertaken to see whether such pathological changes in the plants might not be beneficial to the aphids nitiating them.

The yellow-red pocket galls formed by *Cryptomyzus ibis* on red currant leaves were tried first because the galled parts remain soft enough for the pockets o be pushed inside out, thus turning what were the est sheltered into the most exposed parts of the eaf surface. The aphids, which before were mostly nside the shelter of the pockets, were now all removed from the leaves. The leaves were washed, and resh aphids released on their morphologically upper urfaces. The majority of the aphids settled down o feed again on the galled parts of the morphologically lower surface, although these parts were now convex instead of concave, and were often facing upwards instead of downwards owing to the deformaion caused by everting the galls. The aphids' other references—for shade from the light, and for a ertical or upside-down posture—could still be deected by comparing their densities on otherwise milar leaf areas. But their preferences for the orphologically lower surface and especially for the galled parts of the leaves were more powerful. When the galls are in their normal uneverted state, the shade and posture preferences will, of course, help o get the aphids into the pockets; but they are vidently of subsidiary importance. Cage experiments confirmed that the aphids multiplied faster where they preferred to feed. So it seems that even uch simple 'pseudo-galls' can be physiologically beneficial to the insects causing them, which will be a factor in the evolution of both.



Development of *Aphis fabae* populations on sugar beets with, and without, mosaic virus disease. *A*, five plants of each kind, mosaics inoculated eighteen days before aphids put on; *B*, four plants of each kind, mosaics inoculated twelve days before aphids put on

The effect on *Aphis fabae* of feeding on sugar beets with the mosaic disease caused by a virus this aphid transmits was recorded both in free infestations developing on whole plants for several weeks, and in small cages on individual leaves for 1–4 days. The population on diseased whole plants grew distinctly faster than on healthy plants in both experiments (see accompanying graphs). As a result, overcrowding and emigration also began sooner in the former population. Given fresh plants available for the emigrants to colonize and infect, however, the rising part of the curves should be repeated, and the beneficial effect of the disease should continue exponentially. The confirmatory experiments on individual leaves involved, in all, four batches of diseased plants, some seven thousand adult apterous viviparous aphids caged in groups of ten or twenty, and some twenty-five thousand of their offspring. The average output of young per mother caged on leaves showing mosaic symptoms (systemically infected, following sap-inoculation of the plants 11–240 days before the experiment) was compared with the concurrent output of young on leaves of similar age on uninfected plants of the same batch. The output was higher on the mosaic than on the healthy leaves in twelve out of thirteen experiments on growing leaves, in eight out of nine experiments on mature leaves and in three out of three experiments on senescing leaves. The ratios between the two outputs, mosaic/healthy, from all twenty-five experiments, gave a mean of 1·41 with a standard error of 0·062. Evidently the disease renders the whole plant, and not merely the mature leaves, more suitable for this vector. The epidemiological and evolutionary consequences, for both virus and vector, invite further attention; so also, from the point of view of plant physiology, does the fact that growing, senescing, galled and mosaic-diseased leaves all have something in common for the aphids.

My thanks are due to Dr. K. M. Smith for carrying out the virus inoculations.

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A New Type of Pathogenic *Mycobacterium*

IN 1948 skin lesions due to a new acid-fast organism, *Mycobacterium ulcerans*, were reported from Australia[1]. The lesions were swarming with bacilli; but no growth was obtained on media incubated at 37° C. Culture at 33° C. gave growth.

Some seventy cases of a rather chronic, papulous, cutaneous disease producing ulcerations, which may be due to another acid-fast organism likewise not growing at 37° but at 31° C., have been observed in the past few years at Örebro, Sweden. The lesions were usually localized to the elbows. Some of the patients reported that they had scratched the elbow in a swimming pool two to three weeks earlier. The disease always healed within six months to two years, even when left untreated.

We examined histologically the lesions from thirty patients with this disease. Tuberculoid granulation tissue was almost always found. In one case a few acid-fast organisms were observed inside the lesion. Lesions from twenty patients were examined bacteriologically. In three cases acid-fast organisms growing at 31° C. were isolated. Large yellowish-white colonies appeared on Lœwenstein medium. The colonies were flat with a central nipple. The growth obtained when the glycerine concentration was 0·5–10·0 per cent was good, but when glycerine was omitted from the medium it was poor. Incubation at 31° C. gave growth after 8–10 days; at 22° C. growth usually required three weeks. Culture at 37° C., even with prolonged incubation, gave no growth. The bacilli were Gram-positive and strongly acid-fast. They were not sensitive to *para*-aminosalicyclic acid in experiments kindly carried out by Prof. J. Lehmann (Gothenburg).

Material was then collected from the swimming pool and examined. Organisms with the same characteristics as the bacilli isolated from the three human cases were found in scrapings from the cemented wall of the pool and in samples of the water.

The pathogenic properties of the acid-fast bacilli isolated were studied experimentally in animals. The organisms were found to be only slightly pathogenic for guinea pigs; large intraperitoneal injections occasionally gave localized abscesses in the scrotum. Papulous lesions showing the same microscopic changes as the human lesions were reproduced in the skin of rabbits by infecting ulcerations, produced by rubbing the shaved skin with sandpaper, with a suspension of organisms. Following intraperitoneal, and sometimes also intravenous, injections of bacilli into male rabbits, granulomatous inflammation with caseous necrosis was found in the scrotum. The lesions contained a few acid-fast organisms.

Most white mice infected intraperitoneally became seriously ill and died. Abscesses and ulcerations appeared on the tail, the paws and the scrotum. Widespread lesions were frequently found in the internal organs, especially in the lungs, which showed numerous caseous patches. The lesions produced in the mice contained enormous masses of acid-fast bacilli. Amyloidosis of the liver, spleen and kidneys was frequently observed. After several months of illness a few of the mice seemed to show signs of recovery.

Rats infected intraperitoneally showed no signs of disease; but on microscopic examination numerous tuberculoid structures were found in the omentum and sometimes in the hilar lymph nodes. The lesions contained many acid-fast bacilli. Intravenous or intraperitoneal injection of the bacilli into chickens produced no lesions. The effect of such injections on other animals is being studied.

Guinea pigs and rabbits infected by intraperitoneal injection were tested intradermally with tuberculin (Tuberculin P.P.D. kindly supplied by Dr. K. Tolderlund, of the State Serum Institute, Copenhagen). No reactions to a dose of 5,000 tuberculin units were observed in guinea pigs followed up for three months. Some rabbits gave definite reactions to a dose of 500 tuberculin units six to seven weeks after the injection of the bacilli.

A suspension of autoclaved bacilli was injected intradermally into three tuberculin-positive human volunteers. After forty-eight hours, there appeared skin reactions similar to those obtainable with tuberculin. Later, these lesions became necrotic. Microscopic examination showed the presence of tuberculoid granulations.

Judging by the behaviour of the bacillus, it seems to be a hitherto undescribed type of pathogenic *Mycobacterium*. It is probably not identical with *Mycobacterium ulcerans*. Dr. G. Buckle (Australia) was kind enough to place at our disposal cultures of *Mycobacterium ulcerans*. The bacteria under discussion were found to differ from the Australian bacilli as regards both growth on artificial media and their effect on experimental animals.

Cases of tuberculoid skin granuloma caused by atypical acid-fast bacilli have been reported from Sweden[2,3]. The histological picture resembled that of the lesions seen in our patients. In the less advanced cases, however, numerous rather thick, acid-fast bacilli were seen in the lesions. Culture at 37°, 31° and 24° C. showed no growth[4]. This may therefore be a disease differing from the one observed by us. Tuberculoid skin-granuloma after swimming-pool accidents have been reported elsewhere[5,6], and it is possible that further investigations will show that such skin lesions are also due to acid-fast organisms similar to those described above.

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Surgically induced Splenogenic Anæmia in the Rabbit

THAT alterations in the functional interrelationships of the liver and spleen may cause changes in the formed elements of the blood is suggested by the syndrome of portal vein hypertension. In this connexion, the experimental work of Bock and Frenzel[1] is noteworthy. These workers reported that ligation of the splenic and gastric coronary veins leads to anæmia and leukopænia in the rabbit.

The present study, involving about thirty rabbits, is an examination of the pathogenesis of this anæmia. In a group of eight rabbits, a mean fall of 26 per cent in the red cell count was observed following the ligation of the splenic and gastric coronary veins. Similar changes in hæmoglobin and hæmatocrit were observed. This anæmia is well established by the fourth or fifth day after operation and persists for four to six weeks, after which the red blood cell count returns to normal. Leukopænia, as reported by Bock and Frenzel[1], was not seen in the present work. Splenectomy, as is to be expected from other reports[2], nduced no such anæmia.

Our experimental evidence indicates that: (1) the spleen can elaborate an anæmia-producing factor; (2) this factor is normally inactivated by passage hrough the portal venous system; and (3) when he splenic venous blood is diverted directly into he caval system by-passing the liver, anæmia results.

That splenic congestion plays no significant part in the anæmia is indicated by several findings: (a) the anæmia never reaches maximal intensity beore the fourth day, by which time the collateral irculation is well established; (b) gross increase in pleen size is never noted beyond the first few hours after ligation; and (c) ligation of the splenic and gastric coronary veins after intravenous injection of red cells labelled with phosphorus-32 shows that ess than 4 per cent of the circulating red cells are in the spleen eighteen hours after ligation.

Devitalization of splenic tissue by congestive schæmia (in the first few hours after operation) and absorption of such necrotic tissue apparently play no significant part. Free introduction of the completely extirpated spleen into the peritoneal cavity causes no anæmia, although the spleen is completely absorbed; moreover, absorption of devitalized spleen would not be expected to continue for the six-week duration of the anæmia.

There remains the possibility that the spleen can elaborate a factor which is capable of producing anæmia when introduced into the general circulation without first passing through the portal system. Data which are compatible with this concept include: (a) splenectomy at the height of the anæmia leads to prompt return to normal of the red cell count; (b) intramuscular injections of pestle-homogenized whole normal spleen induce comparable anæmia in he splenectomized animal (this has not yet been ried with the intact animal); (c) *in vitro* incubations f red cells of normal and vein-ligated animals in he plasma of the vein-ligated animal cause significant hæmolysis; (d) upon recovery of the animal from he induced anæmia, injection of the portal system with liquid latex shows newly formed and opened hannels which convey significant amounts of splenic enous blood to the portal system. After recovery from the anæmia, the red cell count can again be epressed by ligation of the short gastric vessels.

This splenogenic anæmia was further characterized by studies of hæmoglobin metabolism using alpha-carbon-14-acetate as hæmoglobin precursor.

The carbon-14 activity of the circulating-erythrocyte-hæmoglobin in the vein-ligated animal does not exhibit the normally observed plateau of about sixty days[3] after the injection of the labelled precursor. Rather, it shows a random decay curve indicative of a hæmolytic type of anæmia[4]. The estimated life-span of the red cell in the vein-ligated animal is of the order of 15–25 days, as contrasted with the normal life-span of 65–70 days.

This paper is based on work performed under contract with the United States Atomic Energy Commission at the University of Rochester Atomic Energy Project, Rochester, New York.

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Psychological and Biochemical Effects of Lysergic Acid Diethylamide

Stoll[1] and Condrau[2] have shown that the psychological effects of lysergic acid diethylamide ($LSD-25$), an amide of one of the constituents of ergot, are similar to those obtained in mescaline intoxication, but are produced by the oral administration of quantities as small as 0·02–0·06 mgm. While, in our experiments, the symptoms varied greatly from one person to another, the basic pattern of reaction seemed the same in twenty subjects who were members of the hospital staff. After initial slight autonomic symptoms, such as enlarged pupils, feeling of cold, 'goose flesh' and mild nausea, the most marked changes were emotional, a pleasurable feeling tone amounting to euphoria and bursts of laughter; this sometimes alternated with, or later was followed by, depression. There was also a general complaint of a feeling of lassitude and muscular weakness. In spite of some difficulty in concentrating, consciousness remained clear and introspection almost undisturbed. Visual illusions and hallucinations, especially illusions of movement, colour and distortions of the body image were frequently present.

The minute dosage required to produce the psychological effect of lysergic acid diethylamide suggested that its mode of action was due to an anti-enzyme action. Since, normally, the only substrate metabolized by the brain cell is glucose, an investigation of the effect of the drug on carbohydrate metabolism *in vivo* was attempted.

Blood samples were taken from the fasting subjects and at intervals of one and two hours after the administration of the drug, the following analyses being made by the methods indicated: glucose[3], hexosemonophosphate[4], lactic acid[5], alkali reserve[6], pyruvic acid[7], inorganic phosphate, total acid-soluble phosphate, lipoid phosphate and adenosine triphosphate[8]. On a subsequent day, identical control analyses were made on most of the subjects, but with the substitution of a placebo for the drug.

No significant variations in the result of the two sets of analyses were found, except in the cases of glucose and hexosemonophosphate. For the latter the mean level of the experimental analyses rose by 1·65 mgm./100 ml. one hour after taking the drug and fell by 0·9 mgm./100 ml. during the subsequent hour. The corresponding figures for the control analyses were falls of 2·3 and 2·4 mgm./100 ml. respectively. In the case of blood glucose the experimental results showed a mean rise of 15 mgm./100 ml. after one hour and 11 mgm./100 ml. after two hours. The control analyses showed a mean fall of 1 mgm./100 ml. after one hour and a mean rise of 1 mgm./100 ml. after two hours.

The subjects were fasting and at rest throughout both the experimental and control periods. In these circumstances the only available source of carbohydrate would be glycogen, the first step in the metabolism of which is the formation of hexosemonophosphate. Under conditions of complete rest the rate of glycogen metabolism might be expected to fall, and this was reflected by a fall in the blood concentration of hexosemonophosphate in the control analyses. The increases in hexosemonophosphate and glucose in the experimental observations suggest that there is an increased metabolism of glycogen coupled with a probable block in the breakdown of hexosemonophosphate. If the increase of hexosemonophosphate should be due to increased demand for carbohydrate by the central nervous system, one would expect increases also in lactate, pyruvate, etc., together with a decrease in glucose. The fact that, on the contrary, no such changes occurred and the glucose is raised, suggests that the raised level of hexosemonophosphate is caused by a break of the cycle at this point.

A certain hypobulia and absorption in the passive state of feeling made the relation in time of biochemical to psychological change somewhat imprecise. However, symptoms of the vegetative system and of emotional nature appeared during the first hour and before the more specific symptoms such as illusions, hallucinations and other disorders of the perceptive field, which were of longer duration.

It is suggested that the changes in carbohydrate metabolism observed after the intake of lysergic acid diethylamide are responsible for at least part of the psychological symptoms. The alternative view that the alterations in carbohydrate metabolism are a parallel effect of the drug unconnected with its psychological effect seems improbable. Further studies which are now in progress should elucidate this point.

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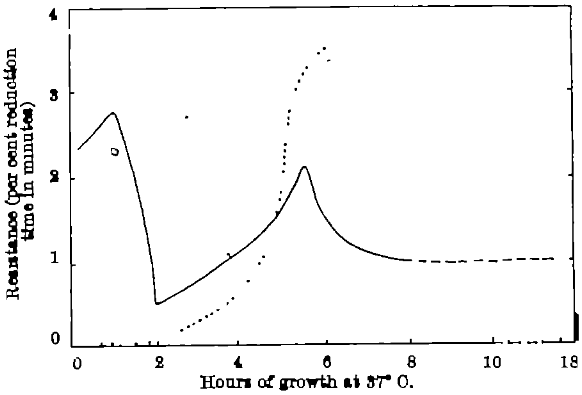
Variation with Age in the Resistance of Bacterial Cells

IN an article in *Nature* of April 28, p. 666, Sir Cyril Hinshelwood discusses some of the possible explanations for deviations from the logarithmic order of death sometimes shown among bacteria exposed to disinfecting agents. Where the final stages of decline are abnormally protracted (that is, where there is a resistant 'tail' of organisms), he suggests that the most obvious explanation would be the presence of some cells of abnormally high resistance, and that these might originate from the interruption of growth at the appropriate stage in the cell-cycle. He considers it possible that at certain phases in the growth of each individual cell there might be a stage of maximum resistance, possibly when the internal condition of the vegetative cell bears the maximum resemblance to a spore.

The work of Ellicker and Frazier[1] with *Bacterium coli* cultures exposed to heat at various ages lends support to this view. These workers found that, after falling to a minimum during the period of most active reproduction, the resistance of their organism reached a high level as the culture entered the stationary-growth phase.

Recent work carried out in this laboratory on the thermal resistance of some strains of *Streptococcus faecalis* has yielded very similar results, and it is hoped to publish these in more detail elsewhere. It was found that after exhibiting very high resistance during the lag phase of growth, the young cultures then experienced a period of minimum resistance which later gave place to a second peak as the rapid growth phase neared its end. Later still, the resistance fell to a level characteristic of mature cultures (see graph).



Variation with age in the thermal resistance of one strain of *Str. faecalis*. Resistance—at 60° C.—is expressed as a percentage reduction time, and the growth curve is obtained by direct microscopic counts of one loopful of incubating culture

The time taken for the full growth/resistance cycle to be accomplished varied with different strains of the same organism; but the general shape of the curve remained the same. Change in incubation temperature did not affect the general character of the age/resistance relationship; but, apart from the obvious effect on the time taken to pass through each stage (varying with the growth-rate), it did influence the degree of resistance attained at any one stage.

The death-rate of young cultures in the logarithmic growth-phase, plotted as the logarithm of the number of surviving cells against time, was characteristic and was rarely in the form of a straight line. Many of the graphs were curves showing a preliminary 'rush' in death-rate, probably due to the large proportion of cells in the most susceptible stage of their cycle (that is, those actively engaged in multiplication). A resistant 'tail' of cells dying more slowly was most distinct in these cases—these were probably the older, more mature cells, which must gradually accumulate in number as reproduction slows down, thus causing the high resistance typical of cultures nearing the maximum-growth stage.

The death-rate of young cultures still in the lag-phase of growth and also of the older ones nearing the stationary phase approached more nearly a logarithmic straight line, in the same way as those of mature cultures.

From this experimental work, it was concluded that one of the possible causes of any variations in resistance among cells in mature cultures might be the slight variations in true (physiological) ages of the cells comprising such cultures. The cells in a 24-hr. culture would be mostly very similar in age; but if some growth were proceeding, however slowly, this might be just sufficient to produce variations in resistance, quite apart from any gradations found in a homogeneous culture. This conclusion is somewhat similar to those drawn by Sir Cyril Hinshelwood.

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Active Relaxation of Unstriated Muscle produced by Adrenaline

ADRENALINE is one of the most powerful inhibitors of tone in unstriated muscle; it is therefore expected to produce active relaxation. Active relaxation by adrenaline has been found in pieces of circular muscle of frog's stomach[1,2] and in guinea pig's uterus[3]. The movements of unstriated muscle, compared with those of striated muscle, are very sluggish, so that complicated apparatus is not necessary to follow conraction and relaxation. These experiments with adrenaline and frog's stomach muscle are most satisfactory, as there is no preliminary contraction except hat of the normal tone, and the muscle just lengthens.

Transverse and longitudinal pieces from the stomach muscle of the frog *Rana tigrina* were used[4]. The length of the unloaded muscle was measured n saline of *p*H 8 before and 20 min. after adding adrenaline chloride. The experiments were performed at 25–27·5° C., this being the optimum temperature or active relaxation. On addition of adrenaline, ircular muscle of frog's stomach begins to lengthen almost immediately up to a maximum of 40 per cent of its initial length, the lengthening being almost omplete in about ten minutes. The muscle relaxed actively in all concentrations of adrenaline tested, the experimental range being 1 in 10 million to 1 in 10,000, and the maximum relaxation occurring in in a million upwards. Compared with circular fibres, ongitudinal fibres lengthened very little. Thus in wenty experiments, ten showed no change in ength, while the rest lengthened by 4–9 per cent. The reaction of the longitudinal fibres was examined o exclude lengthening of circular fibres by their ontraction if there were any such effect. Near the cardio-œsophageal sphincter, the longitudinal bres relax more (5–25 per cent in eight experiments), o that here both sets of fibres relax actively. Circular muscle from the cardiac half of the stomach also is more sensitive than that from the pyloric half, in which active relaxation may not occur owing to the presence of alactic tone[5].

Active relaxation in frog's stomach muscle undergoes seasonal variations; it is best observed when the room temperature is 25–30° C. During the winter months, it diminishes or is absent, even if the temperature of the saline is raised to 25–30°. The optimum *p*H is 8; but if the tone is great, increase in acidity to *p*H 6·5 may indirectly improve the response by diminishing tone[1]. Substances that increase tone, such as replacement of the chloride of the saline with bromide, iodide, thiocyanate, or excess of potassium ions, antagonize active relaxation. Cyanide abolishes active relaxation, which is restored by glucose.

The virgin guinea pig's uterus or a small portion of uterus in early pregnancy has been used to demonstrate active relaxation produced by adrenaline. The guinea pig is killed by a blow on the head, the uterus is removed and the uterine horns are immersed in saline of *p*H 8 at 25–30° C.[6,7]. The horns are then split longitudinally and if pregnant the contents are removed. The muscles begin to relax actively immediately on addition of adrenaline. The maximum relaxation, up to about 60 per cent of its initial length, is produced by small concentrations (1 in 10 to 1 in 5 million). It becomes less with larger concentrations[3], owing to the tendency to contraction with such doses. It is well known that small concentrations of adrenaline produce inhibition although large doses produce contraction. With large doses, after 10 min. the muscle begins to contract, and as tone thereafter increases, active relaxation becomes less or disappears if the experiment is repeated every 30 min. With small concentrations, the experiment can be repeated, as there is no tendency to contraction or such increase of tone. The elongation is not due to contraction of the circular fibres, as there is no eversion of the split longitudinal edges; moreover, substances that cause contraction do not produce any elongation. Active relaxation may be produced by concentrations of adrenaline as low as 1 in 1,000 million. The optimum temperature is 25–30° C. At 37° C., active relaxation is feeble and, if tone increases, it is absent. Substances that increase tone, such as lithium, ammonium, potassium, excess of calcium, strontium, barium, bromide, iodide, nitrate or thiocyanate ions, diminish or abolish active relaxation. Cyanide abolishes active relaxation, which may partially be restored by glucose. Longitudinal muscle of rabbit's gut, though very sensitive to adrenaline as regards passive relaxation, does not relax actively. Therefore the tonus of unstriated muscle can be of three kinds, when active or passive relaxation by adrenaline is considered: (1) the muscle does not relax actively or passively; (2) the muscle relaxes actively as well as passively; (3) the muscle relaxes passively but not actively.

Active relaxation due to the action of adrenaline on the contractile mechanism should be tested on a background of mild contraction, such as produced by *p*H 6·5 (phosphate)[8]; there are individual and seasonal variations, some muscles not contracting in phosphate. Similarly, the action of acetylcholine on the contractile mechanism should be tested on a background of relaxation, such as is produced by potassium[8].

A convincing example of active relaxation has been found to occur in the retractors of the introvert of the marine worm *Golfingia* (*Phascolopsis*) *gouldii* (Pourtales). The retractors are removed along with the brain and immersed unloaded in sea water in a Petri dish. The brain is stimulated by slight pressure with a forceps. The muscles contract and relax actively again. In more than 20 muscles, the relaxation was from 100 to 200 per cent of their length during the contracted state. If sodium cyanide (1 in 10,000) is added to the sea water, the muscles contract, but do not relax actively. Microscopic examination shows that the muscle consists of longitudinal bundles of fibres[10].

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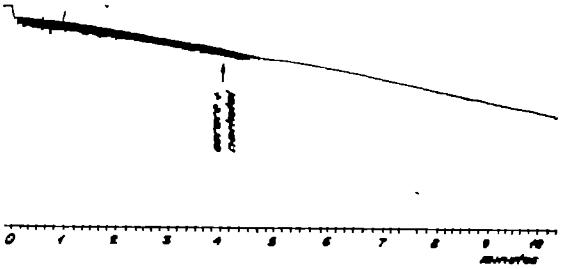
Diffusion Respiration in Man

Draper and Whitehead and their co-workers[1] have described a phenomenon which they have called 'diffusion respiration'. In experiments with dogs, they have shown that the blood under certain conditions will be normally oxygenated from the lungs without respiratory movements and without rhythmical changes of pressure in the lungs. They explain this phenomenon as follows. Owing to the affinity of oxygen for hæmoglobin, the amount of oxygen removed from the alveoli during apnea exceeds the amount of carbon dioxide that simultaneously enters from the blood. The pressure within the alveoli is therefore reduced below that of the atmosphere, and a continuous inward movement of the dead-space air and the external atmosphere takes place. Essential conditions, however, for diffusion respiration are a high percentage of oxygen in the lungs and in the dead space, a free airway and an adequate circulation. During the first thirty minutes of diffusion respiration the uptake of oxygen is not reduced. After this time the oxygen consumption and the oxygen content of the blood decrease due, probably, to the Bohr effect produced by retention of carbon dioxide, with respiratory acidosis and low blood *p*H.

Investigations of the phenomenon of diffusion respiration in man have not so far been reported. Some practical observations, however, particularly from work on anæsthetics, afford ground for believing that, under the above-mentioned conditions, in man also enough oxygen can be absorbed in the lungs without respiratory movements. We have therefore studied this question.

Method. During intravenous anæsthesia with 'Narkotal' (a short-acting barbiturate), an air-tight tracheal tube with inflatable cuff was passed. After 10 min. inhalation of 100 per cent oxygen from an anæsthetic machine, the tracheal tube was connected with the expiratory hose of a Krogh's spirometer containing pure oxygen. The absence of measurable positive pressure in the spirometer was thoroughly controlled. The respiratory movements and the oxygen uptake were recorded during about five minutes. After that the subjects were given curare and 'narkotal' in adequate doses for apnea. The periods of apnea were interrupted by re-connecting the tracheal tube to the anæsthetic machine and starting artificial respiration by rhythmic manual compressions of the re-breathing bag. Immediately before, at the end of, and 5 min. after each period of apnea, samples were taken from arterial blood and from lung air (7–11 cm. below the tracheal bifurcation) for analysis of the oxygen and carbon dioxide content. Pulse-rate, blood pressure and electrocardiogram were recorded during the experiments.



Oxygen consumption before and during apnea. The slope of the curve indicates the oxygen consumption (about 0·2 lit./min.), which thus seems independent of respiratory movements

Results. The subjects were kept in apnea for about five minutes, the maximum being 7 min. 20 sec. The oxygen consumption during this time was, as a rule, the same as during the period before the apnea. The oxygen content of the blood did not decrease during the apnea. The carbon dioxide content of the blood and of the lung air, on the other hand, increased during the apnea, but after five minutes of artificial respiration with the aid of the anæsthetic machine the values of the carbon dioxide were normal again. No changes of importance were noticed concerning pulse-rate, blood pressure and electrocardiogram. The subjects remained all the time in a very good condition.

Conclusion. The phenomenon of diffusion respiration, which Draper and Whitehead and their co-workers have demonstrated in animals, seems to occur also in man. Accordingly, it is possible to get sufficient oxygen uptake during short periods of time without either spontaneous or artificial respiratory movements and without rhythmic changes of pressure in the lungs, if the circulation is adequate, and if pure oxygen is supplied through a free air-passage. The accumulation of carbon dioxide prevents prolongation of the apnea for a considerable time.

A complete report of these investigations will be published elsewhere.

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Fluorometric Determination of Natural Œstrogens in Urine ; Elimination of Fluorogenic Compounds

THE fluorometric analysis of œstrogens in urine using phosphoric acid for the development of the fluorescence has already been described[1,2]. A difficulty was observed in applying this method to urine in which the œstrogen titre was low, for example, to non-pregnancy urines, since the values obtained with the fluorometric method for normal male and female urines were higher than those yielded by the bioassay (Allen–Doisy test). In addition, a 'quench ing' effect has been observed. These findings suggested that another substance or substances were augmenting the fluorescence produced by the œstrogens. The 'non-specific fluorescence' has also been observed by Engel[3,4], who prepared his urinary extracts by the countercurrent partition method.

Another difficulty lay in the comparatively low recoveries of the œstriol added to urine[2].

It was therefore desirable to revise the partition procedure in order so far as possible to eliminate the 'non-specific fluorescence', and also to improve the recovery of the added œstrogen.

Substitution of ether for benzene in the initial extraction of the œstrogens from the urine led to improved recovery of œstriol. This step merely constituted a return to the original method of B. Zondek[5], who used ether for extracting the œstrogenic substances from urine. Recently, Engel also recommended the use of ether instead of benzene[3,4]. On extraction of the ether solution with N sodium hydroxide, the œstrogens (œstradiol, œstrone and œstriol) passed almost quantitatively into the alkaline phase, after which adjustment to a pH of *c.* 8 was again extracted with ether and then evaporated to dryness. For the partition of the three urinary œstrogens into œstrone–œstradiol and œstriol fractions, many pairs of solvents were tried. The most suitable partition was obtained between benzene/petroleum ether (1 : 1) and water, in which œstradiol and œstrone remained n the organic phase, whereas œstriol passed into the water. From this point the two fractions were treated separately.

The benzene / petroleum ether (œstrone–œstradiol fraction) was evaporated to dryness, the residue was taken up in ether, which was evaporated after washing with 30 per cent sulphuric acid, saturated sodium bicarbonate and water. The residue was dissolved in an accurately measured amount of ethanol, from which aliquots were taken for fluorometry.

The œstriol fraction was treated as follows. The aqueous layer, adjusted to pH 8 (according to Engel[3,4] much less fluorogenic material is extracted at this pH), was extracted with ether. The ether solution was washed with saturated sodium bicarbonate and water, and evaporated. The residue was dissolved in 50 per cent methanol, which was washed with carbon tetrachloride and evaporated to dryness. The residue was redissolved in an accurately measured quantity of ethanol, and aliquots of this solution were used for fluorometry.

The development of the fluorescence was essentially he same as that described previously[1,2]. The readings of the fluorescence in the present study were carried out with the aid of a Farrand fluorometer instead of the Coleman fluorometer previously employed. The primary light was filtered with a Farrand interference filter with the transmission at 440 mμ. The secondary filter (to the photomultiplier) was a Farrand interference filter with the transmission at 530 mμ. For eliminating any non-specific fluorescence he readings were repeated using a Corning 5860 filter which passes the 365 mμ mercury line instead of the 440 mμ filter. Subtracting the second reading from the first yielded linear responses for œstradiol, œstrone and œstriol in pure solutions, and it can be used to advantage in urinary extracts. Recoveries obtained using this method have been of the order f 85 ± 15 per cent. The non-specific fluorescence was greatly reduced, and as little as 20 γ œstrone nd about 30 γ œstriol per litre could thus be determined.

A detailed account will be published elsewhere.

I am grateful to Prof. Bernhard Zondek for his interest in, and support of, this investigation. I am also much indebted to Miss L. Berlin, Mr. A. Schwager and Mrs. L. Beyth for their valuable assistance. The investigation has been aided by a grant from the Jane Coffin Childs Memorial Fund for Medical Research.

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Determination and Occurrence of Fluorescent Substances in the Neutral Fraction of Urinary Extracts

IT has been shown that the natural phenolic œstrogens produce fluorescence on being heated with phosphoric acid[1,2]. When applying this method to urinary extracts, it was found that a non-specific fluorescence obscures the readings for the œstrogens, especially in the 'strong phenolic fraction'—the œstriol fraction. On attempting to purify the œstrogenic fractions of the non-specific fluorescence, we observed that a great part of it was non-phenolic, but was due to a 'neutral' substance or substances, which were carried over in the partition procedure then used (a modified Bachmann–Pettit method[3]) to the œstrogenic fraction.

A new procedure was therefore elaborated for the œstrogens (see the preceding communication) and the neutral fraction was studied concurrently. Briefly, the procedure for the preparation of the neutral fraction was as follows. The hydrolysed urine was extracted with ether, and after washing with N sodium hydroxide, saturated sodium bicarbonate and water, it was evaporated to dryness. The residue was dissolved in a small amount of ethanol. Benzene/petroleum ether (1 : 1) was added and the mixture was transferred to a separating funnel. It was vigorously extracted with distilled water, and the aqueous phase was in turn extracted with ether, which after washing with saturated sodium bicarbonate and water was evaporated. The residue was dissolved in 50 per cent methanol, which was then washed with carbon tetrachloride. The methanol was distilled off *in vacuo*, and the residue redissolved in ethanol, from which samples were taken for the development of the fluorescence with phosphoric acid in the usual manner[1,2]. For determination of the fluorescence a Farrand fluorometer was used, and the technique was similar to that described in the preceding communication.

Details about the fluorescent substance or substances in the neutral fraction will be reported elsewhere.

Here we would like to mention that these substances seem to be of biological importance if judged by the fact that they have been found in small amounts in every human urine examined. Their excretion seems to be somewhat increased at the time of ovulation; a considerably increased excretion has been found so far (*a*) in cases with adrenogenital syndrome (pseudo-hermaphroditism), (*b*) in arrhenoblastoma, (*c*) in the last months of pregnancy. Excretion increased following injection of 300 mgm. of adrenotropic hormone over a period of three days.

The chemical constitution of the fluorescent substance or substances of the neutral fraction—probably of adrenal cortical origin—are being studied in collaboration with Prof. T. Reichstein of Basle.

We are much indebted to Miss L. Berlin, Mr. A. Schwager and Mrs. L. Beyth for their assistance. This investigation has been aided by a grant from the Jane Coffin Childs Memorial Fund for Medical Research.

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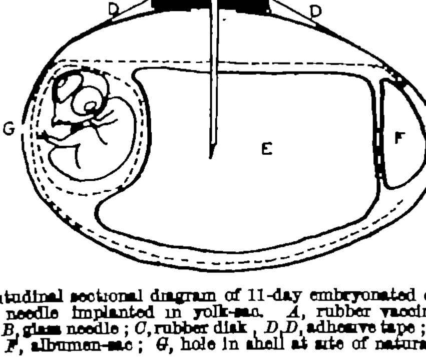
A Method for Administering Chemotherapeutic Agents to Chick Embryos

THE technique described was developed for the purpose of studying the action of chemotherapeutic agents, given in divided doses by the yolk-sac route, on the proliferation of vaccinia virus in embryonated eggs.

A glass needle is prepared by drawing out a piece of tubing of approximately 6 mm. internal diameter to a capillary 4·0–4·5 cm. long. The wide end of the tube is cut off 1·0 cm. from the point of narrowing, and the capillary end is bevelled to a sharp point on the flat surface of a rotating 'Carborundum' dental disk. (It is advisable to wear an eye-shield during this operation.) The wide end of the needle is closed with a small rubber vaccine-bottle cap. A number of these assemblies are prepared and autoclaved.

11-Day embryonated eggs are candled, and a point marked in the centre of the long axis where the chorio-allantois is well developed, but as far from the embryo as possible. A triangle of shell is cut away from this point, the shell membrane is pierced, and the chorio-allantoic membrane is 'dropped' by suction through a hole drilled into the natural air-sac. The yolk-sac can then be seen lying directly beneath the opening.



Longitudinal sectional diagram of 11-day embryonated egg with glass needle implanted in yolk-sac. *A*, rubber vaccine-bottle cap ; *B*, glass needle ; *C*, rubber disk ; *D*,*D*, adhesive tape ; *E*, yolk-sac ; *F*, albumen-sac ; *G*, hole in shell at site of natural air-sac

The glass needle, which has been forced for about 3 cm. of its length through the centre of a sterile rubber disk of the type used in 1-oz. 'Universal Container' caps (2·75 cm. in diameter), is next inserted through the chorio-allantoic membrane, and into the yolk-sac, until the rubber disk rests upon the shell, to which it is then secured with strips of adhesive tape (see diagram). One worker, with an assistant to drill the eggs, can set up thirty to forty such preparations within an hour.

The chorio-allantois can be infected with the test virus before insertion of the glass needle, or afterwards by injection with a fine hypodermic needle through the rubber disk.

Injections of the chemotherapeutic agent can now be made at desired intervals through the vaccine cap with a hypodermic syringe. The small quantity of fluid remaining in the glass needle after injection is expelled into the yolk-sac by the further injection of a small quantity of air. Up to 1·0 ml. of fluid may be thus administered in divided doses.

At the end of the experiment, the glass needle is withdrawn, the rubber disk removed, and the egg opened for examination. The interference with the chorio-allantois is minimal. A small hole surrounded by a very small area of tissue reaction will be seen where the needle has passed through. The embryos tolerate this procedure remarkably well; in our hands deaths attributable to inoculation trauma have amounted to less than 5 per cent of the total treated, in experiments lasting 48–72 hr.

The advantages claimed for this method are: (*a*) the chemotherapeutic agent is not given by the same route as the virus, thus obviating any direct virucidal action; (*b*) repeated injections may be given under completely sterile conditions, maintaining a high concentration of test agent in the tissues; (*c*) the injections are placed in the yolk-sac with absolute precision, especially in older embryos in which the usual injection route via the air-sac is not always satisfactory; (*d*) repeated doses may be given to large numbers of embryos with rapidity.

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Isolation of 2 : 3 : 4 : 6-Tetramethylpyridine from Coal Tar

DURING an investigation, previously referred to[1] of the nitrogenous bases extracted by sulphuric acid from the 'benzol absorbing oil' fraction of vertical retort coal tar, a tertiary base has been isolated which has been proved to be 2 : 3 : 4 : 6-tetramethylpyridine, a compound which has not hitherto been reported as a constituent of coal tar. This compound however, has been previously isolated from Fushun shale oil by Eguchi[2], and from Scottish shale oil by Benzie and Milne[3].

The base was isolated from a fraction (boiling point 135–135·2° C./100 mm.) obtained by high-efficiency fractional distillation (efficiency approximately 100 theoretical plates) as follows. The fraction was treated with the theoretical amount of picric acid in three equal portions, the picric acid being added as a saturated alcoholic solution. In this way three batches of picrate were obtained, the first two of which melted at 110–120° C. and consisted of fine needles. The third batch of picrate melted at 150–170° C.

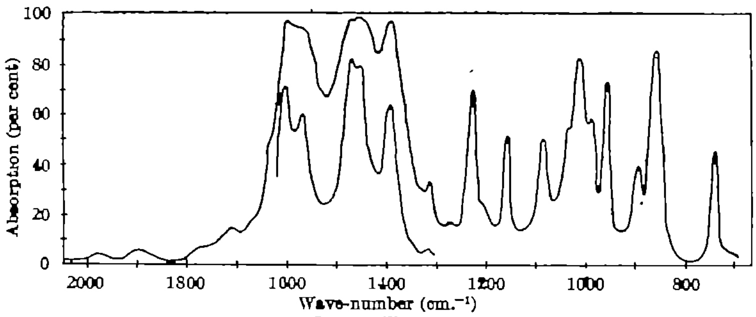
The first two fractions of picrate were combined and recrystallized repeatedly from 95 per cent alcohol until a constant melting point of 122–123° C. was attained. This material was then recrystallized twice from acetone, thereby raising the melting point to 122·5–123° C. This melting point agrees very well with the value of 122·5–123·5° C. given by Benzie and Milne for 2 : 3 : 4 : 6-tetramethylpyridine picrate, and a mixed melting point determination showed no lowering.

The free base was regenerated from this pure picrate by treatment with caustic soda and steam distillation. It was then dried and redistilled. The pure base was found to be a colourless liquid with quite a pleasant smell and the following physical characteristics.

b.p. 203° C./750 mm. Lit. 203·3° C./760 mm. (ref. 2)
n_D^{25} 1·5087 Lit. 1·5084 (ref. 2)
D_4^{25} 0·9322 Lit. 0·9345 (ref. 3)

From this pure product, the picrolonate (m.p. 225·5° C., decomp.) and the methiodide (m.p. 192–193° C.) were prepared. The value found for the picrolonate was identical with that given by Benzie and Milne, and a mixed melting point determination showed no lowering.

The infra-red absorption spectrogram of the base, which was recorded by Mr. J. L. Hales of the Department of Scientific and Industrial Research, was found to be identical with that for the compound obtained by Benzie and Milne and to follow the graph reproduced herewith.



50-μ capillary cell

The above evidence of infra-red absorption spectrograms, physical properties, melting points and mixed melting points, is sufficient to prove that this base, isolated from coal tar, is 2 : 3 : 4 : 6-tetramethylpyridine.

The isolation of this compound leaves only two of the nineteen possible methyl homologues of pyridine still unidentified in coal tar. These are 3 : 4 : 5-trimethylpyridine and pentamethyl pyridine, neither of which has been reported as being isolated from any natural source, nor has either been prepared.

A complete account of this work will be published at a later date.

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Paper Chromatography of Flax Fibre Polyuronide Hemicellulose

IT is well known that pectic substances are broken down during the retting of flax. There is evidence that other polyuronides also occur in flax straw and are attacked in retting[1]. Their constitution is therefore of great interest in flax research. The sugar constituents of the polyuronide hemicellulose have been investigated. This substance was obtained from fibre separated from flax straw by purely mechanical means without previous retting. Finely ground fibre was extracted successively with ether, petroleum ether, ethanol and water. Pectic substances were removed with seven 30-min. extractions with boiling 0·5 per cent ammonium oxalate solution. The residue, after washing with water, ethanol and ether followed by air-drying, was extracted twice for 24 hr. with cold 4 per cent sodium hydroxide solution. The filtered extract was acidified with glacial acetic acid and the hemicellulose was precipitated with ethanol. The precipitate was well washed and dried from ethanol and ether. Approximately 3 gm. of polyuronide hemicellulose was obtained as a slightly greyish powder, lignin content 1·8 per cent, uronic acid anhydride content 7·1 per cent (19 per cent hydrochloric acid method[2]).

The hemicellulose was hydrolysed with *N* sulphuric acid at 100° C. for six hours. After cooling, solid barium carbonate was added until the liquor was no longer acid to congo red paper. The clear liquor obtained after centrifuging was evaporated on a hot water-bath and the residue dissolved in pyridine[3]. Mineral matter was separated by centrifuging, the solution was allowed to evaporate in a stream of air and a thin syrup was prepared for paper chromatography.

The procedure of Jermyn and Isherwood[4] was followed and the following solvent mixtures were used: (*a*) butanol – ethanol – water (4 : 1 : 5)[5] and (*b*) (4 : 1·1 : 1·9)[6] parts by volume; (*c*) butanol – acetic acid – water (2 : 1 : 1)[6] and (*d*) ethyl acetate – acetic acid – water (3 : 1 : 3)[4]. Known sugar solutions (1 per cent w/v) were run simultaneously on the filter paper with the hemicellulose hydrolysate for identification purposes. The positions of the sugars were revealed by brushing with aniline hydrogen phthalate[7] or *p*-anisidine hydrochloride[8]. Solvents (*a*) and (*b*) did not separate arabinose and mannose, but (*c*) and (*d*) showed the presence of both in the hydrolysate. All four solvents showed the presence of galactose, glucose, xylose and rhamnose. No ketoses were detected. In addition to these six sugars, when a more concentrated syrup was used, two faint spots were observed of R_D values (distance moved relative to rhamnose or *iso*-dulcite)[6] in solvent (*c*) 0·84 and 0·92 respectively.

Flax fibre polyuronide hemicellulose therefore contains arabinose, xylose, galactose, glucose, mannose and rhamnose, together with a uronic acid constituent, the nature of which is under investigation, and traces of two other substances. The flax plant is seen to contain a variety of polyuronides, namely, pectic substances, hemicellulose, seed mucilage and probably polyuronides of a gummy nature. An intensive study of this one species may therefore throw some light on the origin of these carbohydrates.

This communication is published by permission of the Home Flax Production Department, Board of Trade.

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Quantitative Chromatographic Separation and Estimation of Cadmium in Copper Alloys using Paper Strips

Bishop and Liebmann[1] have described the quantitative separation of zinc from soldering alloys by chromatography on cellulose columns followed by polarographic estimation. We employ a similar method for the determination of small amounts of cadmium in copper–cadmium alloys, except that we use paper strips of normal thickness.

Our procedure is briefly as follows. A solution of a weighed amount of the alloy is prepared in the minimum volume of nitric acid diluted 1 to 3, and made up accurately in a volumetric flask to a cadmium concentration in the range 10^{-4} to 10^{-3} gm. per millilitre; 0·3 ml. of this solution is placed by means of an 'Agla' micrometer syringe (Burroughs Wellcome, Ltd.), 5 cm. from one end of a 4 cm. × 45 cm. strip of Whatman No. 1 paper. Spreading of the band of solution may be lessened by applying the solution in 0·1 ml. or smaller portions and allowing each to dry before applying the next. The chromatogram is developed by a method very similar to that described by Linstead *et al.*[2], but using methyl ethyl ketone plus 30 per cent by volume of A.R. hydrochloric acid as the developing solution. After about sixteen hours the chromatogram is allowed to dry in air. The copper band, which is yellowish-green in colour, begins about 20 cm. from the starting position; the cadmium band commences within a few millimetres of the front of the copper band and extends for 2–4 cm. It is usually accompanied by a brown to pink coloration apparently derived from the developing solution; a freshly mixed solution gives less of this coloration than an old one. No interference with the separation has been observed, but the front of the copper band is more easily visible when the coloration is absent.

The whole of the lower portion of the strip containing the cadmium is extracted and washed with boiling 1 per cent hydrochloric acid. The filtrate and washings are combined and evaporated gently to dryness. The residue is treated with about 0·5 ml. of 60 per cent perchloric acid and again evaporated to dryness to destroy traces of organic matter which have been found to interfere sometimes with the polarographic wave-form. The residue is then dissolved in exactly 2 ml. of 0·5 *M* potassium chloride solution in 1 per cent hydrochloric acid and a portion polarographed in a 2-ml. cell after passing hydrogen for five minutes. As an internal standard, 0·002 ml. of a standard solution of cadmium metal in A.R. hydrochloric acid is then introduced directly into the polarographic cell with the 'Agla' syringe.

For alloys containing 0·2–1·3 per cent cadmium, the coefficient of variation of our results has been found to be of the order of 1 per cent, which compares very favourably with the spectrographic solution – spark method, which we have found to give a coefficient of variation of about 3 per cent. The method is less time-consuming and much more convenient than the usual macro-chemical methods, and it is suggested that it could be readily adapted for other analyses.

It is hoped to describe the method in greater detail elsewhere.

A large part of the credit for this work must be accorded to Miss J. Houghton, who has carried out the practical work, and without whose patience and practical suggestions its completion would have been long delayed. Thanks are due to Dr. L. G. Brazier, director of research and engineering, British Insulated Callender's Cables, Ltd., for permission to publish this communication.

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Carbohydrate Primers for Q-Enzyme

For some time we have been engaged in a study of the starch-synthesizing enzymes of *Polytomella caeca*, a flagellate which produces starch from sodium acetate and ethyl alcohol, but not from sugars[1]. This starch is similar to most natural starches inasmuch as it consists of amylose and amylopectin components, the latter being the major constituent[2]. It has already been reported by Lwoff, Ionesco and Gutmann[1-3] that *Polytomella caeca* contains a phosphorylase which utilizes glucose-1-phosphate as the substrate for the synthesis of an iodophilic polysaccharide; this claim has been verified in these laboratories[4]. However, since phosphorylases are known to catalyse the formation of only 1 : 4-α-glycosidic linkages, it seemed probable that, for the synthesis of the branch points of amylopectin, the organism must employ a second enzyme, similar to the *Q*-enzyme of the potato[5] or the 'branching factor' of liver and heart[6].

This second enzyme has now been isolated[4] by a method which was essentially that used by Barker, Bourne and Peat[7] in the case of potato *Q*-enzyme. The protozoal enzyme converts amylose into a polysaccharide, which is stained red with iodine and has been proved to belong to the amylopectin–glycogen class[4].

The purpose of the present communication is to record certain phenomena encountered during the early stages of the reaction catalysed by the *Q*-enzyme of *Polytomella caeca*; these phenomena have not been described in reports of the properties of *Q*-enzyme samples derived from other sources. When dilute solutions of the protozoal enzyme were incubated with amylose samples containing different degrees of amylopectin impurity, the rates of reaction, as measured by the changes in the iodine-staining powers of the digests, were markedly different; in general, the higher the blue value[9] of the amylose the slower was the reaction-rate. Indeed, with amyloses having the highest blue value there was an appreciable time-lag in the initiation of the reaction and, thereafter, the rate of reaction increased progressively. The lag phase was reduced considerably and the subsequent reaction-rate increased by the introduction of potato amylopectin, the native amylopectin of *Polytomella caeca*, glycogen, dextrins, or commercial maltose, whereas inulin, xylan, dextran, cellobiose, lactose, sucrose, glucose, galactose or fructose did not show this effect. Thus it would seem that, for the display of optimum activity, samples of the *Q*-enzyme of *Polytomella caeca* require the presence of a carbohydrate primer containing glucose units mutually linked by 1 : 4-bonds in the α-configuration. The autocatalytic reaction observed with the purest amyloses in the absence of added primer may be attributed to the ability of the products of the reaction to function as primers.

That the observed effects were not due to the activation of possible traces of amylase impurities in the enzyme samples was shown by the fact that the small reducing powers developed during the course of the enzyme action were not influenced by the presence or absence of primer. Pending further work on this problem, we tentatively suggest that it is the *Q*-enzyme itself which requires the carbohydrate primer. If this be true, then the phenomenon is analogous to that obtaining in the phosphorylase-catalysed synthesis of linear chains, for it is already generally agreed that a 1 : 4-α-linked glucose polymer is required to initiate the synthesis of amylose from glucose-1-phosphate[9].

We are indebted to Prof. M. Stacey for his interest in this work, and to the Royal Society and the Department of Scientific and Industrial Research for grants to two of us (S. A. B. and A. B.).

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Pregnan-7-ol and Pregnan-12-ol

Ruff and Reichstein[1] have described a pregnan-7-ol and a pregnan-12-ol prepared by Wolff–Kishner reduction of acetoxypregnane ketones. They state that these two substances are probably the 7α- and 12α-hydroxy compounds; but since epimerization during Wolff–Kishner reduction is not excluded, they name them provisionally '7ξ' and '12ξ'[2]. The molecular rotations of pregnan-7ξ-ol and of pregnan-12ξ-ol and their derivatives show that the two new compounds are indeed 7α and 12α.

Barton and Klyne[3] have summarized the molecular rotation contributions of a large number of substituents in the steroids. The terms ΔO and ΔA have been used for the contributions of hydroxyl and acetoxyl groups, and Δ_1 (Barton[4]) for the molecular rotation difference on acetylation ($\Delta A - \Delta O$). The ΔO, ΔA and Δ_1 values for pregnan-7ξ-ol and -12ξ-ol are compared with the standard values in the accompanying table.

Molecular rotation difference	Compound	Δ Values for ξ compounds[1]	Standard Δ values[3] α	β
ΔO	Pregnan-7-ol	− 54	− 79	+95
ΔO	,, -12-ol	+ 43	+ 93	+50
ΔA	,, -12-ol acetate	+205	+280	+76
Δ_1	,, ,,	+162	+187	+26

The ΔO value for pregnan-7ξ-ol shows that it must have the 7α configuration. While no conclusions can be drawn from the ΔO value of pregnan-12ξ-ol, the ΔA and Δ_1 values for its acetate prove clearly that it must have the 12α configuration.

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Use of Nuclear Research Emulsions for Fast-Neutron Dosimetry

THE use of nuclear research emulsion for the measurement of fast neutron doses has been described by Titterton[1]. The purpose of this communication is to describe an extension of this technique to the measurement of energy absorption in hydrogenous material irradiated by fast neutrons.

A unit of biological significance in irradiation of living material is the energy absorption of the material from primary or secondary ionizing particles. It has been shown theoretically by Mitchell[2] that in tissue irradiated by fast neutrons of energies between 0·5 and 5 MeV., 90 per cent of the energy deposition is due to elastically scattered protons. Such recoil protons may be observed and their ranges measured in nuclear research emulsions exposed to fast neutrons. On the assumption that the ratio of the energy deposition per unit volume of emulsion and tissue is equal to the ratio of the atomic density of hydrogen in the two materials, the energy deposition in tissue can thus be determined.

Ilford *C*.2 plates of 400 microns nominal thickness were exposed to a beam of D + D neutrons from the electrostatic generator at the Radiotherapeutic Research Unit, Hammersmith; the maximum spectral energy of the neutrons was 5 MeV. The energy deposition in a volume of emulsion defined by a rectangular parallelepiped was determined by measurement of the ranges of all proton tracks observed in the volume, using the range–energy relation for that emulsion[3] for determination of the corresponding energies. Boundary effects were taken into account by scanning a volume of emulsion which was surrounded in every direction by a thickness of emulsion greater than the maximum proton range. This was effected by scanning between two planes parallel to the free surface of the emulsion at 100 microns distance from the top and lower surfaces of the emulsion respectively.

Tracks totally enclosed in the parallelepiped were measured, also the partial lengths within the scanned volume of those tracks which crossed the horizontal boundaries. To enable the energy dissipation of a proton which starts in the scanned volume and proceeds out of it to be determined, it is necessary to measure both the full and enclosed length of its track. The energy dissipation in the enclosed portion of the track is then obtained by subtracting the energy dissipation in the residual portion of the track from that of the whole track.

Since in this energy region the neutron–proton scattering is isotropic in centre-of-gravity co-ordinates, recoil protons of all energies from zero to the incident neutron energy are emitted with equal probability. Tracks produced by low-energy protons are difficult to detect and measure, more especially if they have a large angle of dip. The energy deposition by protons of energy less than an arbitrary value E_1 may, however, be applied as a correction to the total energy deposition measured. The value of this correction factor is small, and for mono-energetic neutrons of energy E_0 is $E_0^2/(E_0^2 - E_1^2)$. For *C* 2 emulsion and a minimum track-length of four microns, corresponding to $E_1 = 0{\cdot}40$ MeV., the correction is less than 5 per cent when E_0 is greater than 2 MeV.

The correction for a complex neutron spectrum can be calculated if the energy distribution of the neutrons is known.

In a typical plate, the scanning of 250 fields of view gave 851 complete tracks of energy greater than 0·4 MeV., and 41 partial tracks in a volume corresponding to 0·493 mm.^{3} of unprocessed emulsion. The total energy dissipation in this volume was found to be $1{\cdot}37 \times 10^3$ MeV. The energy spectrum of the neutrons was determined from an Ilford *C*.2 plate of 200 microns thickness which was simultaneously exposed in the same position as the 400-micron plate, the analysis being made by the standard method of measurement of the ranges of forward-scattered protons[4]. From this spectrum the correction factor for protons of energy less than 0·40 MeV. was found to be 4 per cent. Hence the total energy dissipation is found to be 4·60 ergs per c.c. of emulsion. Assuming the tissue to have unit density and 11 per cent hydrogen content by weight, and the *C*.2 emulsion to have a normal hydrogen content of 0·056 gm./c.c.[1], the equivalent tissue dose is calculated to be 9·04 ergs/gm. or 0·11 rep.

Experiments indicate the suitability of this method for determination of the energy deposition due to a fast-neutron dose up to 0·2 rep.; larger doses lead to an inconveniently high track density for microscopic observation. Further experiments are in progress, in conjunction with Dr. L. H. Gray, to compare the results obtained by this method and the ionization chamber[5].

I am indebted to the Medical Research Council for permission to expose plates at the Radiotherapeutic Research Unit, Hammersmith, the British Empire Cancer Campaign for the award of a research fellowship, and Prof. J. Rotblat for his interest and encouragement throughout the work.

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A New Calculation of the Cohesive Energy of Metallic Beryllium

Following the success of the Wigner–Seitz cellular method[1] for the calculation of binding energies of the alkali metals, a treatment for divalent metals was given by Herring and Hill[2], who carried out detailed calculations for beryllium, taking into account the effect of the Brillouin zone boundaries. Recently, a simpler method has been used by Raimes[3] for magnesium, and reasonable agreement with experiment was obtained. This communication presents the results of a new calculation for beryllium, similar to that of Raimes, undertaken with the object of ascertaining whether a simpler treatment could be applied to beryllium, and whether Raimes's suggestion regarding the correlation energy in the free atom would be satisfactory in this case.

Wave functions corresponding to the lowest state of an electron in the lattice have been obtained by numerical integration for eight values of the radius r_s of the atomic sphere. The field acting on a given electron was taken to be that of the ion-core[4] plus that due to all the electrons with opposite spin. The eigenvalue of the Schrödinger equation was found by approximating successively until the boundary condition was satisfied at $r = r_s$ (gradient of wave function equal to zero). The Fermi energy was obtained in the form α multiplied by free electron value, and the effective mass parameter α was determined by Bardeen's method[5]. Values of α were obtained by numerical integration for all eight values of r_s; at the experimental radius $r_s = 2{\cdot}37$ Bohr units, the value $\alpha = 0{\cdot}616$ was obtained, in exact agreement with Herring and Hill, but the present calculation gives somewhat higher values for larger values of r_s. The free electron expressions for the exchange and correlation energies have been used, as in Raimes's paper. Exchange interaction between valence and core electrons was neglected in the metal and in the free atom; moreover, interaction between the ion-cores was assumed to be negligible.

For the free atom the energy of the valence electrons was taken from the Hartree approximation[4]; in the treatment of Herring and Hill the experimental value was used, which resulted in a low value for the cohesive energy. The correlation energy was derived according to Raimes's suggestion of a proportion of the total energy of the valence electrons or of the Coulomb interaction energy. For beryllium both methods give the same result, namely, − 0·013 Rydbergs/electron.

Finally, the work function was evaluated according to the method described by Herring and Nichols[6], using the calculated total energy (− 1·086 Rydbergs/electron) at the calculated lattice constant ($r_s = 2{\cdot}34$

	Present calculation	Herring and Hill	Experimental
Lattice constant (Bohr units)	2·34	2·23 to 2·57	2·37
Cohesive energy (kcal./mole)	84	53	75
Compressibility (cm.^{2}/kgm. × 10^7)	8·0	7·5 to 11·3	7·8
Work function (volts)	−0·3	−1·9	3·9

Bohr units). The complete results are shown in the table and, with the exception of the work function, show very satisfactory agreement with experiment.

The experimental compressibility is taken from Bridgman[7] and refers to 30° C.; the calculated values refer to absolute zero.

A detailed account of these calculations will be published elsewhere.

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Mechanical Properties and Structure of Sol-type and Gel-type Gelatine Films

FILMS can be prepared from aqueous sols of gelatine either by evaporating off the water slowly at room temperature, when gel formation precedes dehydration, or directly from the sol by maintaining the drying temperature at a sufficiently high level (for example, 60° C.), which defers the development of structure until the drying process is nearing completion. Pinoir and Pouradier[1] showed that thin sol-type films produced in this way were soluble in water at room temperature, whereas the gel-type films merely swelled under the same conditions. They pointed out the significance of their observation in view of the earlier discovery of Katz and his colleagues hat gelatine film prepared at room temperature gave a crystalline X-ray powder diagram, whereas that given by the film prepared hot was of the more amorphous type. They inferred that the difference in solubility between the two was caused by the more extensive organization and bonding of chains in the gel type.

We have produced gel-type and sol-type films by regulating the temperature of drying as described bove, and have made an X-ray examination of heir structure. In general conformity with Katz's findings, the results suggest the presence of small randomly arranged crystallites in the sol-type film, and of much larger crystallites in the gel type. The crystallites in the gel type tend to lie in the plane of he film, but are randomly arranged within this plane. This orientation in a direction parallel to the plane of the film has been found in films made from other ubstances in which development of a network ructure precedes drying out. The orientation is no oubt caused by the uni-directional collapse of the etwork as the film contracts on drying in a direction erpendicular to the supporting base.

When immersed in boiling methanol, the gel-type film contracted very considerably in length and width and increased in thickness; the sol-type film softened with the same treatment but its dimensions did not change. This thermal contraction of the gel-type film indicates that the chains in the original film were in the (at least) partially extended condition in the plane of the film, and the lack of it in the sol type that the chains were fully, or almost fully, contracted in this film. It seems likely, therefore, that, starting with a state of contracted chains in the sol, straightening of the chain results as a necessary consequence of its association into an ordered crystalline structure, and the degree of straightening should depend on the length of the crystallite. In the preparation of the sol-type film, the rapidity with which the structure is developed in the crowded system of contracted chains favours the development of many small crystallites, while the more leisurely development of structure in the more widely spaced chain system in the gel and in the subsequent slow drying is consistent with the presence of much more extensive crystallites in the gel-type film.

The tensile properties of the two types of film have been measured after conditioning in atmospheres of relative humidity ranging from 45 to 85 per cent, and the results of these tests (see table) are consistent with the structural picture outlined above.

TEMPERATURE OF PREPARATION OF FILM AND THE AMBIENT HUMIDITY DURING TESTING: EFFECTS ON TENSILE PROPERTIES

Temp. of preparation of film (° C.)	Relat. hum. during testing (per cent)	Tensile properties Tensile strength (kgm./sq. cm.) Mean	 S.D.	 Extension at break (per cent) Mean	 S.D.
20°	45	910	48	1·9	0·2
60°	45	654	31	1·1	0·1
20°	55	832	52	2·2	0·3
60°	55	585	33	1·5	0·1
20°	65	646	59	3·7	0·7
60°	65	350	22	1·7	0·2
20°	75	418	29	10·2	1·7
60°	75	172	36	46·1	5·6
20°	85	170	38	23·8	3·6
60°	85	81	11	179	20

S.D. = standard deviation.

As would be expected, the structure containing the larger crystallites (gel type) is always stronger than that in which the inter-chain bonding is less extensive. For both types of film the tensile strength falls, and the extension at break increases, with increasing ambient relative humidity, and is a consequence of the progressive weakening of the inter- and intra-chain bonds by the increasing amount of water absorbed. Up to 65 per cent relative humidity, the extension is small and is probably mainly due to a partial failure of these bonds since, although small, it does increase appreciably with the relative humidity. At relative humidities of 75 and 85 per cent, the extension at break is much greater than before, and is much greater in the sol type than in the gel type. It is evident that failure of the inter- and intra-chain bonding is much more nearly complete at these humidities, so that the chains themselves are able to extend. When this occurs, the contracted chains in the sol-type film are able to allow a much greater extension than the comparatively extended chains in the gel type. Even after extending to the point of breakage, the films recover their original length (to within 5 per cent) on relaxing the stress, and it seems likely that the elastic behaviour could be largely accounted for in terms of the entropy change on extension.

We hope to publish these results in more detail elsewhere at a later date.

E. Bradbury
C. Martin

British Cotton Industry Research Association,
Shirley Institute, Didsbury. June 20.

[1] Pinoir, R., and Pouradier, J., *C.R. Acad. Sci., Paris*, 227, 190 (1948).

Magnetic Properties, Internal Strains, and the Bauschinger Effect in Metals

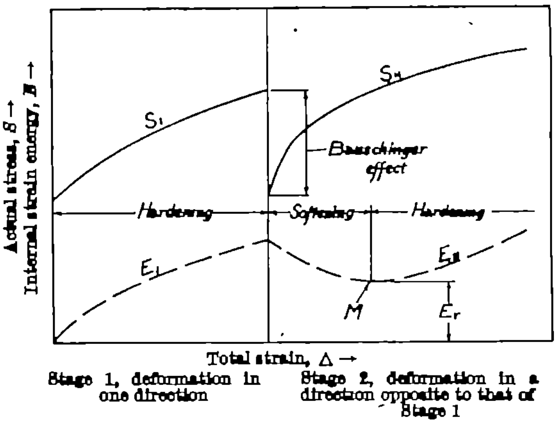
Wilson[1] has recently reported that the intensity of magnetization of a high-carbon steel increases with plastic deformation of one kind, but that it suffers a recession after a relatively small additional plastic strain applied in a direction opposite to that originally used. I suggest that these results could be predicted from an analysis of the Bauschinger effect.

The conventional explanation of this effect[2] accounts for the abrupt fall of resistance to deformation when the direction of the external stress is reversed (see diagram, S-curves). It is easy to see, however, that the simultaneous decrease of internal strain energy E of the cold-worked metal can be only gradual, and that E must reach a minimum M before starting to rise again. Since work-hardening is never fully reversible, some residual strain energy E_r remains latent in the metal.

This analysis implies that all energy-dependent properties affected in one manner during unidirectional deformation must be affected in the opposite manner on subsequent reversed straining. In fact, tensile elongation, recrystallization temperature, and sharpness of X-ray diffraction rings and spots, do behave in the way expected[3], and in a detailed report[4] it will be shown that the Bauschinger effect is also accompanied by appreciable mechanical softening. The maximum decrease of Vickers hardness was 3–10 points in steels with 0·07–0·14 per cent carbon, and up to 26 points in medium- and high-carbon steels with 0·45–1·15 per cent carbon. Equivalent results were obtained with non-ferrous metals, and the amount of softening was consistent with the magnitude of the Bauschinger effect in each case.

Upon these findings, a general rule was formulated stating that work softening occurs whenever the method of cold working used tends to produce an internal stress system different from that left after the preceding treatment, irrespective of whether the latter was of mechanical or of thermal nature. Since the building-up of a new system of internal stresses must be preceded by a partial destruction of that existing previously, there is a transient decrease of E, demonstrated by softening.

The above rule immediately explains why the hardness of sorbitic and troostitic steels either remains constant[5,6] or even falls substantially[6,7] during the early stages of cold working. The same apparently applies to magnetic properties[1], and probably to density as well. Obviously, if 'back straining' is continued, the intensity of magnetization will also ultimately increase, but only after passing through a minimum, just like E in the right-hand side of the diagram.


Actual stress, S →
Internal strain energy, E →
S₁
S₂
Bauschinger effect
Hardening
Softening
Hardening
E₁
E₂
M
Eᵣ
Total strain, Δ →
Stage 1, deformation in one direction
Stage 2, deformation in a direction opposite to that of Stage 1

Diagrammatic representation of changes of resistance to deformation S, and of internal strain energy E, associated with the Bauschinger effect. It is assumed that for $\Delta = 0$, also $E = 0$

It seems, therefore, that Brinell or Vickers hardness tests provide a more convenient and sound basis for investigating internal stresses in metals than magnetic tests. Not only are they less cumbersome, but also they are more sensitive, since for reversed deformations varying from 4 to 8 per cent no difference whatever in intensity values was detected (ref. 1, curve 3). Furthermore, hardness tests are equally applicable to steels and non-ferrous metals, and are also sensitive to directional variations of properties. Finally, although the relations between hardness and stress values are not always clear, they are certainly simpler than those between magnetic properties and mechanical stresses.

N. H. Polakowski

Metallurgical Department,
University College, Swansea. June 12.

[1] Wilson, D. V., *Nature*, 167, 899 (1951).

[2] Barrett, C. S., "Structure of Metals", 339 (McGraw-Hill, New York, 1943).

[3] Burgers, W. G., "Handbuch der Metallphysik", 3, Pt. 2, 492 (review) (Akad. Verl. Becker and Erler, Leipzig, 1941).

[4] Polakowski, N. H., *J. Iron and Steel Inst.* (to be published).

[5] Andrew, J. H., and others, *J. Iron and Steel Inst.*, 165, 145 (1950).

[6] O'Neill, H., *Proc. Inst. Mech. Eng.*, 151, 166 (1944).

[7] Armour, J. D., *Trans. Amer. Soc. Steel Treat.*, 17, 531 (1930).

Large Prime Numbers

For about seventy-five years the largest known prime number has been $P = 2^{127} - 1$, identified as such by Edouard Lucas. It has remained the largest known in spite of many attempts to identify larger ones, although there have been conjectures and claims insufficiently substantiated or entirely unproved.

Recently we have prepared a routine for testing on the Edsac the primality of numbers of the form $kP + 1$, with P as defined above, and have found ten values of k that give prime numbers. The largest of these gives the present (June 7) largest known prime, namely,

$$934(2^{127} - 1) + 1.$$

J. C. P. Miller
June 7. D. J. Wheeler

Note added in proof (*October* 8). Further work on the Edsac by Wheeler and myself has demonstrated the primality of

$$978(2^{127} - 1) + 1$$

and culminated in early July in the identification of the present largest known prime,

$$180(2^{127} - 1)^2 + 1.$$

Also, in early July, A. Ferrier, of France, using a desk machine, demonstrated the primality of

$$(2^{148} + 1)/17,$$

which is the second largest known prime.

J. C. P. Miller

University Mathematical Laboratory,
Cambridge.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, November 12

University of London (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Prof. P. Gourou: "La Géographie du Monde Tropical".* (Further Lectures on November 13 and 15.)

British Society for the History of Science, Philosophy of Science Group (in the Council Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. W. I. B. Beveridge: "What is Wrong with the Philosophers' Accounts of Scientific Method?"

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, Victoria Embankment, London, W.C.2), at 6.0 p.m.—Discussion on "The Equipment of an Electrical Engineering Laboratory" (to be opened by Mr. A. Draper and Mr. T. Siklos).

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Dr. M. V. Wilkes: "Automatic Calculating Machines" (Cantor Lectures). (Further Lectures on November 19 and 26.)

Tuesday, November 13

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Illuminating Engineering Society (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. H. F. Stephenson: "The Equipment and Functions of an Illumination Laboratory".

Sheffield Metallurgical Association (at the Grand Hotel, Sheffield), at 7 p.m.—Dr. K. W. Andrews: "Some Simple Theoretical Aspects of Ferrous Metallurgy".

Wednesday, November 14

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. S. F. Birch: "Detergents from Petroleum".*

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. G. H. Metson, Dr. S. Wagener, Mr. M. F. Holmes and Mr. M. R. Child: "The Life of Oxide Cathodes in Modern Receiving Valves".

Physical Society (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5.30 p.m.—Dr. A. B. Wood: "Underwater Acoustics" (Duddell Medal Address); Dr. J. H. E. Griffiths: "Ferromagnetic Resonance" (Charles Vernon Boys Prize Address).

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. D. D. Woods: "The Scientific Basis of Medicine, 11, Folic Acid and Vitamin B_{12} in the Metabolism of Micro-organisms".* (Further Lectures on November 16, 20, 23, 27 and 29, December 4, 6 and 11.)

Royal Society of Arts (joint meeting with the British Horological Institute, at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. H. Alan Lloyd: "George Graham and his Clocks".

Royal Statistical Society, Study Section (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. A. Anson and Mr. T. Canter: "Market Research".

Textile Institute, Macclesfield, Leek and District Section (at Wm. Frost and Sons, Ltd., Elizabeth Street Canteen, Macclesfield), at 8 p.m.—Dr. B. P. Ridge: "The New Textiles".

Thursday, November 15

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Special General Meeting to consider the Annual Report of Council; Scientific Papers.

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. R. K. McDermott: "Major Changes in Mining Practice during Ten Years 1940–1950, Rhokana Corporation, Ltd.".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. M. H. A. Newman, F.R.S.: "Coincidence and Fixed-Point Theorems" (Presidential Address).

University of London (at King's College of Household and Social Science, Campden Hill Road, London, W.8), at 5.30 p.m.—Miss L. E. Charlesworth: "The United Nations and Technical Assistance".*

Wool Education Society (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 7.15 p.m.—Prof. W. T. Astbury, F.R.S.: "How the Wool Molecule Works, and its Further Significance in Biology and Medicine".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Royal Society of Tropical Medicine and Hygiene (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 7.30 p.m.—Laboratory Meeting.

British Institute of Radiology (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8 p.m.—Prof. J. E. Roberts: "Is Your Physics Really Necessary?" (Presidential Address).

Friday, November 16

Royal Society of Medicine, Epidemiology and State Medicine Section (at 1 Wimpole Street, London, W.1), at 4.30 p.m.—Discussion on "Undergraduate Teaching of Social and Preventive Medicine".

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Lieut. L. R. R. Foster: "Navigational Work with the Polar Ship *Norsel*".

Royal Institute of Philosophy (at University Hall, 14 Gordon Square, London, W.C.1), at 5.15 p.m.—Rev. Dr. A. M. Farrer: "Religion".* (Further Lecture on November 23.)

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. H. Roxbee Cox: "Some Fuel and Power Projects" (Thomas Hawksley Lecture).

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. F. G. Young, F.R.S.: "The Scientific Basis of Medicine, 12, Adrenal Hormones and ACTH".* (Further Lectures on November 20, 23, 27 and 29, December 4, 6 and 11.)

Society of Public Analysts and Other Analytical Chemists, Polarographic Discussion Panel of the Physical Methods Group (at the Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W.1), at 6 p.m.—Annual General Meeting; Scientific Papers.

Wolverhampton Society of Applied Science (at the Chamber of Commerce, New Street, Birmingham), at 6.30 p.m.—Dr. A. E. Werner: "Scientific Examination of Paintings".

Institute of Physics, Manchester and District Branch (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Mr. W. J. Meredith: "Recent Advances in the Applications of Physics to Medicine" (Chairman's Address).

Society of Chemical Industry, Fine Chemicals Group (at the Middlesex Hospital Medical School, London, W.1), at 7 p.m.—Dr. C. R. Ricketts and Dr. K. W. Walton: "Blood Anticoagulants with Special Reference to Dextran Sulphate".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. T. E. Allibone, F.R.S.: "New Materials in Engineering".

Saturday, November 17

British Psychological Society, Social Psychology Section (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Prof. R. W. Russell: "Psychological Research in American South-west Indian Cultures"

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Analyst in the Department of the Public Analyst—The Registrar and Secretary, The University, Bristol (November 17).

Assistant Lecturer in Applied Mathematics—The Clerk, Birkbeck College, Malet Street, London, W.C.1 (November 17)

Head of the Chemistry Department, Rutherford College of Technology—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 1 (November 17).

Head (Grade II) of the Engineering Department, Chance Technical College—The Chief Education Officer, 215 High Street, Smethwick 41 (November 17).

Lecturer in Agricultural Engineering and Building Construction at Gwebi Agricultural College—The Secretary, Southern Rhodesia Government, 429 Strand, London, W.C.2 (November 24).

Chief Electrical Engineer, an Electrical Engineer, a Water Supply Engineer, and an Industrial Chemist, in the Development Board of the Government of Iraq—J. D. Atkinson, c/o Coode, Vaughan-Lee, Frank and Gwyther, 9 Victoria Street, London, S.W.1 (November 26).

Senior Lecturer in Mechanical Engineering—The Principal, Heriot-Watt College, Edinburgh (November 26).

Weed Ecologist—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (November 28).

Assistant Lecturer in Pathology at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 30).

Assistant Statisticians in the Civil Service—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 96/51 (November 30).

Chair of Electrical Engineering in the New South Wales University of Technology, Sydney—The Agent-General for New South Wales, 56 Strand, London, W.C.2, or the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 30).

Lecturer in Entomology, and an Assistant in Zoology—The Secretary, The University, Edinburgh (November 30).

Assistant Agricultural Economists (two in the Ministry of Agriculture and Fisheries and one in the Department of Agriculture for Scotland)—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 4097/51 (December 6).

Chair of Psychology at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 7).

Senior Principal Production Engineer, Admiralty Production Pool—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4098/51 (December 18).

Senior Lecturer and a Lecturer in Applied Mathematics, and a Lecturer in Pure Mathematics, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 15).

Senior Lecturer and a Lecturer in the Departments of Pure and Applied Mathematics, University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 15).

Senior Lecturers and Lecturers in Crop Production, Animal Production, Agricultural Economy, Agricultural Engineering, and Soil Science, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 15).

Civil Engineers, Sanitary Engineers and Structural Engineers, in a number of Departments in England and Scotland—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No 3405/A (December 31).

Bacteriologist at the Institute of Medical and Veterinary Science, South Australia—The Agent-General and Trade Commissioner for South Australia, Marble Arch, London, W.1 (Adelaide, January 2).

Professor of Philosophy—The Registrar, University College, Singleton Park, Swansea (January 5).

Aeronautical and Mechanical Engineers (Experimental Officer grade) mainly in the Aerodynamics and Structures Departments at the Royal Aircraft Establishment, South Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W 1, quoting C.572/51A.

Assistant Biochemist (university degree essential)—The Secretary, Preston and Chorley Hospital Management Committee, Royal Infirmary, Preston.

Assistant Educational Psychologist (woman, honours or research degree in psychology and experience in teaching essential) to Child Guidance Clinic and Bristol Schools—Chief Education Officer, Council House, College Green, Bristol 1.

Assistant (Grade B) in the Mechanical Engineering Department—The Principal, Royal Technical College, Salford.

Banana Research Officer (with a university degree in botany, preferably with chemistry, and capable of organizing the work of a small cold storage station), Jamaica—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27059/260.

Head of the Mechanical Engineering Department (Grade III), Lecturers in Physics, Chemistry, Mechanical Engineering, Mathematics (Engineering), Production Planning, and Assistants in Biology and allied subjects (Grade B), and English Usage for technical students (Grade A), Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton.

Horticulturist to take charge of glasshouse and small botanic garden and experimental plot—The Registrar, University College, Singleton Park, Swansea.

Lecturer in the Electrical Engineering Department—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1.

Metallurgists to lead teams engaged on development work involving physical metallurgy, metallography, mechanical working, powder metallurgy, and melting and casting; Metallurgists to undertake development work in one of the fields mentioned above, involving large-scale plant in some cases, Chemical Engineer to undertake large-scale development work on processes for the reduction and recovery of less common metals, at Springfields Factory, Salwick, Preston—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

Physical Chemists (Scientific Officer grade) at Ministry of Supply experimental establishments mainly in the vicinity of Waltham Abbey, Sevenoaks and South-East London—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.603/51A.

Physicist or Mechanical Engineer (honours degree in physics or mechanical engineering essential) for research on wire and bar drawing, at Sheffield—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Wire Drawing'.

Physicists at the Ministry of Supply Radiochemical Centre, Amersham Principal Scientific Officer/Senior Scientific Officer (Ref. A.320/51A) to take charge of the Physics Department, and a Scientific Officer (Ref. A 321/51A) for research and development work related to the production of radioactive isotopes, concerning particularly the absolute calibration of radioactive sources and health physics and associated problems in instrumentation—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, or Almack House, 26-28 King Street, London, S.W.1, quoting the appropriate Ref. No.

Scientific Officers at a Ministry of Supply Design Establishment in Surrey. Physicist (Ref. A.308/51A) preferably with interest in statistics, to plan, supervise and report full-scale field trials which often involve optical and electrical instrumentation; Physicists (Ref. A.307/51A) for general physical investigations and for work connected with fire control equipment, Mechanical Engineer (Ref. C.644/51A) with aptitude for applied mathematics for work on vibration, stress and thermodynamics, or Mechanical Engineer preferably with electrical bias and workshop experience for general mechanical research and development; Electrical Engineers (Ref. D.466/51A) for the application of electrical and electronic techniques to engineering problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

Senior Engineers in the Ministry of Supply to encourage the adoption of improved production processes in the field of aircraft engineering—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.649/51A.

Senior Metallurgist, to take general charge of research on bearing metals, bronze and other alloys containing tin—The Director, Tin Research Institute, Fraser Road, Perivale, Greenford, Middx.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Medical Research Council. Special Report Series No. 275: Studies of Undernutrition, Wuppertal 1946–9. By Members of the Department of Experimental Medicine, Cambridge, and associated Workers. Pp. xiv+404+62 plates. (London: H.M. Stationery Office, 1951.) 12s. 6d. net. [278

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 873, Vol. 243: Farey Section in $k(i)$ and $k(\rho)$. By J. W. S. Cassels, W. Ledermann and K. Mahler. Pp. 585–628. (London: Cambridge University Press, 1951.) 10s. [298

Fossil Mammals of Africa. No. 3: Associated Jaws and Limb Bones of *Limnopithecus macinnesi*. By W. E. Le Gros Clark and D. P. Thomas. Pp. 27+6 plates. (London: British Museum (Natural History), 1951.) 15s. [308

Department of Scientific and Industrial Research: Food Investigation. Special Report No. 54: The Condensation of Water on Refrigerated Surfaces. By J. K. Hardy, K. C. Hales and G. Mann. Pp. iv+34. (London: H.M. Stationery Office, 1951.) 1s. 6d. net. [308

University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1949–1950. (Cmd. 8307.) Pp. 38. (London: H.M. Stationery Office, 1951.) 1s. 6d. net. [49

Record of the Science Research Scholars of the Royal Commission for the Exhibition of 1851. 1891–1950. Pp. iii+92. (London: Royal Commission for the Exhibition of 1851, 1951.) 7s. 6d. [49

Other Countries

The Malayan Grading Rules (Export) for Rough Sawn Timber. Pp. 43. (Kuala Lumpur: Department of Forestry, 1951.) 1 dollar; 2s. 6d. [208

Western Australia: Geological Survey. Bulletin No. 102: Greenbushes Mineral Field. By R. A. Hobson and R. S. Matheson. Pp. 219+9 plates. Bulletin No. 104: Some Economic Aspects of the Principal Tantalum-bearing Deposits of the Pilbara Goldfield, North-West Division. By H. A. Ellis. Pp. 93+9 plates. (Perth: Government Printer, 1949–1950.) [228

Commonwealth Scientific and Industrial Research Organization. Bulletin No. 250: Habitats and Community Relations of the Acrididae of the Trangie District, N.S.W. By L. R. Clark. Pp. 20+3 plates. Bulletin No. 255: A Review of the Australian Mydaidae (Diptera). By S. J. Paramonov. Pp. 32. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1949–1950.) [228

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 27, No. 6: Relationships of the Pelagic Shark *Euprotomicrus bispinatus*, with Description of a Specimen from off California. By Carl L. Hubbs and J. L. McHugh. Pp. 159–176. (San Francisco: California Academy of Sciences, 1951.) [228

Kungl. Skogshogskolans Skrifter. Nr. 5–6: Beräkning av Slutavverkningen; calcul de la possibilité, av Sven Petrini; Die Geschwindigkeit und der Verlauf des Transpirationsstromes bei der Birke, von Aino Mathiesen. Pp. 24. (Experimentalfältet: Skogsbiblioteket, Skogshogskolan, 1951.) [278

United Nations. Supplement (1951) to Catalogue of Economic and Social Projects 1950. Pp. xvi+310. (New York: United Nations; London: H.M. Stationery Office, 1951.) 2.50 dollars; 17s. 6d. [278

Geologisches Jahrbuch fur das Jahr 1949. Herausgegeben von den Geologischen Landesanstalten der Bundesrepublik Deutschland. Band 65. Pp. lxxxii+790+7 plates. (Hannover: Amt fur Bodenforschung, 1951.) 25 D. marks. [278

French Bibliographical Digest. No. 7: Science—Physics. Pp. iii+87. No. 8: Science—Chemistry. Pp. vii+72. (New York: French Embassy, 1951.) [298

Annals of the New York Academy of Sciences. Vol. 53, Art. 4: The Fundamental Aspects of Lubrication. By O. A. Beeck and 14 other Authors. Pp. 753–994. 4 dollars. Vol. 53, Art. 5: Specific Methods of Analysis. By Dr. S. E. Q. Ashley and 13 other Authors. Pp. 995–1118. 2.50 dollars. (New York: New York Academy of Sciences, 1951.) [49

Fieldiana. Anthropology, Vol. 36, No. 6: Acculturation and Material Culture, 1. By George I. Quimby and Alexander Spoehr. Pp. 107–148. (Chicago: Chicago Natural History Museum, 1951.) 1 dollar. [49

Annali della Facoltà di Scienze Agrarie della Università di Palermo. Vol. 1, Anno 1950. Pp. 370. (Palermo: Università, 1951.) [49

Nyasaland Protectorate. Annual Report of the Geological Survey Department for the Year 1950. Pp. 16. (Zomba: Government Printer, 1951.) [49

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PHY ICS Dept

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HUMAN RELATIONS IN INDUSTRY

SOME passages in Prof. C. A. Mace's presidential address to Section J (Psychology) at the Edinburgh meeting of the British Association bear so closely on current problems, and notably on that of productivity and industrial relations in industry, that they deserve attention from a much wider audience than that of the psychologists to whom they were originally directed. Prof. Mace remarked, for example, that the collective personality of a group of professional scientific men, the relations within such groups, and the relationship of these groups to other groups in society as a whole, determine the social function of each science as well as the extent of its responsibilities and powers. Moreover, in Great Britain, political and scientific institutions have developed as mutually reinforcing systems, and he suggested that the health and efficiency of any professional body depends in some measure on the quality of the laity it serves. Given the integrity of the particular professional discipline or science, its efficacy depends also on the existence of a critical and educated laity.

The absence of this condition, at least in part, has handicapped progress in productivity and in dealing with problems of human relations in industry; but it is true also in the sphere of science generally that the effective utilization of scientific knowledge depends upon a wider and clearer understanding of what science is and what it is really doing. There is a political if not a social climate that has to be taken into account. Prof. Mace considers with some justification that the failure to apply the results of research in the field of the human and social sciences is due mainly to the lack of professional men and technologists who combine experience and training in certain basic skills of application with the relevant basic scientific qualifications. But it is equally clear from discussions on productivity—even from that on higher technological education in relation to productivity to which Prof. Mace referred—that the attitude and understanding of labour as indicated by the trade unions is an important factor. The evidence of a change in this attitude provided by the support afforded by the Trades Union Congress to the work of the Anglo-American Council on Productivity, and the unanimity which has marked the reports coming from the productivity teams, is one of the most hopeful signs for the future.

Prof. Mace himself seems to recognize this factor, for it is implicit in the suggestion he makes for fundamental research into the basic conditions of 'status' and 'prestige'. Prof. Mace believes, for example, that it would be worth while to investigate thoroughly the reasons for the common belief in Great Britain that a career in applied science in industry is in some way inferior to that in other professions; but, in addition, he suggests that it would be worth studying carefully also what lies behind the apparent reluctance of university students, at particular times, to enter particular careers like teaching or industry. The historical reasons for the drift to particular occupations—to Whitehall, to

Harley Street, to the Inns of Court—are in part psychological reasons, and as such they require attention.

The relevance of Prof. Mace's address to the question of human relations in industry would thus have been sufficiently manifest had he not specifically referred to poor human relations between management and the factory being detrimental to co-operation in production, and to both industry and commerce suffering from poor public relations between business and the professions. His argument finds ample support both in the two pamphlets, "The Extent of Centralisation"[*] which the Acton Society Trust has since published in its series of studies of nationalized industry, and in the Beckly Social Service Lecture, "Christianity and Human Relations in Industry"[†], which Sir George Schuster delivered to the Methodist Conference in July.

Prof. Mace urged that psychologists have a special responsibility, first for the maintenance of the British tradition in the popularization of science, and second for the preservation of a common medium of communication. This duty of communicating understanding, above all to those who are concerned in any way with the management of men, is one of the most interesting points to be found in Sir George Schuster's analysis, from a Christian point of view, of human relations in industry. Sir George is as convinced as Prof. Mace of the imperative need for clear interpretation of scientific findings, as indeed of religious truths, in terms which can be understood by ordinary people. He will have no truck with the superficial. All the width of his experience as an industrialist, as chairman of the Sub-Committee on War Production of the Select Committee on National Expenditure, and as one of the 'working party' for the cotton textile industry and of the Panel on Human Factors of the Committee on Industrial Productivity gives authority to his statement of the case for enlightened management, and his plea both for the humanizing of management and for a fuller response from the trade union side.

The larger part of Sir George Schuster's lecture is concerned with the relationship of management to workers, and with the contribution which management can make towards establishing industrial employment as an essential part of a satisfying human life, in which there is sufficient scope for personal self-expression and personal responsibility. He insists that human values must not be sacrificed either to efficiency or inefficiency : efficiency, in fact, provides the real basis for confidence and co-operation, and this is no less true on the workers' side than on that of management. Efficiency, understood in the Greek sense of excellence, is an end itself.

As to the organization which will best secure such a purpose, Sir George Schuster has little to say beyond that every decision should be taken at the most effective level—the level where, as Mary Follett would have put it, the decision can be seen to be the demand of the situation ; and like Mary Follett and Elton Mayo, he believes that the most important problem in modern industrial organization is to discover the most appropriate working group for each organization. Of even deeper interest to the man of science are his observations on the way in which scientific study is improving working conditions, eliminating hazards to health and assisting to establish better relations between workers and management. Sir George is convinced that there is a wide field of study here, including not only industrial health in the broadest sense, the fitting of the job to the man and, conversely, the fitting, by selection and training, of men to the job, and the assessment of the job, but also human relations and human behaviour. In this connexion, scientific investigation could build up a body of knowledge of immense value for the increase of productivity and of industrial efficiency in the truest sense.

If such study, however, is to replace the subjective opinions and assumptions on which judgments and policies are now too frequently based, we must be on our guard against any tendency in such research to accept men merely as units for providing data for hypotheses and conclusions. Above all, in studying human relations and human behaviour, each individual must be treated with sympathy and understanding as a unique personality. The limitations as well as the possibilities of the scientific method have to be kept in mind.

Sir George Schuster's experience leaves him full of confidence that this intellectual approach can succeed. There is less resistance than even a generation ago, though the public interest in the scientific approach is not without misunderstanding as to what science can and cannot do. Moreover, he believes that success is possible without a complete change of the economic system, given the outlook and approach which he postulates on the side of the workers as well as on that of management.

The approach that Sir George advocates is obviously in harmony with Christian teaching ; but the distinction from scientific humanism in general is not manifest. Nevertheless, the Lecture shows how such a policy could contribute to the creation of the atmosphere in which right human relations are established. The first step must come from the side of management, but it cannot suffice without an adequate response on the workers' side. In insisting on the necessity for at least a philosophical, if not a religious, basis for a full life, Sir George roundly challenges the inadequacy of the materialistic outlook which has shipwrecked so many promising ventures in industrial co-operation in the past. We need a sound moral attitude, and unless that is forthcoming the instruments which science provides for the increase of industrial productivity and raising of standards of living are as liable to be used for evil as for good. On this question of values, all our attempts to further co-operation in industry by joint consultation and other methods, no matter how much hard intellectual effort and scientific study are put into the study of concrete problems of industry, may well founder. Without general acceptance of a common scale of values, there can be no co-operation or common purpose.

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[*] The Extent of Centralisation : a Discussion based on a Case Study in the Coal Industry. (Nationalised Industry Series 6 and 7.) Part 1. Pp. ii+20. Part 2. Pp. iii+21–44. (Claygate : Acton Society Trust, 1951.) 2s. each Part.

[†] Christianity and Human Relations in Industry. By Sir George Schuster. (Beckly Social Service Lecture.) Pp. 128. (London : Epworth Press, 1951.) 6s. 6d. net.

The analysis of the organization of the coal industry made by the Acton Society Trust points to much the same conclusions as are drawn by Sir George Schuster, as well as supporting Prof. Mace's observations on the importance of human relations, and particularly of status and the need for education. Behind the question of how far centralization or decentralization can wisely and efficiently be carried lies this fundamental problem of establishing the most effective working group or unit, on which Sir George lays such stress. The Acton Society Trust's study recognizes that the problems of decentralization are common to all large-scale organizations, though appearing with different intensity in different industries. It is, however, the informal and uncodified relations which cause the trouble, rather than the officially defined limits of authority.

The main conclusion drawn from the present study is, in fact, that decentralization is primarily a problem of the adjustment of human relationships, and it is urged, in accordance with Sir George Schuster's view, that further research in other industries such as electricity or transport is desirable. Attention is directed, however, to two basic errors of thinking about the organization of the nationalized industries. The first is the belief that there is a 'best way' of carrying out any specific task and that science can discover it. The specialist is then conceived as the man who can work out what the 'best way' is. Accordingly, if the pattern of organization is such that the best specialist is put at its peak and consulted on everything, the undertaking will be run in the best possible manner. This assumption leads both to the construction of organizations of maximum size and to the imposition of uniform practices throughout those organizations. This view is based on a popular misconception of the natural sciences, and embodies just that habit of thought in the application of science against which Sir George gives so firm a warning. In the coal industry it is responsible for exceptional difficulties, partly because, while reorganization was urgently needed, experience in using specialists was considerably lacking, and there was also an acute shortage of specialists.

This is the feature of the study which is of most immediate interest here. Its discussion was indeed confined to the use of technical specialists in production, but this section of the study deserves careful examination by those concerned with the most effective use of the scientific worker or technologist in industry generally. Even if the difficulties are particularly acute in the coal industry for the reasons indicated, the nature of the relations between the operational or works manager and technical specialists of higher status, diffusion of authority resulting from the number of such specialists and from the number of stages in the management hierarchy, as well as the character and extent of the control and supervision exercised by higher management over lower management, all involve problems which require solution before high productivity can be expected. This brief discussion by the Acton Society Trust brings out very clearly the need for further thought as to the adequacy of the staff and line system in industry, on the definition of responsibility, and the need for much more forethought in the launching of large new projects involving new methods of operating. It is to be hoped that these problems of large-scale organization will not escape the notice of the British Institute of Management.

The second error of thinking relates to decentralization. It is assumed that an ideal compromise can be found which will make the best of both worlds, giving the plant or works manager freedom without sacrificing the advantages of scale. It may be, however, so the Acton Society Trust points out, that a compromise only provides the worst of both worlds, leaving the manager handicapped without achieving the technical advantages supposed to accrue from size. If that is so, a decision in favour of one extreme or the other would be necessary; but there may be room here also for further investigation. Such investigation must, however, keep clearly in mind the point made so strongly by Sir George Schuster regarding the importance of respecting human personality. That is no less important in considering changes in organization which affect the manager or the technologist than in considering conditions which affect workers on a lower level, and this latest study from the Acton Society Trust is implicitly as firm a protest against the purely materialistic or economic treatment of industrial problems as Prof. Mace's address on psychology and the laity or Sir George Schuster's Beckly Lecture. What is said about the importance of status in connexion with the colliery manager, and the recognition that the problem is at least as much one of education as of organization, sufficiently illustrate this, and have implications for other scientific and technical workers which suggest that professional bodies might well give careful consideration to these pamphlets.

CHEMISTRY OF THE EARTH

Geochemistry

By Dr. Kalervo Rankama and Prof. Th. G. Sahama. Pp. xvi+912. (Chicago: University of Chicago Press; London: Cambridge University Press, 1950.) 112s. 6d.

THE last important book in English on geochemistry, F. W. Clarke's "The Data of Geochemistry", first published in 1908, was also the earliest in this field of science which serves as intermediary between chemistry and geology. Since the third edition of Clarke appeared, major contributions have come from Vernadsky and Fersman in Russia, from Scandinavia, and especially from V. M. Goldschmidt of Oslo and Göttingen and his co-workers. Moreover, chemistry itself has made great new strides, especially, on the theoretical side, in the direction of radiochemistry, and on the practical side, in the application of spectrography and spectrometry to problems of analysis and separation. The earth is now to be understood in terms not merely of 96 elements, but also of 272 stable and 23 longest-lived unstable nuclides. The time is certainly ripe for a treatment in English on the subject, and this comprehensive work by Rankama, of Helsinki and Chicago, and Sahama, of Helsinki, is one of first importance both for geologists and chemists.

The authors accept the threefold task of geochemistry as defined by Goldschmidt: to establish the abundance relationships of elements and nuclides in the earth; to account for the distribution of elements in the various terrestrial spheres; and to determine the laws governing the abundance and distribution of the elements. The book is divided into two parts, the first dealing with the general laws and regularities which determine the abundance and manner of occurrence of the elements, and the second considering the elements one by one.

In Part 1 the determination of abundance figures largely. On this subject it is difficult not to feel some misgivings about possible errors of sampling which might have a serious influence upon the conclusions reached. It might be asked, for example, whether 5,159 analyses, even when weighted according to superficial areas of rock-types, are sufficient to assess the composition of so large a subject as the lithosphere, particularly when the tendency for petrologists to collect specimens of only a few pounds or even ounces in weight is remembered. Similarly, it seems very doubtful whether the "average meteorite" has any fundamental significance. If any criticism of this excellent book is justified, it is that the formidable tables of abundance data give an impression of finality which more detailed investigation may perhaps prove to be misleading. A chapter on the geochemical structure of the earth deals chiefly with hypotheses originated by the geochemists Washington and Goldschmidt; the exclusion from this discussion of the numerous alternative views advocated by geophysicists (apart from a brief consideration of Kuhn and Rittmann's revolutionary ideas) is presumably deliberate and, for the purpose of the book, probably wise; the nature of the subcrustal layers and of the core remains a speculative subject and not open to direct geochemical observation. The spheres which are open to direct observation —the upper lithosphere, the hydrosphere, the atmosphere and the biosphere—receive very adequate treatment.

The elements which enter into the composition of the lithosphere are divided into oxyphile (the petrogenic elements of Washington) and sulphophile. A discussion of crystal chemistry follows, based upon the useful structural classification of the silicates advocated by Hugo Strunz, and this leads to a thoroughly modern account of the rock-forming minerals. Magma, not migma, is regarded as the basis for the crystallization of the important minerals, and the authors state their faith when they say ". . . notwithstanding the geological significance of the igneous-looking rocks formed by metasomatic infiltration and recrystallization processes . . . the phenomena connected with the crystallization of a rock melt are fundamentally important". This compromise has much to recommend it. The conception of a major endogenic cycle (rock-melt–igneous rocks–sediments–metamorphics–migmatites–rock melt) springs from it.

A minor cycle involving exogenic processes is also usefully recognized as underlying the formation of the sedimentary rocks. Here the geological reader will find unfamiliar terms such as resistates (clastic sediments), hydrolysates (clays, shales, bauxites), oxidates (iron–manganese ores), reduzates (sedimentary sulphides), precipitates (calcium and magnesium carbonates), evaporates (the evaporites of current mineral literature) and bioliths (organic sediments), the whole providing a system of sedimentary chemistry.

In Part 2 the individual elements are treated in accordance with a rigid plan under which abundance in rocks and meteorites is stated, occurrence in primary and secondary minerals in various spheres is considered, and a cycle of transition is deduced in most cases. Concentration into deposits of economic value is referred to here.

This book may well be hailed as a major contribution both to geology and chemistry, and it should have an important influence on workers in those fields where the two subjects converge.

K. C. Dunham

DEMOCRATIC PLANNING AND LIBERTY

Freedom, Power and Democratic Planning

By Karl Mannheim. Edited by Hans Gerth and Ernest K. Bramstedt. (International Library of Sociology and Social Reconstruction.) Pp. xxiv+384. (London: Routledge and Kegan Paul, Ltd., 1951.) 25s. net.

The Logic of Liberty

Reflections and Rejoinders. By Prof. Michael Polanyi. (International Library of Sociology and Social Reconstruction.) Pp. viii+206. (London: Routledge and Kegan Paul, Ltd., 1951.) 15s. net.

"FREEDOM, Power and Democratic Planning" concludes the studies of the theory and practice of sociology which Dr. K. Mannheim first expounded in "Ideology and Utopia" and continued in "Man and Society in an Age of Reconstruction". Like his earlier books, this posthumous volume is not always as clear in its treatment as might be desired, and here, far more than in the earlier books, the writing is marred by jargon which obstructs the argument and in the latter chapters even obscures the meaning. This is most conspicuous when he deals with religion and philosophy and the integration of the social order. While it is evident that Dr. Mannheim believed that society cannot be held together except by ethical, moral or religious forces, no more than in his "Diagnosis of Our Time" does he succeed in conveying to the reader any clear idea of what he understands by religion.

That is a serious defect in a book, which, addressing itself to the development of happier arrangements for achieving social reforms, establishes clearly the necessity for some spiritual or ethical basis such as the Western tradition and the acceptance of such values if a coherent society is to exist. It is the more unfortunate because for all the jargon, indifferent style and sometimes muddled thinking on certain topics, the book gives a picture of what is likely to happen to our society, and it is often both stimulating and suggestive. In spite of its faults it is an important book which directs attention to subjects which require careful thought and more objective study than they commonly receive.

Mannheim believed that freedom is impossible without the continuance of free institutions, but that the institutions which have served us in the past require modification if they are to be effective for the preservation of freedom to-day. In what he called creative politics—or the creation or evolution and use of the appropriate institutions—planning has its place, although with Mannheim central planning was essential only in regard to certain basic issues of policy. Government and the community are not separate entities and he looked to the organized group to give to the individual the opportunity to express his personality, while the activities of the groups are broadly co-ordinated in the interests of the community as a whole by the central authority.

For this to be possible, there must be a degree of social unity such as was achieved with our existing institutions in time of war. In time of peace this involves, first, re-shaping institutions so that power may be brought under democratic control; next Prof. Mannheim postulated the fostering by more adequate social education of democratic behaviour and personality to inculcate co-operation and tolerance; and third, the re-definition of values and re-discovery of an ethic generally shared to be found in what he describes as a 'dynamic religion'. On the defects of existing institutions Mannheim wrote shrewdly, and his criticisms and observations on such matters as the selection and training of leaders, the dangers of levelling down, the problem of loyalty, the position and functions of the Civil Service, the Press or broadcasting, and functions and relations of organized groups to society as a whole are often illuminating as well as wise. He understood, too, the limits as well as the dangers of some of the new techniques, and while he recognized their value he insisted that by themselves they offer no solution to the problem of power.

Some of his comments here recall Mr. Charles Morgan's recent emphasis on the dangers of the control or changing of human personality to which such techniques now expose us, but Mannheim is no more constructive than Morgan and some of his proposals are unconvincing. He appears to be over-confident as to the possibility of transforming men and institutions, and leaves his readers at least in some doubt as to whether his restraints and moderating influences will suffice.

For this there are probably two reasons. First, in espect of the re-shaping of institutions, he does not eally feel the problems of the conflict that inevitably ccompanies the disturbance of privilege and tradiional patterns. His discussion rarely goes as deep as that of Sir Ernest Barker in his "Reflections on Government", and on the institutional side there is little to be found here that was not implicit or xplicit in that book of nine years earlier.

The second reason is Mannheim's failure to convey any clear idea of what he understands by a dynamic religion. If some ethic or religion is to supply a ement which will hold the fabric of society together and give it unity, that ethic or religion must be xpressed clearly enough to fire the imagination of men and women and claim not merely intellectual assent but also something of the moral fervour or assion that has marked all the great cultural or religious revivals of the past. For that the sincerity f this book, the clarity of its diagnosis, are insufficient. When he wrote, Mannheim himself appears to have been still groping for the faith, for the spiritual basis which he recognized as essential if the atrophy of Western civilization is to be arrested nd men are to recapture that sense of purpose, that vision of greatness, required for the re-shaping of its nstitutions.

"New Ideas," wrote Mannheim, "always have originated in small groups with enduring personal contacts. . . . It is still the dissenting small group that favours inspired adventures of the mind and intellectual enthusiasm." This passage, in which he urged that such intellectual oases are the natural and only protection of society to-day from the deadening uniformity which propaganda tends to impose, provides a natural link with those reflexions and rejoinders on the theme of liberty which Polanyi has collected under the title "The Logic of Liberty". The essays, indeed, are not new, but through them runs the same theme of the vulnerability of freedom, the necessity for a fresh defence in this troubled period of history and for a re-assertion of ideals which we have allowed to become discredited.

Pólanyi is concerned primarily with the defence of science, but this he insists is part of the defence of our civilization. The forces undermining the position of science are a detachment of those assailing our whole civilization, and when he claims for science the respect due to it as a cultural and moral value he is repudiating as firmly as Mannheim the adequacy of a purely materialistic basis for civilization. This, far more than his re-assertion of the incompatibility of planning or directed research with the freedom which is the very essence of science as a vital activity, the search for truth and an example of the good life, is the keynote of the book, and it would be unfortunate if his shrewd attack on planning and exposition of the limitations in any way obscured this wholehearted challenge to the materialistic thesis.

Throughout the book, Polanyi emphasizes that liberty is conditioned by society and that the freedom in which science develops is a form of intellectual liberty, while economic liberty he regards as a kind of technique. Polanyi is easiest to follow in this first part of the book, where he deals with the example of science and is here even more suggestive than Mannheim as to the way in which small groups or professional institutions can contribute to the building up and safeguarding of a free society. His exposition of an engineering or physical approach to economics is more difficult for a layman to follow, and its value appears to be less constructive. He is more effective in disposing of the pretensions of central planning than in concrete suggestions as to how liberty is to be defended.

The great value of these two books is that they do not merely defend freedom: they assume the offensive and attack the ideas that lie at the basis of those forces or institutions which to-day threaten the free society. Both writers have the courage of their conviction that a free society is a true end in itself—a body of men who respect truth, desire justice and love their fellows—and that accordingly it may rightly demand the services of its members in upholding its institutions; and, as already noted, where Polanyi deals specifically with the freedom of science itself, it is as a part of the larger problem. Scientific beliefs, in his view, are part of the beliefs cultivated in a free society and accepted by its members.

Polanyi's argument that the scientific worker should not limit himself to the defence of freedom of science as such but should play his part in the defence of the free society in which alone science can fully function, carries, however, the corollary that there should be a much clearer understanding in the community as a whole of what science really is, and how it works to widen the understanding of Nature necessary to all men. That academic freedom can claim to be an efficient form of organization for discovery in all fields of systematic study controlled by a tradition of intellectual discipline has its implications outside the strictly scientific field and especially in relation to what Polanyi describes as the achievement of spontaneous order. So, too, inasmuch as freedom of science, like freedom of worship or freedom of thought in general, can be described as a public institution by which society opens to its members the opportunity for serving aims that are purposes in themselves, the way in which the mutual co-ordination of scientific activities is achieved within the field of science itself by consultation, competition and persuasion bears closely on the evolution of the new forms of organization and means of social adjustment which Mannheim sought.

There is much, indeed, in both these books to stimulate the thinking among professional men which is required to safeguard freedom to-day. They represent one group which has an indispensable part to play, not the less because of the inherent tendency of all professional bodies or associations to become conservative or ossified. They, of all men, need to keep in mind the warning from the sixteenth century: "There never was anything by the wit of men so well devised, or so sure established, which in continuance of time hath not been corrupted". R. Brightman

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UNIVERSITY OF MANCHESTER, 1851–1951

Portrait of a University, 1851–1951

To Commemorate the Centenary of Manchester University. By Prof. H. B. Charlton. Pp. x+185+23 plates. (Manchester: Manchester University Press, 1951.) 15s. net.

One reviewer of this book has complained because Prof. H. B. Charlton did not write a full, systematic history of the University of Manchester. Evidently, he did not know Prof. Charlton—the last person to try to produce such a thing on any occasion. On the occasion of a centenary it would have been wrong to try. Instead, he has done something more difficult, which he alone could do, and which will be far more useful to future historians of Manchester and other universities. He has done precisely what the title of the book claims. One hundred years is not long in the life of an institution, so that it is possible to depict it as a unity during that time. But one hundred years, in these migratory times, is almost immeasurably beyond the span of one man's memory. Prof. Charlton has an academic memory far longer than most, for he has been on the staff of the University of Manchester for very nearly forty years. Not only has he seen and taken part in all that has happened since the First World War, but also he knew the leading men of the previous period when Manchester was emerging as a complete university. (In parenthesis: though Owens College ceased to exist legally in 1904, its name still came easily to the ordinary man in the Manchester street thirty years later, whereas the name 'University' meant little and the title 'Victoria' nothing.) Charlton is fortunate, too, in earlier historians. Edward Fiddes, for long a colleague of his, whose actual acquaintance with the University went back to 1890, wrote its history up to 1914. There is also a valuable account of Owens College up to 1886 by Joseph Thompson.

The main theme of this book is: What were the aims of the founders and initiators, and in what manner have they been fulfilled? Prof. Charlton distinguishes four stages in the process. The early stage was that of the old Owens College in its cramped quarters in Quay Street, with its sixty or seventy students and its half-dozen professors, each teaching two if not three subjects. (To be exact, on the photograph opposite p. 16 there are eight professors; they are less bewhiskered and bearded than one would expect, perhaps because they were rather young.) The next stage was the move to the new site in Oxford Road, soon discovered to be too small, the incorporation of the Medical School, older than Owens, and the foundation of a federal university, with Liverpool and Leeds as partners. In the third stage came the attainment of full university status; and then the modern period, with, now, nearly six thousand students, including those in medicine and technology, and a teaching staff of more than eight hundred. Incidentally, the book is well equipped with statistical data, plans and illustrations.

In claiming that the aims of the founder have been and are being fulfilled, Prof. Charlton has to make a very interesting qualification. Robert Owens wrote in his will that the college was to be for the education of "young persons of male sex", and we can only guess what he would have thought of the thousand or more young persons of female sex now studying there. In 1845 when he died there could as yet be no question of higher education for women, since there was next to nothing of secondary education for them; indeed, there was not too much for their brothers. A quarter of a century later, conditions had changed, the question did arise and Parliamentary sanction was obtained to set aside the restriction. However, Manchester acted on it extremely cautiously. If there was too much delay in admitting women, particularly into the Medical School, there has been compensation since. Assuming that Owens was hostile to the higher education of women (we do not know that he was), he would have been instantly converted on being introduced to the first lady who occupied a chair and the two who have followed her. Edward Fiddes's account of this whole controversy is reprinted in an appendix.

Robert Owens, and his friends and successors who took the first steps, wished to foster higher education, and in doing so to serve the special interests of Manchester and its neighbourhood. Young people need to have their minds enlarged and elevated; they also need to earn a living, and can do that best by pursuing effectively the normal activities of the community they live in. On the narrowest interpretation of technical efficiency, the practitioner is none the worse if he grasps the principles underlying his practice or even knows something about other things also.

Prof. Charlton quotes a number of statements of university aims and methods from earlier members of Owens College, from Ward, Roscoe, Schuster and Tout; he also does a valuable service in printing in full Samuel Alexander's essay, written in 1931 which begins: "I should describe a university as an association or corporation of scholars and teachers engaged in acquiring, communicating, or advancing knowledge, pursuing in a liberal spirit the various sciences which are a preparation for the professions or higher occupations of life. The omission of any part of this description would convey a false impression of what a university is. It does not exist only for acquiring or communicating the higher branches of knowledge, but for extending them as well; and it does not only pursue the sciences for their own sake, but, so far as the larger part of its members are concerned, pursues them in preparation for the professions. I had almost said that the purpose of a university was to prepare for the professions, and I should be ready to defend this, provided that the qualifying words, 'in a liberal spirit', are not merely not omitted but emphasized." It is tempting to go on quoting from one who did so much within the University of Manchester and outside to demonstrate what is meant by 'a liberal spirit'. A. D. Ritchie

LAW OF COPYRIGHT AND INDUSTRIAL DESIGNS

Copyright and Industrial Designs

By A. D. Russell-Clarke. Pp. xv+262. (London: Sweet and Maxwell, Ltd., 1951.) 37*s.* 6*d.* net.

THIS book embodies all aspects of copyright, whether literary, dramatic, musical or artistic, together with copyright in industrial designs. It is the first of its kind to include all these branches of copyright. The author is to be congratulated upon the lucidity and practical manner with which he deals with the difficult questions in the field covered by the Copyright Act of 1911 and the Registered Designs Act, 1949. Prior to the coming into operation of the Designs Act, 1949, copyright in industrial designs was largely associated with the patent law rather than the copyright law. In 1947 the departmental committee, set up under the chairmanship of Sir Kenneth Swan to inquire into the working of the Patent and Designs Acts, recommended a number of changes of the law relating to designs. As a result of these changes, it has been made clearer that the law of copyright in industrial designs has a closer affinity to the law of literary copyright than to the law of patents.

The first part of the book is devoted to a detailed examination of the Copyright Act of 1911, in relation to literary, dramatic, musical and artistic work. The author points out the remedies available to copyright owners, and two chapters are usefully devoted to questions of licences and publishing and other agreements. At a time when publishers appear to be inclined to remunerate authors of technical books at the lowest possible rates, the suggestions contained in this part of the book are likely to be of some help. A chapter is devoted to miscellaneous matters such as the term of copyright, University Copyright and Crown Copyright.

Part 3 of the book concerns the Registered Designs Act, 1949, which came into force in January 1950. So far there have been very few reported cases under this Act which have anything at all to do with designs. The author deals with the nature of the design, its publication, the available remedies for its infringement and the procedure for applying for registration at the Patent Office whereby copyright may be obtained for a period of up to fifteen years. Part 4 deals with cases of overlapping which occur between the Copyright Act and the Designs Act.

The book is well indexed, and the fact that neither of the two Acts is set out in full has assisted in keeping the price and the size reasonable. It is certainly a book which should prove of great assistance not only to practitioners, but also to members of the technical staff of firms, designers and authors. R. G. Lloyd

SOCIETY UNDER THE MICROSCOPE

Social Surveys and Social Action

By Mark Abrams. (Contemporary Science Books.) Pp. v+153. (London: William Heinemann, Ltd., 1951.) 8*s.* 6*d.* net.

IN this little book Mr. Mark Abrams starts with the emergence of Booth and Rowntree, the pioneers, and shows what has developed out of their pioneering experiments. He is concerned with the social survey, not as an instrument of fundamental research, but as a form of investigation used in the twentieth century to assist in the identification and quantitative analysis of social problems which call for social action. He traces the development from poverty studies to a wide range of inquiries directed to matters in which questions can be more exactly related to the needs of social policy—nutrition, old people and town planning—and he explains how the Second World War led the British Government to start its own survey department and how companies specializing in survey work arose and have been increasingly employed to make investigations on behalf of public authorities and private agencies. These are the direct descendants of the pioneers. In addition, there are the 'borrowers'—market research and public opinion polls. Finally, Mr. Abrams discusses the role of the social survey in the Welfare State, and has some interesting things to say about the way in which surveys might help to discover how to make public communications intelligible to the masses. This is a worthy aim provided one does not forget the complementary process of making the masses sufficiently intelligent to understand the communications.

Thus the reader is given a genealogy which will be helpful to the novice; but that is not enough to satisfy the serious student, and the book as a whole is disappointing, although the subject is fascinating and the author an acknowledged expert. With such limited space at his disposal, the author could achieve success only by selecting a narrowly defined theme and sticking to it. He has, by a narrow margin, failed to do this. A chapter is devoted to the historical antecedents of the pioneers, and it treats familiar material in a rather crude manner. Another chapter gives an account of social surveys in the United States and is too sketchy to have much value. The author would have done better to fill out his descriptive picture of survey organizations in Great Britain at the present time. A better balance would have been obtained if he had devoted less space to Mass Observation and had found room to mention such organizations as the British Institute of Public Opinion and the National Institute of Economic and Social Research.

If we assume that Mr. Abrams's theme is the social survey as an application of scientific method to the handling of practical social problems, then we should expect to be taken rather further on three points: first, the grounds for claiming that the survey method can be truly scientific; secondly, the respective roles of routine official collections of data and of *ad hoc* surveys; and thirdly, the extent to which the results of social surveys can, and do, point unequivocally to particular forms of social action and the point at which political judgment must enter. All these points are mentioned; but the argument is not sufficiently firmly pulled together to leave a clear impression on the mind of the reader.

T. H. Marshall

The Infinite in Giordano Bruno

By Sidney Greenberg. With a translation of his Dialogue, Concerning the Cause Principle, and One. Pp. ix+203. (New York: King's Crown Press; London: Oxford University Press, 1950.) 20s. net.

THIS erudite contribution to our knowledge of the works of Bruno the Nolan is one of the latest examples of the value of the policy adopted by the King's Crown Press in making specialist studies available to scholars at a very reasonable cost. The volume divides naturally into two—the place of the infinite in Giordano's system, and a translation of the "De la Causa" into English. (Incidentally, there seems to be a comma missing from the title-page, which makes the full, and very noble, phraseology read rather oddly.)

Broadly, these massive writings are, as the author states, the outcome of Bruno's striving to "comprehend the Universe". At the same time, allowing for the tensions inseparable from the onset of humanist philosophies, it is not surprising that much heat was generated *en route*, and that only comparatively recently has this one-time Dominican monk come into his own. We are beginning to realize more explicitly nowadays that the *ordo essendi* is seldom the *ordo cognoscendi*. Meanwhile, Dr. S. Greenberg's reference to Gilson (p. 15) gains added weight if the original setting is consulted. For there, 'good' is contrasted with 'Being': a limitation is implicit in the former, but not in the latter, which is why the Greek 'infinity' was always coupled with imperfection.

English-speaking students will be grateful for being enabled to follow Bruno's great work of 1584 the more readily, and thus to appreciate some of the qualities of that tempestuous intellect.

F. I. G. Rawlins

Die botanische Buchillustration

Ihre Geschichte und Bibliographie. Von Claus Nissen. Band 1: Geschichte, Lieferung 1. Pp. vii+80. Band 2: Bibliographie, Lieferung 1. Pp. vii+80. (Stuttgart: Hiersemann Verlagsgesellschaft m.b.H., 1951.) n.p.

IN the drawing and painting of plants—especially of flowers—art and science meet, sometimes overlap and occasionally combine. The diversity and beauty of form and colour to be found in the plant kingdom attract the artist, while the botanist often finds accurate representation in black-and-white or in colour more valuable as a record of his studies than verbal description. The best botanical artists have combined in their work the feeling of beauty with the accuracy of detail demanded by the man of science. Lately, there has been an increased interest in the history of botanical illustration, an interest apparently not confined to Great Britain.

It is impossible fully to judge the value of C. Nissen's work from Part 1 of Volume 1 and Part 1 of Volume 2. The first volume is to deal with the history of the subject. Its first part contains a brief introduction dealing with some aspects of technique and consideration of botanical illustration in ancient times, the Middle Ages, the period of early printing, the Renaissance, and the Baroque Period (in part). The second volume is, in the first part, strictly bibliographical (authors *A* to *He*). Since there is at present no scheme of contents, it would be unfair to criticize the scope and arrangement of the work from the two parts. There appear, however, to be a number of surprising omissions. Thus, under William Curtis one would expect to find some information about the *Botanical Magazine*. Again, under H. N. Dixon there is no mention of the third (1924) edition of "The Student's Handbook of British Mosses".

The many references provided in both parts should be of considerable interest and use to all who study the history of botany. It is to be hoped that a good index will be provided.

W. B. Turrill

Fourier Methods

By Prof. Philip Franklin. Pp. x+289. (London: McGraw-Hill Publishing Co., Ltd., 1949.) 34s.

PROF. PHILIP FRANKLIN surveys a wide field, interpreting the phrase of his title as covering any method which analyses or synthesizes a function by means of periodic components. He is writing for the technologist, and illustrates plentifully from the field of mathematical physics, but is content to quote the fundamental theorems of pure mathematics which he requires. References to the mathematical theory and for further reading are given.

The first chapter deals with the elements of the theory of complex numbers, with applications to impedances. The second chapter describes the Fourier series and the Fourier integral, including a summary of twelve-ordinate harmonic analysis, the third studies partial differential equations, and the fourth boundary values problems, particularly those arising in heat conduction and in transmission lines. In the last chapter the Laplace transform is briefly described and applied to problems of electric circuits and transmission lines. There is a full supply of worked examples, and an excellent collection of elementary exercises for the reader, with answers.

The treatment is clear, but since so much is dealt with in a comparatively small book, it is never profound. The book would thus serve to introduce the young student to a wide field of knowledge, without requiring anything more than a grasp of elementary calculus as a prerequisite. But it is only an introduction, and the suggestions for further reading should be taken seriously.

The Life of a University

By Basil Cottle and J. W. Sherborne. (Published for the University of Bristol.) Pp. vi+116 (50 plates). (Bristol: J. W. Arrowsmith, Ltd., 1951.) Paper, 6s. net; cloth, 10s. 6d. net.

THIS brochure is a well-written sketch of the growth and organization of the University of Bristol and some institutions connected with the University. There are some fine illustrations; but the title of the book is not happily chosen. Rather less than half of the book is occupied by a short history of the University, the remainder sketching the organization and present activities. It is thus less an account of the life of a university than of its growth and structure, being purely descriptive. Although entirely different in form, it covers essentially the same ground as the pamphlet "An Introduction to a University" put out by the University of Birmingham, but is scarcely so well designed as the latter pamphlet to guide those who are facing a decision as to whether to enter a university at all. The "Life of a University" appears to be designed, on the contrary, for past or present members of the University of Bristol itself, whether students or staff, and to them it may be further commended for the excellence of its general production.

ARTIFICIAL ACCELERATION OF ATOMIC PARTICLES*

By Prof. O. R. FRISCH, O.B.E., F.R.S.
Cavendish Laboratory, Cambridge

THE progress of nuclear physics in the past two decades has depended greatly on the use of machines for producing high-energy particles; these fast particles are used for bombarding atomic nuclei with the aim of producing nuclear transformations. Though the first machines were built nearly twenty years ago, much still remains to be known about the atom. It must be remembered that we know to-day about nine hundred different kinds of atomic nuclei; only three hundred of them are found in Nature, while the remainder have to be prepared artificially, using either high-energy particles or neutrons coming from a nuclear pile. Furthermore, each of these nuclei is a complicated structure, with features many of which are still not understood. Finally, quite new phenomena have been recently discovered, such as the artificial creation of mesons in high-energy nuclear collisions. These mesons, previously found only in the cosmic radiation, can now be studied much more closely, and their study is thought to bear closely on the riddle of the 'nuclear forces', the forces whereby the particles in an atomic nucleus are held together.

Considering the use of fast particles for splitting atoms, it must be remembered that nearly the whole weight of an atom is contained in its nucleus, in size a minute fraction of the atom; all the rest is a tenuous cloud of electrons moving around the nucleus at great speed. Removal of a few of these electrons does not constitute atom splitting; it happens in many chemical reactions, in flames and even in friction, as when glass or ebonite becomes electrified by rubbing. The arrangement and motion of those electrons follow the laws of quantum theory and are, on the whole, so well understood that it is possible, in principle, to compute beforehand the physical and chemical properties of a new chemical compound, though the calculations are usually hopelessly complicated.

Of the structure of atomic nuclei far less is known. Their sizes and their electric and magnetic properties can be measured, but give only indirect evidence of internal structure. In order to learn about the parts of a nucleus and how they are held together, we must break up the nucleus, and the most suitable tool is another nucleus, preferably a smaller one. Such a particle is fired with great speed at the nucleus to be broken up. Of course, we cannot take aim: we have to fire a great many shots at random and hope that some will score. Passing through any given atom, such a nuclear bullet has only a minute chance—perhaps one in a hundred million—of hitting its nucleus, but it can pass through many thousand atoms in succession. Thin aluminium foil—the so-called 'silver paper'—contains about a hundred thousand layers of atoms; on passing through this foil, a nuclear bullet has about one chance in a thousand of hitting an aluminium nucleus. By using many millions of bullets a respectable number of hits can be achieved without any marksmanship whatever.

There are two reasons why bullets of high energy, that is, very fast ones, have to be used: the bullet must be able to break through the electronic shells of many thousand atoms; and it must be able to overcome the electric repulsion which it experiences on approaching another nucleus, caused by the positive electric charge which they both carry. This repulsive force gets very large; for example, an alpha-particle—that is, a helium nucleus—almost touching a uranium nucleus gets pushed away with a force of nearly a hundredweight. Such force represents a kind of barrier through which the bullet has to break before it can touch the nucleus, and the size of this barrier corresponds to the electric potential at the surface of the nucleus. This potential can be easily calculated, from the known size and electric charge of the nucleus. For example, the potentials on the surface of nuclei of carbon, copper and uranium are 2·6, 7 and 15 million volts respectively. Thus, nuclear bullets have to be accelerated with potentials of the order of several million volts in order to enable them to enter an average atomic nucleus.

Potentials of several million volts are not easy to produce or to handle, but generators for potentials up to about four million volts have been built and are being used by nuclear physicists. They usually follow a design by Van de Graaff and employ a fast-moving belt to carry electric charge to the high-voltage electrode, much as a belt-conveyor carries gravel or coal to a higher level. Ions are produced by an electric discharge and are then driven through the accelerating tube to a target at ground potential containing the nuclei to be bombarded. To delay the onset of sparking, the whole arrangement is usually placed in a boiler-like container which can be filled with compressed air or nitrogen. Because of their limited voltage, these electrostatic generators are useful for attacking light nuclei only—that is, elements in the Periodical Table up to, say, calcium. On the other hand, they are very suitable for precision work since they can be stabilized so that the voltage varies by less than one part in ten thousand; this is important because some of the phenomena caused by nuclear bombardment depend extremely sharply on the bombarding energy, that is, on the accelerating voltage.

For the acceleration of particles to much higher energies, the principle of multiple acceleration has been developed, whereby a comparatively small voltage is applied to the same particle a number of times. The first multiple accelerator was built by E. O. Lawrence and D. H. Sloan in 1930. It consisted of a number of metal tubes, all lined up in an evacuated container, and connected alternately to the terminals of a high-frequency generator of alternating electric potential. The length of the tubes was chosen such that a particle which had been accelerated on entering a tube would again be accelerated on leaving it, the potential having changed sign in the meantime. In this way they succeeded in accelerating mercury ions to energies of 90,000 volts, merely to show that the method would work, and well knowing that such mercury ions are useless for nuclear disintegration work. The chief difficulty of extending that method to lighter particles and higher energies lies in the great speeds involved. For example, a proton, that is, a hydrogen nucleus, which has been accelerated by a potential of five million volts—or by an equivalent repeated application of smaller voltages—will have a speed of about 17,000 miles per second. Even if we allow that its average speed during acceleration is somewhat lower, it will travel fifty feet in one-millionth of a second. During this short time the electric potential must change a number of times if we are to get any real benefit from the multiple acceleration principle. In other words, we have to apply an electric potential which changes many million times in a second, as in a short-wave radio transmitter, and such transmitters, with the required power, did not exist in 1930.

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* Substance of a Friday Evening Discourse at the Royal Institution, delivered on May 11.

In order to accelerate protons to several million volts, Lawrence had to use a much longer path, of many hundred feet, and in order that the apparatus should be of manageable size he made the particles follow a circular path. The principle can be illustrated by a crude model in which there is a horizontal circular rail, pivoted so that it can be slightly tilted one way or the other, and by suitable manipulation a steel ball can be made to go round faster and faster until it jumps from the rail on account of its centrifugal force. To make a charged particle follow a circular path, a magnet is used. If a particle moves at right angles to the magnetic lines of force it will be pushed sideways at right angles to the lines and to its direction of motion; and, if the field is uniform, it will describe a circle in a plane perpendicular to the lines of force. The diameter of the circle is inversely proportional to the strength of the field and proportional to the speed of the particle; this latter fact is of decisive importance because it means that a particle always takes the same time for one circuit, whether its speed be high or low. Although at extremely high speeds, approaching that of light, this is no longer true, when Lawrence and Livingston built their first 'multiple magnetic resonance accelerator', or cyclotron as it was nicknamed, the constant time for one circuit greatly eased their task of design.

To produce economically the strong and extended magnetic field which is needed, one employs an electromagnet consisting of a suitably shaped core of soft steel surrounded by coils through which an electric current is passed. Its shape can be derived from two horseshoe magnets by appropriate deformation. Between the two horizontal circular pole-faces, where a fairly uniform magnetic field exists, the tank is inserted and thoroughly evacuated by continuously operating pumps so that the protons to be accelerated can move freely. The electric accelerating field is usually made between two hollow electrodes called 'dees' (because they are shaped like a D), which are connected to a short-wave generator with the power of a medium-sized radio transmitter and working at a frequency adjusted accurately so that the voltage changes sign in step with the protons going round. The protons, which are produced near the centre by passing fast electrons through hydrogen gas, are then pushed back and forth by the electric field between the 'dees', and at the same time their path is bent by the magnetic field; thus each proton describes a path which looks like a spiral but is more nearly a succession of larger and larger semi-circles. The acceleration ends when the proton gets near the edge of the magnet; hence bigger magnets are needed to make faster protons, since the intensity of the magnetic field is limited by saturation of the steel. The fast protons can be utilized either by inserting a target into the tank so as to intercept the protons at the desired speed, or else an electrically charged deflexion-plate can be employed to persuade a fraction of the protons to leave the magnet in a tangential beam so that experiments can be more conveniently done away from the magnet.

The particles most usually accelerated by a cyclotron are protons and deuterons, the nuclei of ordinary and heavy hydrogen, respectively. Although the latter forms a rare admixture—about one part in five thousand—of natural hydrogen, it is fairly easily separated and is nowadays marketed by the ton for nuclear fission piles. A cyclotron accelerating deuterons uses a few ounces a year.

A deuteron is composed of a proton and a neutron, and if a beam of deuterons impinges on a target made of a light element, it often happens that the proton sticks to a nucleus while the neutron goes on. The target thus becomes a source of neutrons, and by choosing the target element and varying the speed of the deuterons, the speed of the resulting neutrons can be adjusted within fairly wide limits. This feature is still valuable, although for sheer numbers produced a fission pile is now a much superior neutron source.

The impact of the deuteron may also result in the emission, not of a neutron, but of a proton, an alpha-particle (a fast helium nucleus) or some other nucleus. The distribution in energy and angle of those particles emitted provides valuable clues to the structure of nuclei and is being intensively studied. Furthermore, the nucleus left behind may in many cases be one of those which are not found in Nature, because they are intrinsically unstable, that is, radioactive. Indeed, one of the most important applications of cyclotrons is the production of artificial radioactive substances, for, though many of them can be made more cheaply by neutron bombardment in a fission pile, others still need to be made in a cyclotron.

The construction of cyclotrons for energies substantially higher than, say, ten million volts is made difficult by the fact that the mass of the particles increases with increasing energy, in accordance with the laws of relativity theory, and that the time taken for one whole turn increases in the same proportion. A proton of ten million volts energy is one per cent heavier than a slow proton and hence takes one per cent longer for each turn; at this stage a proton can still make a number of turns before it gets out of step. But at a hundred million volts the difference is ten per cent, and also many more turns are needed to achieve acceleration to such an energy. This problem is aggravated by the need of shaping the pole-faces so that the magnetic field decreases slightly from the centre to the edge. Such a decrease causes the lines of force to bend like the staves of a barrel, and this in turn has a beneficial 'focusing' effect on the particles: it deflects them back to the mid-plane between the pole-faces if, by starting obliquely or by being slightly deflected in flight, they have started to move towards one of the pole-faces. Without this focusing, practically all the particles would strike one or the other pole-face long before they are fully accelerated.

When Lawrence, shortly before the Second World War, started to build a giant cyclotron with a magnet weighing 4,000 tons and pole-pieces 15 ft. in diameter, many people doubted that he would be able to accelerate protons up to the edge of that magnet. Yet it was done, by using a high-frequency generator with variable frequency, containing a tuning condenser driven by an electric motor, so that the frequency goes up and down a thousand times a second. Most of the time the frequency is wrong; protons may start, but get out of step after a few turns. However, once in each cycle, the frequency decreases through its 'correct' value, and then a swarm of protons starts spiralling outwards. As they get faster they gradually take longer for each turn, but the electric waves, too, get slower, so the protons can remain in step. No careful adjustment is needed: if the protons are accelerated too rapidly, they begin to get out of step, and that automatically reduces their acceleration so that the tuning condenser can catch up with them. This self-synchronizing feature is extremely valuable, and indeed this so-called synchro-cyclotron (also termed frequency-modulated cyclotron) is much easier to operate than an ordinary one, where the frequency has to be very carefully adjusted. The biggest synchro-cyclotron at present in operation is in Chicago and generates protons of nearly 500 million volts.

Not only fast nuclei but also fast electrons are of interest to the nuclear physicist. Being negatively charged, they are not repelled by nuclei; on the other hand, they are found to have very little effect on them. But fast electrons can be used for making hard X-rays, which are very suitable for putting a well-defined amount of energy into a nucleus.

Electrons are much lighter than protons—about 1,800 times lighter—and can thus be easily accelerated to speeds close to that of light. At three million volts, an electron has 99 per cent of the speed of light. Any further voltage produces scarcely any increase of speed, but merely an increase of mass: the electrons are 'aggravated' rather than accelerated—though the latter term is still generally used. This nearly constant speed means that electrons can be accelerated on a fixed circle by an electric field of fixed frequency, but the magnetic field which bends their path into a circle must be made to increase rapidly with time, to keep them to the same circle in spite of their growing energy. Again, the system turns out to be self-synchronizing, and it has become known as the synchrotron. It was invented about 1945 by Weksler in the U.S.S.R. and independently by E. McMillan in the United States, who also built the first big one, for about 300 million volts, after a small one had been built and operated in Great Britain.

The synchrotron is capable of reaching higher energies than the earlier and somewhat similar betatron; but with both machines the radiation of electromagnetic waves from the circulating electrons rises very rapidly with increasing energy and sets a practicable limit somewhere about 500 million volts. This difficulty is avoided if the electrons are accelerated in a straight line; such an arrangement harks back to Lawrence's first multiple linear accelerator, but, in the meantime, the development of radar has made possible the generation of much higher frequencies at much greater power.

A modern linear accelerator for electrons (a proton accelerator has been built, but seems to have no great advantages) consists of a long evacuated tube through which electrons are pushed along by electromagnetic waves, much as a surf-rider is propelled by ocean waves. In order to adjust the speed of the waves to the correct value, the interior of the tube is 'corrugated' by the insertion of numerous metal irises, accurately machined and spaced. Several pilot models have been built and operated in Great Britain during the past few years, and machines for medical use are now under construction. A large linear accelerator, designed for producing electrons of 1,000 million volts, is partly completed in Stanford, California.

The chief object of these extreme-energy machines is the production and study of mesons, particles intermediate in mass between the electron and the proton. Yukawa pointed out in 1935 that the short-range forces, known to exist between the parts of a nucleus, suggested the existence of such intermediate particles, about two hundred times heavier than electrons. This theory, now widely accepted, does not suggest that mesons are actually present in nuclei. Theoreticians, if pressed on that point, like to say that the particles in a nucleus are held together by the exchange of virtual mesons. It is difficult to picture a virtual meson; perhaps I may suggest that the relation between a real and a virtual meson is the same as between a £5 note and an I.O.U. Like the latter, a virtual meson has a limited circulation; it can be exchanged only between particles in the same nucleus, which are, so to speak, held together by their mutual debts. If a nucleus is hit by a particle from outside, bringing a lot of energy with it, this sudden affluence may enable one or more of the particles in the nucleus to settle their debts and to escape. If the energy is big enough—some 200–300 million volts—then a real meson may appear. Under bombardment at such energies, mesons are indeed observed, usually through the characteristic tracks they form in special photographic emulsions; these tracks are intermediate between the fairly straight tracks formed by protons and the thin and rather curly ones formed by electrons.

It should be stressed that the theory of mesons is much more definite and clear-cut than my general description may suggest. It makes definite predictions relating the known properties of nuclei to the as yet unknown properties of mesons. To test those predictions, we have to study the velocities with which mesons emerge from a nucleus struck, say, by a fast proton, the effect of proton speed on the speed and number of mesons created, the interaction of mesons with matter through which they pass, and so on. We know already that there are at least three kinds of mesons with different mass, each of them unstable and prone to transform itself within a small fraction of a second into a lighter meson or an electron, or even into two photons (quanta of electromagnetic radiation). Thus there is a whole new world to be explored, a world of ghostly, fast-moving, short-lived particles, at the very fringe of our everyday world and yet perhaps essential for our understanding of why ordinary matter is what it is.

PRESERVATION OF BIOLOGICAL MATERIALS BY FREEZE-DRYING

During June 29–30 the Institute of Biology held a symposium on "Freezing and Drying" in the rooms of the Royal Institution. The first session, with Dr. R. I. N. Greaves in the chair, was devoted to consideration of the industrial applications of freeze-drying and its use in the preservation of food. E. W. Flosdorf surveyed methods current in the United States for the preparation of materials for large-scale drying, including pre-freezing and freezing *in situ*, and for the supplying of heat to the drying product by circulating hot water, direct electrical heating or infra-red radiation. A variety of systems for vacuum maintenance are in use, including oil pumps in conjunction with mechanically refrigerated condensers or direct pumping of the water vapour with multi-stage steam ejector pumps. Materials now available commercially in frozen-dried state in the Western hemisphere include human blood products such as immune serum globulins, enzymes, vitamins, antitoxins, antibiotics, hormones, veterinary vaccines, laboratory biological reagents such as complement, and food products, coffee, pineapple juice, orange juice and raw ground beef.

Application of the method to the production of antibiotics was discussed by J. H. Singer. The problem of maintenance of sterility has been overcome by fitting the trays of antibiotic (either in vials, or in bulk) with metal lids which can be raised hydraulically within the desiccator chamber by outside control. Bulk-drying procedures have been adopted for streptomycin calcium chloride and dihydrostreptomycin sulphate. Sterility is maintained by filling sterile stainless-steel trays *in situ* with a dispensing device delivering the correct quantity of sterile solution.

The high cost of production will almost certainly prevent the commercial utilization of freeze-drying for food preservation, but R. Gane showed that such varied materials as sliced apple, fruit juices, liquid egg, meat and fish can be dried without much difficulty. Reconstitution of meat and fish tends to be difficult, however, if the pieces are more than 1 cm. thick. Vegetables, such as peas, with an impermeable skin cannot be frozen by evaporation and pre-freezing, and grinding is essential. The immediate value of freeze-drying applied to food lies in its preparation for biochemical analysis. The last paper in this session, by L. G. Beckett and A. S. D. Barrett, was a consideration of physical aspects of the design of freeze-drying equipment with reference especially to vacuum technology.

Papers given in the second session, with Sir Alexander Fleming in the chair, concerned the preservation of mammalian cells, avian tissues and whole organisms at low temperatures. P. B. Medawar and R. E. Billingham showed that Malpighian cells of the epidermis of rabbit's ear skin could survive either very rapid *or* very slow freezing. These cells in grafts soaked in Ringer's solution did not survive slow thawing. Survival could be obtained, however, if the Ringer's solution contained 15 per cent glycerol. Suspensions of isolated epidermal cells would withstand slow freezing in this medium, but not in Ringer alone. It appears that slow freezing of skin grafts is, from all considerations, preferable to fast. B. J. Luyet, however, claimed that his results on the survival after freezing of muscle fibres, chick embryo amniotic muscle and heart, red blood cells, 'vinegar eels', frog spermatozoa, moss leaves and the epidermal cells of some plants confirm in general the predictions of the theory of vitrification by *rapid* cooling, especially with regard to (*a*) the necessity for a high freezing velocity together with subsequent rapid re-warming, (*b*) the beneficial effect of an initial reduction in water content, (*c*) the existence of a limited range of 'dangerous' temperatures, and (*d*) the innocuity of very low temperatures once they have been attained. He described techniques for the determination of cooling velocities which are capable of measuring speeds as high as 3×10^5 deg. C. per sec., and for obtaining such high velocities. R. D. Passey, L. Dmochowski and I. Lasnitzki discussed the freeze-drying of mouse tumours and the assessment of cell survival by growth of the rehydrated tissues in tissue culture or by grafting into susceptible mice. They stressed the need for reliable, non-destructive methods for the estimation of residual water in the dried tissue.

In the last paper of this session, A. S. Parkes gave the results obtained by himself and his collaborators (Miss A. U. Smith, C. Polge and H. A. Sloviter) on the survival after freezing of spermatozoa, endocrine tissue and red blood cells. Both fowl semen and bull and goat sperm withstood freezing in bulk to −79° C. in Ringer–glycerol and resumed full motility on thawing. Slow removal by dialysis of the glycerol from thawed fowl semen gave a sperm suspension with normal fertilizing power. The cumulus cells of rabbit ova grew in tissue culture after rapid (or slow) freezing of the ova in solid carbon dioxide or liquid air. Fragments of adult ovarian tissue similarly treated retained, after implantation, their endocrinological activity but the ova were destroyed. The freezing at −79° C. of whole rabbit or guinea pig blood diluted to a final concentration of 10–15 per cent glycerol was followed by recovery on thawing—even after three months of storage—and the glycerol could be removed by dialysis. The long-term storage of rare types of whole human blood and even of endocrinological 'spares' thus seems to be practicable.

The third session, with Dr. C. H. Andrewes in the chair, brought together papers on the freeze-drying of bacteria and viruses. R. M. Fry has found that suspending media for the drying of bacteria are improved by the addition of 5–10 per cent glucose or lactose, which he considers probably prevents the culture from being over-dried. In addition, a protective colloid is necessary for optimum results, and broth, serum, albumin, hæmoglobin or milk have been used. For especially delicate organisms such as *N. gonorrhœæ* and *V. choleræ* a mixture of one part nutrient broth and three parts human serum, and containing 7·5 per cent glucose, gives optimum results. Similar conclusions have been reached by H. Proom from his experience in the preservation of more than 2,500 bacterial strains. A drying temperature lower than −30° C. is found to be essential and, so far as storage loss is concerned, two factors are important, namely, residual water content and the presence or absence of oxygen. It is therefore recommended that cultures should be given a secondary drying, sealed in dry, oxygen-free nitrogen or *in vacuo* and stored at the lowest practicable temperature.

R. Daubney described the units at Abbassia, Cairo, for the production of vaccines for veterinary use. Rinderpest vaccine, which freeze-drying has made available at very low cost, has, in a few years, given life-long protection to millions of native cattle of such low economic value that they did not warrant the expense of immunization by older methods. Dr. Daubney discussed the factors of preparation—desiccation, including the rate of application of heat to the drying product; residual moisture and temperature of storage of the dried product—all of which determine to a more-or-less extent the overall loss in viability of the ultimate product.

I. A. Galloway, L. H. Collier and Wilson Smith contributed papers on problems they have encountered in drying viruses, vaccines and anti-sera, and

S. T. Cowan dealt with two aspects of infection in drying procedures: cross-infection in the vacuum chamber where different organisms are being dried at the same time, and human infection as a result of aerial contamination of the room in which ampoules are being filled or of lack of care in handling and opening dried cultures.

The final session, with Prof. J. F. Danielli in the chair, comprised four papers on tissue fixation by freezing and drying. I. Gersh stressed the importance of techniques which would preserve cell structure for specific purposes in a state which approximated as closely as possible to that which is obtained in the living state, and gave an example in the use of polyethylene glycol in the infiltration of dried tissues, such as adrenal, for the excellent preservation of lipids. The calculations of J. L. Stephenson have shown that the limiting factor in the speed of withdrawal of water from frozen tissues is not the size or design of the vacuum system but the resistance of the dry tissue mass to the passage of further water vapour.

The papers and illustrations of B. Sylven, of F. Sjöstrand and of L. G. Bell show, beyond doubt, that the disadvantages such as dissolution of cell contents, diffusion within the cell, chemical reaction and physical change of common fixing procedures can largely be avoided by freeze-drying. However, the cell proteins might still be denatured, and it is also most important both that the existence of ice-crystal artefacts should be recognized, and that subsequent cytochemical operations upon dried material should be carefully controlled.

Various aspects of the techniques were discussed, and the meetings may be considered to have served their purpose if, in the opening words of Dr. Greaves, "in the pooling of our ideas . . . our knowledge of this most useful technique may be advanced". The full proceedings of the symposium will be published by the Institute of Biology (Tavistock House South, Tavistock Square, London, W.C.1).

R. J. C. Harris

DRY OXIDATION AND WET CORROSION[*]

By Dr. U. R. EVANS, F.R.S.

Department of Metallurgy, University of Cambridge

TWENTY-FIVE years ago it was customary to draw a sharp contrast between high-temperature oxidation (then regarded as a simple example of direct combination between metal and non-metal) and wet corrosion at low temperature (a complex electrochemical phenomenon). The fact that the alloying constituents—chromium, aluminium and silicon—added to combat the first trouble often serve to prevent the second suggests that the two phenomena are not wholly disconnected. An attempt is made in this article to present an interpretation which covers them both.

High-temperature Oxidation. Metal heated in air becomes covered with an oxide film, which increases in thickness, rapidly at first, but then more slowly. The fact that the film continues to thicken at all indicates that either oxygen must cross it (moving inwards) or metal must cross it (moving outwards). It is now known that metal moves outward as cations and electrons; the electrons arriving at the outer surface convert any adsorbed oxygen atoms into ions, while the metallic cations take their place between them, giving an additional layer of oxide. Thus new oxide is built up continuously on the *outside* of the oxide-film. This outward movement of metal is met with also in the case of sulphide films and is responsible for the curious fact, recorded by Fischbeck and Dorner[1], that a copper wire exposed to liquid sulphur gives a *hollow tube* of sulphide.

Much evidence for outward movement was provided by Pfeil[2], while Wagner[3] and Mott[4] have put the matter on a quantitative footing. The oxidation-rate depends on the *electrical* properties of the *oxide*, and where these are known the oxidation-rate, calculated from electrical data, agrees well with that measured directly; the comparisons between calculated and measured values of film-growth provided by Wagner[3] include films not only of oxide but also of sulphide, bromide and iodide. Evidently, any film which resists the passage *either* of cations *or* of electrons should be protective; that is probably the cause of the protective quality of oxide films containing chromium, aluminium and silicon, and explains why, when these elements are added to iron and other metals, they confer resistance to high-temperature oxidation.

Oxygen in Wet Corrosion. The corrosion-velocity of metal immersed in water is connected with rate of replenishment of oxygen at the metallic surface and can be altered by moving the metal more quickly through the liquid or, under stagnant conditions, by increasing the oxygen-pressure in the gas mixture above the liquid. In general, the corrosion-velocity first increases with the rate of oxygen-replenishment, reaches a maximum and then decreases. For iron or zinc in neutral or weakly acid liquids, the maximum occurs at a high replenishment-rate, and under ordinary conditions oxygen is a 'stimulator' of corrosion. In alkaline liquids, the maximum occurs at a lower replenishment-rate[5] and oxygen can sometimes be regarded as an 'inhibitor'. Also, certain other inhibitors are only effective in presence of oxygen; the chalky protective film, which allows some hard waters to be run through steel pipes without bad results, is only satisfactorily produced in the presence of oxygen; Haase[6] states that organic reducing-agents interfere with its formation and should be destroyed with hypochlorous acid. For stainless steel[7] and aluminium[8], oxygen often reduces the corrosion-velocity—even in acid solutions.

When pure iron[9] or zinc[10] is whirled rapidly in pure distilled water containing oxygen, it undergoes no appreciable change and no visible corrosion-product appears in the liquid; placed in the same water containing the same oxygen under stagnant condition, iron soon develops rusty spots and zinc develops white spots, below which pits are found. Under whirling conditions the rate of replenishment of oxygen is high, permitting an invisible oxide-film to be formed by the outward movement of cations and electrons indicated above; the rate of thickening becomes extremely slow at a very low value of the thickness—the film being still invisible. (The film formed on unheated metal exposed to dry air is also invisible; the oxidation, which can be detected gravimetrically, electrometrically or optically, probably occurs mainly at sensitive spots—a term explained below—and soon becomes extremely slow.)

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[*] Substance of a lecture delivered at a joint meeting of the Chemical Society (London) and the University of Birmingham Chemical Society, held in the Chemical Lecture Theatre, University of Birmingham, on October 26.

If, however, zinc is immersed in stagnant water, the replenishment-rate of oxygen becomes low; there is now a risk that at 'sensitive' spots cations may arrive at the external surface more quickly than oxygen arrives and can then escape into the liquid as hydrated ions, so that local corrosion, leading to pitting, occurs; a sensitive spot may be a place where the film is thin or cracked or rich in lattice defects, or a point where, owing to local strain in the metal, there is an abnormally high supply of high-energy cations which can move outwards more quickly than they can be 'arrested' by the oxygen. If the material is stainless steel or aluminium, and builds a highly protective film-substance, a much slower replenishment-rate suffices to ensure the arrest of the outward-moving cations, and it is not necessary to 'whirl' the specimens in order to avoid corrosion; nevertheless, oxygen is needed, and some liquids, which do not normally attack stainless steel or aluminium, produce corrosion if all the oxygen is eliminated. We see why those elements (for example, aluminium, chromium and silicon) which confer resistance to high-temperature oxidation, often confer resistance to low-temperature wet corrosion, and also why corrosion sometimes starts at crevices inaccessible to oxygen.

Electrochemical Mechanism. If on zinc or iron placed in a dilute salt solution the oxygen replenishment is insufficient to arrest the emerging cations at a sensitive spot, they will emerge into the liquid as hydrated ions (unless the liquid contains an anion forming a nearly insoluble salt, or a substance which prevents emergence in some other way). However, the emergence of cations must leave an excess of electrons in the metal, and the negative charge would halt the process unless the electrons were used up in reducing oxygen, either to hydrogen peroxide or to hydroxyl. A rate of oxygen-replenishment which is insufficient to arrest the cations emerging at the sensitive spot may nevertheless serve to use up the electrons left in the metal, since this can occur anywhere on a relatively large area around the sensitive spot. The two reactions can proceed without hindrance—the 'anodic reaction' (the passage of cations into the liquid at the sensitive spot), and the 'cathodic reaction' (the reduction of oxygen at the area around it); the migration of anions and cations through the liquid towards the anodic and cathodic areas prevents accumulation of charge anywhere.

Thus we have arrived—by an unfamiliar argument—at the well-accepted electrochemical mechanism of corrosion. The idea that the 'film theory' and the 'electrochemical theory' are rivals is clearly wrong; each expresses the same essential idea—approached from a different angle. It may be doubted, however, whether the word 'theory' should be applied to the electrochemical mechanism, which is to-day established on a firm experimental basis; the currents passing between cathodic and anodic areas have been measured by six independent experimental methods and been found equivalent to the corrosion-velocity measured chemically or gravimetrically.

Inhibitors. With iron in saline water (say, a dilute sodium chloride solution), very rapid whirling is needed before oxygen can act as an inhibitor[11]. Normally, oxygen helps the corrosion both of iron or zinc, since the corrosion products (iron or zinc chloride at the anodes, and sodium hydroxide at the cathodes) are freely soluble, and the solid oxides or hydroxides (rust in the case of iron) are only precipitated where they meet at a perceptible distance from the corrosion site. But if sodium phosphate or sodium hydroxide is present, a supply of oxygen otherwise insufficient may now suffice to stop attack, since any cations which are not arrested by the oxygen can be arrested by the phosphate or hydroxyl ions. Thus Mayne and Menter[12] have found, by electron diffraction, that the invisible protective film formed on iron placed in sodium orthophosphate solution containing oxygen consists partly of gamma-ferric oxide and partly of hydrated ferric phosphate. Likewise, Pryor and Cohen[13] have shown that, in the *p*H-range between 7·2 and 10·0, phosphates completely prevent corrosion in the presence of oxygen but fail to prevent it if oxygen is absent. The amount of phosphate—or other inhibitor—has to be increased if chlorides are present.

Corrosion by aqueous solutions is complicated by the fact that these always contain hydroxyl ions which may serve to arrest emergent cations under some conditions, since the hydroxides of most heavy metals are sparingly soluble. As to whether a solution of sodium chloride (or sulphate) will attack a metal, producing its soluble chloride (or sulphate), or build a protective layer of hydroxide (or oxide), depends largely on the *p*H value, which may itself be changed by the incipient reactions. The principles involved are discussed elsewhere[14]. Evidently, although there are analogies between high-temperature oxidation and wet corrosion, there are also differences.

Effect of Sulphur. It has been shown why certain alloying additions (chromium, aluminium and silicon) which retard high-temperature oxygen often prevent low-temperature wet corrosion. The same reasoning shows why certain other elements, particularly sulphur, enhance both types of attack. Copper, like most other metals, suffers no visible change if exposed to pure air at ordinary temperatures; a film is formed, but its rate of thickening becomes very slow while it is still invisible[15]. However, copper exposed to air containing a trace of hydrogen sulphide gives the same sequence of interference tints as is obtained in pure air at a slightly raised temperature[16,17]. The presence of foreign (sulphur) atoms in the oxide film favours the lattice defects and allows more rapid passage outwards, so that 'visible' thicknesses are reached at ordinary temperatures; other sulphur compounds present in town air enhance atmospheric attack. Sulphur plays a similar part in promoting wet corrosion. A polished iron specimen placed in a solution containing sodium chloride with sufficient inhibitor (sodium carbonate) to prevent corrosion over the greater part of the surface is nevertheless attacked locally around sulphide particles; inclusions of silicate and alumina do not act as sensitive spots[18]. The phenomenon is not shown by coarsely abraded iron, since the deformed material then provides sensitive spots which mask the effect of the sulphide inclusions.

Effect of Impurities. Atoms of a foreign metal can greatly reduce the protective character of an alumina film. A copper–aluminium alloy, if first heated under very feebly oxidizing conditions to produce an alumina film free from copper, shows far greater resistance when afterwards heated in oxygen than the alloy which is exposed to the strongly oxidizing conditions from the first—since, then, the film consists of alumina with copper oxide in solid solution[19]. Similarly, commercial aluminium containing iron and other impurities is much more attacked by citric acid containing sodium chloride than pure aluminium, which forms a highly protective film; in the latter case the attack is localized[8] and may take the form of pitting, so that purity is not always an advantage.

It should be added, however, that this is not the only reason why impure metals are sometimes corroded more quickly than pure metals. Commercial zinc is attacked more rapidly by acids than pure zinc because the metallic impurities, passing into solution, are reprecipitated to form cathodes of low 'overpotential', on which hydrogen can readily be liberated.

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OBITUARIES

Dr. Harald Blegvad

The science of marine biology has suffered a great loss by the death on August 22 of the director of the Danish Biological Station, Dr. Harald Blegvad. Blegvad was born on the small Danish island, Samsø, on July 24, 1886. When he had matriculated at the University of Copenhagen in 1904, he took up the study of natural history; he took the degree of M.Sc. in 1910 and in 1921 he obtained a doctorate for a thesis on the biology of some coastal Gammarids and Mysids.

Already as a student he took part in cruises with Danish research vessels in home waters and in the Atlantic. In 1908 he became assistant at the Danish Biological Station, and in 1931 he succeeded A. C. Johansen as director of the Station.

Blegvad's scientific work centred upon the study of the biology of the marketable fishes and of their food organisms. The long series of papers from his hand bear evidence to his keen eye for the essential points of the problems, and further of his clear understanding of what conclusions the material available allowed. His papers show that he possessed that sober self-criticism which is so indispensable to all true scientific work.

Blegvad combined science and practice, and his services to the fishery industry were manifold. He worked on the transplantations of plaice and cod, on the protection of fishes, and, on trips with fishing vessels, he tried new gear and helped the fishermen to find new fishing grounds. Through his personal contact with fishermen and by publishing popular articles and handbooks, he caused a growing understanding of the value of biological science to the fishery industry.

In the work of the International Council for the Exploration of the Sea, Blegvad played a great part; during 1931–45 he was chairman of the Transition Area Committee and since 1945 he had been general secretary to the Council.

As a result of his international reputation as a fishery expert, Blegvad was often called upon by foreign governments which wished to re-organize their fisheries. In 1928 he acted as fishery expert in Lithuania, during 1936–38 he was for two half-years in Persia, and in 1949 he worked for the Government of Ceylon.

By his friends and colleagues Blegvad was much appreciated for his fine, human qualities. He was kind, true and helpful, and his sudden death by heart-failure caused widespread regret.

Erik M. Poulsen

Dr. E. G. V. Percival

The death of Dr. E. G. V. Percival at Edinburgh on September 27, at the early age of forty-three, at the height of his powers as a teacher and investigator, is a serious loss to organic chemistry.

Edmund George Vincent Percival was born at Coalville in 1907 and was educated at King Edward VII Grammar School, Coalville, and at the University of Birmingham. After a brilliant undergraduate career he joined Dr. (now Prof.) W. Wardlaw in researches in inorganic chemistry. This experience was followed by a period with Prof. Harold Hibbert at McGill University, Montreal, where he undertook physico-chemical investigations in the field of cellulose chemistry.

With this wide background Percival returned to Birmingham as research fellow in Sir Norman Haworth's laboratories, where he speedily acquired the interest in carbohydrate chemistry which he maintained so vigorously to the end of his life. In 1933 he was appointed lecturer in chemistry in the University of Edinburgh, and was promoted to a readership in 1948. He was a member of the Faculty of Science, a director of studies and in 1951 he was elected a member of the Senatus Academicus. In addition to his University work, Percival gave generously of his services to the Royal Institute of Chemistry, the fellowship of which he had gained in 1936, and to the Society of Chemical Industry. He became a fellow of the Royal Society of Edinburgh in 1938. For many years he took an active interest in the work of the Pharmaceutical Society and of the Scottish Seaweed Research Association. In 1948, when the annual meeting of the Society of Chemical Industry was held in Edinburgh, and again in 1951 on the occasion of the meeting of the British Association, he played a notable part in securing the success of the local arrangements. He served with distinction on many committees, and at the time of his death he was a member of Council of the Chemical Society.

His interests were wide, including travel, gardening, tennis and cricket. He was an inspiring teacher and director of research, fertile in ideas and energetic in their development. In all his dealings he was supremely generous, and his kindness, understanding and loyalty endeared him to his many friends and colleagues.

Percival was the author of some seventy papers, dealing with the chemistry of the sugars. Among his achievements special mention may be made of his part in the elucidation of the structure of vitamin C, his work on the ring structure of osazones, on the alkali addition compounds of the sugars, on the molecular structure of plant seed mucilages, seaweed polysaccharides (notably agar, fucoidin and laminarin) and the naturally occurring fructosans. In all these subjects he had become a recognized authority, and his book (1950) on the "Structural Chemistry of the Carbohydrates" is a model of its kind.

In 1934 he married E. Elizabeth Kempson, herself a chemist who has collaborated in many of these investigations. She and their two children survive him.

E. L. Hirst

We regret to announce the following deaths:

Prof. R. B. Denison, formerly principal of Natal University College, and president in 1918 of the South African Chemical Institute.

Prof. Allan Ferguson, until 1945 assistant professor of physics in Queen Mary College, University of London, on November 9, aged seventy-one.

Prof. R. Sekiguti, lately director of the Tokyo Observatory, on August 10.

NEWS and VIEWS

Royal Society: Medal Awards for 1951

The following awards of medals have been made by the president and the Council of the Royal Society:

Copley Medal to Prof. D. Keilin, Quick professor of biology and director of the Molteno Institute, University of Cambridge, for his fundamental researches in the fields of protozoology, entomology and the biochemistry of enzymes.

Davy Medal to Sir Eric Rideal, professor of chemistry in King's College, University of London, for his distinguished contributions to the subject of surface chemistry.

Hughes Medal to Prof. H. A. Kramers, professor of theoretical physics in the Technical University, Delft, for his distinguished work on the quantum theory, particularly its application to the optical and magnetic properties of matter.

Physics at Leeds: Dr. J. G. Wilson

Dr. John Graham Wilson, reader in physics in the University of Manchester, has been appointed to the second professorship of physics at Leeds (rendered vacant by the succession of Prof. E. C. Stoner to the Cavendish chair, also at Leeds, on the retirement of Prof. R. Whiddington), and is to take up his new duties in June 1952. Dr. Wilson was born at West Hartlepool, Durham, in 1911, and was educated at the Grammar School there and at Sidney Sussex College, Cambridge. He carried out research for three years at the Cavendish Laboratory, Cambridge, under the direction of C. T. R. Wilson. He then joined P. M. S. Blackett as research assistant at Birkbeck College, London, and was later appointed assistant lecturer in the University of Manchester (1938). During the Second World War he was with the Air Ministry and the Ministry of Aircraft Production.

Dr. Wilson's first research was concerned with the development of new forms of expansion apparatus, which figured largely in his pre-war work on cosmic ray physics. He developed new methods of temperature control which made possible high-precision measurements of momentum above and below an absorbing plate placed in a cloud chamber, and, with Blackett, he made extensive measurements of the energy loss of cosmic ray particles in such plates. Since the War, his immediate work has mainly been in the design, construction and application of the momentum spectrograph for cosmic ray particles which has been built in Manchester. In addition to his papers, Dr. Wilson has written a valuable specialist book, "Principles of Cloud Chamber Technique", and an eminently readable general book, "About Cosmic Rays", and he has edited a volume on "Progress in Cosmic Ray Physics" which is to be published shortly. At Leeds, where most of the research is concerned with the solid state, in its atomic and electronic aspects, Dr. Wilson will greatly strengthen the representation of nuclear physics in the Physics Department. At the same time his keen interest in work with undergraduates will do much to ensure the maintenance of a proper balance between teaching and research.

Veterinary Science in the University of Queensland: Prof. John Francis

It is announced that Mr. John Francis has been appointed to the newly-established chair of preventive medicine within the Veterinary Faculty of the University of Queensland. This is the second professorship to be filled since the full five-year veterinary course was re-established in 1950, the earlier one being in animal husbandry (see *Nature*, 166, 136; 1950). The designation of the two senior research and teaching posts within the young faculty in this manner serves to emphasize the present trend in veterinary science. The aim of reducing economic loss and animal suffering is being met by an increased application of pathological and bacteriological knowledge to the prevention of disease, while recent advances in animal physiology and genetics are being applied to increase the efficiency of animal production. Queensland, with nearly eight million cattle, eighteen million sheep and more pigs than any other State of the Commonwealth, and with the majority of its stock within the tropics, possesses many important unsolved epizootiological and ecological problems. The shortage of veterinarians is acute in every Australian State; but it is believed that the development of the Veterinary School of the University of Queensland will in time greatly help to overcome this.

Mr. Francis graduated from the Royal Veterinary College in 1938, having concurrently taken the B.Sc. degree of the University of London. He was for a year demonstrator in bacteriology at the Royal Veterinary College before becoming a research officer at the Foot and Mouth Research Station, Pirbright. In 1943 he joined the Biological Department of Imperial Chemical Industries, Ltd., and studied the metabolism and antibacterial action of the sulphonamides and sulphones. This work has led to a better understanding of their application in veterinary medicine, and also to the use of 4 : 4′-diamino diphenyl sulphone for the treatment of leprosy; this sulphone is the first effective drug cheap enough to be used on a wide scale. The isolation of the growth-factor for *Myco. johnei*, first demonstrated by Twort and Ingram in 1913, has added to our knowledge of the acid-fast bacteria and may assist in the development of chemotherapeutic substances. In addition to his main work on the application of chemotherapy to veterinary medicine, Mr. Francis has developed a keen interest in many problems of epizootiology. This has been shown in recent years in his studies of bovine tuberculosis and the relationship of the bovine disease to that in man, on which he published a book in 1947. He was a delegate to the World Health Organization conference in Geneva last year, where recommendations were made for the control of 'zoonoses', or animal diseases transmissible to man.

Scientific Workers and Defence Research in the United States

A STATEMENT on scientific workers and mobilization, issued on September 12 by the Science Advisory Committee of the United States Office of Defense Mobilization, makes a number of suggestions regarding the participation of universities or academic men of science in research on defence in America. The Department of Defense has already expanded its research and development to more than double that of the late 1940's, mainly in industry and government laboratories, and only about 10 per cent of it represents work done on contract with universities. The statement expresses the view that the major part of the academic research effort of the United States should, in present circumstances, continue to be devoted to fundamental research, but that there should be an appropriate balance between academic science and the abnormal and immediate demands of military problems. A substantial portion of the academic effort should accordingly be devoted to urgent defence needs and to building up throughout the academic community a widespread knowledge of the scientific problems of defence and a reserve of scientific workers to meet emergencies.

The statement suggests that outstanding men should be made available to projects which analyse military objectives in a broad area of technology and possible means of achieving them, and also to other defence activities where they can simultaneously learn research needs by participating in them. Specially qualified leaders should be given leave of absence to take positions in the Department of Defense and other government agencies which will familiarize them with the problems needing attention. Universities and colleges, it is suggested, should welcome opportunities for joint projects. To a considerable extent the best place for an individual scientific worker depends on whether his own interest and aptitude are for fundamental research and teaching or for applied research or administrative work on defence projects. Periods of leave for such defence work should be of specified duration, both to prevent undue interruption of an individual's normal activities and to spread participation in defence research. The importance to the United States of research and teaching is a major consideration. With these conditions the Committee believes that research and teaching activities would also benefit by widening the experience of scientific workers. The signatories to the statement include the chairman, Dr. Oliver E. Buckley, and Dr. D. W. Bronk, Dr. L. Dubridge, Dr. J. R. Killian, Dr. R. F. Loeb, Dr. J. B. Conant, Dr. J. R. Oppenheimer, Dr. C. A. Thomas, Dr. A. Waterman, Dr. H. Dryden and Dr. W. Whitman.

French Palæontological Documentation and Translation Service

THE Centre d'Études et de Documentation Paléontologiques, Muséum d'Histoire Naturelle, Paris, was set up in 1947 with the aim of providing the palæontological documentation required by the modern research worker in the different branches of the sciences of the earth. In addition to supplying general bibliographical information, the Centre has developed its translation service and provides, for scientific workers in France and elsewhere, French translations of recent publications in other languages, in particular, in Dutch, German, Polish and Russian. It has concentrated on the two types of translation: articles on subjects which are of particular interest at the present time, such as tectonics (and in particular neotectonics), sedimentation, the Quaternary era and evolution; and, within the field of palæontology, translation of works on systematics, especially of those written in Russian, in order that descriptions of new forms should be readily available. So far, nearly four hundred translations have been made, 80 per cent of them being of Russian, Polish or Dutch works. The three-monthly bulletin published by the Centre gives the titles of the new translations as they are prepared, and complete lists of all the translations made since the Centre was set up can also be obtained. At the request of other organizations or research workers, the Centre also carries out special translations, and these and the diagrams can be easily reproduced. The charges for reproductions of translations are approximately 10*d*. per page of text, plus 2*d*.–1*s*. each for photostats of the diagrams, depending on the size. Further information can be obtained from J. Roger, Centre d'Études et de Documentation Paléontologiques, 3 Place Valhubert, Paris 5e.

Preparation of Manuscript for Publication

UNDER the title "Preparing Technical Material for Publication; a Manual for Authors of College and Station Publications", the University of Illinois Engineering Experiment Station has issued as Circular Series No. 62 (pp. 39; Urbana: University of Illinois, 1951; 60 cents) a revised and enlarged edition of the manual "Preparation of Manuscript" published by the Station fifteen years ago. It deals especially with the publications issued by the Experiment Station and by the College of Engineering, alone or in collaboration with other divisions of the University, including recommendations for the preparation of manuscript and illustrations and also for proof-reading. Much of the material, particularly in the first three chapters relating to the range and form of publications issued by the Station and College, is concerned with the characteristic style or form of those publications; but the succeeding chapters, dealing with content and preparation of copy, contain comments and observations of general validity. While much of this is thoroughly sound, there is little to justify commending the manual to British, as distinct from American, writers, particularly in view of the recent flow of British publications of this type, among which it should suffice to mention the "General Notes on the Preparation of Scientific Papers" issued last year by the Royal Society and which itself gives a representative list of British reference books. The bibliography included in the Illinois manual is entirely American and, even so, omits two of the best American books: S. F. Trelease's "The Scientific Paper" and J. R. Nelson's "Writing the Technical Report". There is a further reason for caution in recommending this manual to British readers. While the principles of arrangement and construction are independent of language, when it comes to the handling of words, the fact that the manual is written in English can disguise the truth that British and American writers are really dealing with two different languages. The same words quite commonly have different meanings or nuances. This is apt to give the impression, which sometimes may be quite mistaken, that American writers do not handle their tools with the same precision or show the same regard for style as their British confrères.

Physical Society: Meeting at Southampton

The autumn provincial meeting of the Physical Society will be held in the Physics Department of University College, Southampton, during December 18–19. The meeting will be divided into three sessions on the following subjects under the direction of the persons indicated: (1) optics of metals (Prof. A. M. Taylor); (2) thermal properties and growth of crystals (Mr. S. Weintroub); and (3) complex spectra and nuclear structure (Prof. H. A. Jahn). In addition to contributions from the Departments of Mathematics and Physics of University College, Southampton, papers will be presented by members of the Physics Departments of the Universities of Birmingham, Bristol, London (Royal Holloway College and Guy's Hospital), Oxford and Reading, and of the South-West Essex Technical College, Walthamstow, the Atomic Energy Research Establishment, the Telecommunications Research Establishment, the British Scientific Instrument Research Association, and Hilger and Watts, Ltd. The meeting is open to non-members of the Society. Application forms and further information can be obtained from the Secretary-Editor of the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

Awards for Technical Writing on Radio

To encourage the writing and publication of articles reporting technical progress and development in radio and electronics in Great Britain, the Radio Industry Council is to award premiums of twenty-five guineas each, up to an average of six a year, to the writers of published articles which, in the opinion of a panel of judges, deserve to be commended by the industry. It is hoped in this way gradually to increase the number and standard of articles available to editors. Any non-professional writer will be eligible, and the awards will be made for articles published in Great Britain or abroad in papers or periodicals which can be bought by the public on the bookstalls or by subscription. Writers and editors will be invited to submit published articles to the Secretary, Radio Industry Council, 59 Russell Square, London, W.C.1 (if possible, five copies of the journal, proofs or reprints), for consideration. The judges will be asked broadly to take into consideration the value of an article in making known British achievement in radio and electronics, originality of subject, technical interest and presentation and clarity. The judges will be four members of the Radio Industry Council, and Prof. Willis Jackson, professor of electrical engineering, Imperial College of Science and Technology, University of London, assisted by the editors of *Wireless World* and *Electronic Engineering*.

Gas Council Research Committee

Additions to the membership of the Gas Council Research Committee have been appointed as follows: J. H. Dyde, president of the Institution of Gas Engineers; G. le B. Diamond, chairman of the West Midlands Gas Board; Prof. F. H. Garner, professor of chemical engineering, University of Birmingham, and part-time member of the West Midlands Gas Board; and Dr. F. J. Dent, director of the Gas Council Birmingham Research Station. The Committee was established in September of last year with the responsibility of advising the Gas Council on all matters connected with research, drawing up programmes and reviewing progress from time to time.

Announcements

The American Society for the Study of Sterility is offering a prize, with a cash award of 1,000 dollars, for the most outstanding contribution to the subject of infertility and sterility, as judged from among essays submitted for this competition, which must be received not later than March 1, 1952. Further particulars can be obtained from the Society at 20 Magnolia Terrace, Springfield, Massachusetts.

Applications for grants from the Clough Memorial Research Fund of the Edinburgh Geological Society are invited for the period April 1, 1952–March 31, 1953. This Fund was instituted in 1935 for the purpose of encouraging geological research in Scotland and the North of England, the latter being defined as comprising the counties of Northumberland, Durham, Cumberland, Westmorland and Yorkshire. Applications must be in the hands of the Secretary, Clough Memorial Research Fund Committee, Edinburgh Geological Society, Synod Hall, Castle Terrace, Edinburgh, 1, not later than March 1, 1952.

The Institution of Naval Architects has made the following awards: 1851 Exhibition Commissioners Postgraduate Research Scholarship in Naval Architecture (1949), of £500 a year, to I. M. Yuille, for one further year; Sir William White Postgraduate Scholarship in Naval Architecture (1951), of £150 a year for two years, to M. C. Eames, of King's College, Newcastle upon Tyne; Aluminium Development Association Research Scholarship in the Application of Light Alloys to Ship Construction (1949), of £400 a year, to J. B. Caldwell for one further year; Elgar Scholarship in Naval Architecture (1951), of £175 a year for four years at the University of Glasgow, to R. R. Phillips, of H.M. Dockyard, Devonport; Vickers-Armstrongs Scholarship in Naval Architecture (1951), of £220 a year for three years at King's College, Newcastle upon Tyne, to G. A. Smith, of Aldous Successors, Brightlingsea.

PRE-BREAKDOWN DISCHARGES IN D.C. POSITIVE POINT TO PLANE CORONA

By H. M. GAUNT and DR. J. D. CRAGGS
Department of Electrical Engineering, University of Liverpool

PREVIOUS workers[1-4] have shown that D.C. positive point to plane corona in air and in other gases of moderate purity consists of several forms of discharge. These are, in order of appearance with increasing voltage, burst pulses and pre-onset streamers, burst corona and finally streamers the lengths of which increase with voltage until one of them crosses the gap and gives rise to a spark.

Recently it has become apparent that a further discharge is present in conditions suitable for streamer formation. In D.C. coronas, this discharge is of a filamentary nature, and, it is submitted, should be clearly distinguished from streamer discharges. It will be referred to in this article as the 'filamentary' or 'diffuse discharge'.

Discharges have been found in impulse corona, mainly by Saxe[5,6], Komelkov[7,8] and others[9-11] which differ from the classical streamers[1-4,12]. Confusions in nomenclature have arisen; but in the present discussion a streamer is taken to be a filamentary discharge which, on crossing the discharge gap, leads to a breakdown.

Discharges in air. A photograph of pre-breakdown corona in air, taken with a small aperture and long exposure, is shown in Fig. 1. Three distinct regions are visible: (*a*) a very intense glow, localized at the point surface; (*b*) an intense discharge directed outwards from the point in a straight line along the axis of the gap with a fairly sharp termination; and (*c*) a fainter continuation of zone *b* which spreads out into a diffuse luminous cone; only the more intense part of the latter discharge is visible in Fig. 1 because of the small aperture used. (*a*) is probably a region in which a succession of avalanches moves into the point, as in burst corona; (*b*) is the region of the pre-breakdown streamers which are limited in extent to the high-field region around the point; and (*c*) shows the diffuse discharges which have a filamentary structure.

The electrode geometry has little effect on the discharge.

The filamentary discharge (*c* above) has been studied with a photomultiplier – video amplifier – oscillograph technique. Light pulses from two small regions of the discharge, one near the streamers and one near the plane, have been displayed on the oscillograph screen so that, knowing the distance apart of the two observed regions and the time displacement of the pulses observed on the screen, the velocity of propagation of the filamentary discharges towards the plane could be measured. The mean velocity across the gap was thus found to be $\sim 10^7$ cm./sec., which is of the same order as the lower published values for streamer velocities.

A further experiment was carried out to test for simultaneity of the streamers and the filamentary discharge. A photomultiplier tube and amplifier were used for displaying light pulses from the streamers on one beam of a double-beam oscilloscope, while another photomultiplier and amplifier displayed light pulses from the filamentary discharge on the other beam. The coincidences of the pulses showed that the streamers and the filamentary discharge occurred more or less simultaneously.

Light pulses from two separate parts of the filamentary discharge, situated on opposite sides of the axis, were recorded with the above apparatus. Simultaneous pulses showed that many filaments are propagated at once. These experiments suggest that the discharge consists of an intense streamer extending

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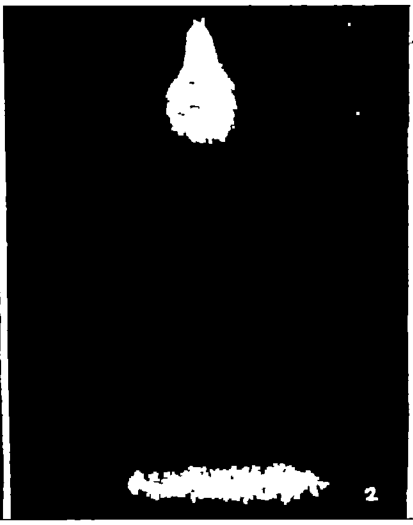
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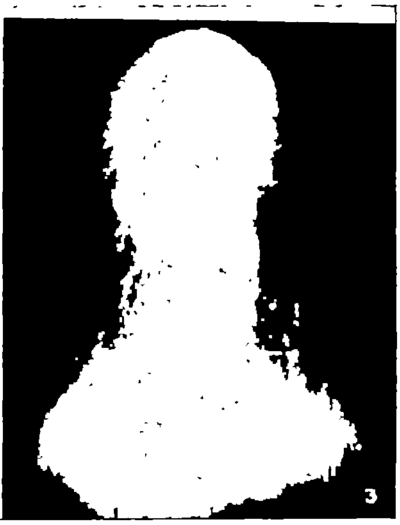
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Fig.	Gas	Gap length (cm.)	Point diam. (mm.)	Camera exposure	Voltage of fig. (kV.)	Sparking voltage (kV.)
1	Air	5·6	1·5	60 sec. : *f*/6·3	34	37
2	Nitrogen	7	0·2	2 sec. : *f*/1·5	36·5	37
3	Argon	5·8	0·2	5 sec. : *f*/1·5	—	—

a few millimetres from the point with many less intense filaments being propagated from the streamer to the plane, with a possible continuous luminous background. The whole discharge occurs in about a microsecond, repeating every few hundred microseconds.

If the voltage drop along the streamer is negligible, the applied voltage will appear across the filamentary discharge. In typical conditions, some 30 kV. is thus applied to filaments about 5 cm. long so that the mean potential gradient is roughly 6 kV./cm., to be compared with Komelkov's figure[8] of 6–8 kV./cm.

Discharges in nitrogen. The appearance of the corona discharge near spark breakdown in nitrogen differs greatly from that in air. The streamers in nitrogen are much longer and more erratic than in air and are often branched at their extremities (Fig. 2). In nitrogen of commercial purity, the filaments in the filamentary discharge are apparently fewer and less diffuse than in air; there is also a large increase in intensity of the filaments very near the plane (Fig. 2), although occasionally this increased intensity occurs along about 3–4 mm. of filament.

The addition of a few per cent of air shortened the streamers and tended to concentrate them along the axis. Ultimately, as the proportion of air increased the discharge tended gradually to that observed with air.

Discharges in argon. The corona in argon resembled that in nitrogen, showing long erratic streamers, in general agreement with Weissler[4]. The filaments were intense in regions very near the surface of the plane electrode (Fig. 3).

The effect of adding air was less than might be expected from Weissler's results[4], since several per cent of this contaminant merely produced a slight rise in starting voltage and little alteration in the appearance of the discharge.

Discharges in oxygen. The corona in oxygen was very faint, as in hydrogen, even though the applied voltage was about 65 kV. compared with 30 kV. in the other gases. Streamers were visible before breakdown, extending a few millimetres from the point as in air. The filamentary discharge was invisible except for a faint glow near the tips of the streamers and a glow near the plane electrode which was so faint that it was scarcely visible.

Discussion. If the discharges referred to above as 'streamers' are those of the Loeb–Meek–Raether theory, as seems likely since the filaments bridge the gap without causing spark breakdown, then it is desirable to seek a mechanism for the filaments. This point will be discussed later; but for the moment it will be assumed that the streamer theory is not applicable to the filamentary discharge. At present it does not seem possible to formulate a definite mechanism, and this discussion will be concerned with certain suggestions and general tentative conclusions.

The filamentary structure of the discharge, its high velocity of propagation, and the direction of propagation of the filaments all suggest a streamer type of mechanism. The tendency to follow lines of force, the lack of spark breakdown when the filaments bridge the gap, the low intensity and, possibly, the high axial potential gradients suggest that the filaments have lower ion densities than streamers, resulting in less field distortion.

The increased luminosity near the plane can be readily explained if the discharge does, in fact, consist of continuous conducting filaments, since the field between the tip of a filament and the plane cathode will be high when the distance between them is small. This field intensity may be high enough to permit true streamers to be formed near the plane, or may merely increase the intensity of the filaments. Photoemission from the plane probably contributes. It also seems possible that the enhanced intensity is due to a negative leader[10,11] developing from the cathode.

It is known[12–15] that there exists, in certain gaseous discharges, photons which are absorbed less readily than those usually considered to be involved in streamer propagation[13]. Any such photons produced by a streamer will probably cause weak ionization at appreciable distances from the streamer tip. Any photoelectrons so produced will move slowly towards the point, and such of these photoelectrons as find themselves near the tip of the filament may create avalanches which feed into the filaments. It seems possible that it is these avalanches, initiated by the streamer or burst corona, that enable the filaments to be propagated in low fields.

Loeb[14] discusses this discharge in pre-onset D.C. corona, but does not refer to its filamentary structure; and indeed it would be very difficult to observe such a structure in the small pre-onset discharges. He suggests that the discharge is caused by photon absorption some distance from the main streamer channel, and that the photoelectrons so produced move towards the streamer channel along the lines of force, ionizing and exciting atoms in their path. This would give rise to an extended diffuse glow and is inconsistent with many properties of the discharge.

In impulse corona, Saxe and Meek[5,6] have also suggested that the discharge consists of a zone of continuous ionization. Their photomultiplier technique could not by itself reveal the filamentary structure which is apparent in photographic work by Allibone and Meek[16], Garfitt and Meek[17] and others[7,8,11,18].

Other authors[7,8,18] apparently consider that the theory of streamer propagation[13] applies to the filaments and that the breakdown streamer (or leader stroke) is, in some way, formed from these filaments. If this view be accepted, it becomes difficult to account for the absence of a spark when the filaments bridge the gap, which they do at voltages considerably below the sparking potential.

Conclusions. It is now fairly well established that there exists a filamentary but extensive discharge apparently associated with the streamer discharge in inhomogeneous field breakdown.

Since the above work was completed, more than a year ago, new data on breakdown processes in uniform field gaps at high pressures (some hundreds of millimetres of mercury) have been obtained by Fisher and Bederson[19,20] and by Llewellyn Jones and Parker[21]. The former, from a study of formative time-lags at small overvoltages, have suggested that, especially for the rare gases, as described earlier by other authors[22,23], the streamer theory does not apply (at least in its simple form) for low overvoltages, and may be replaced by a Townsend mechanism. For non-uniform field gaps, it is more difficult to explain breakdown by cathode effects, particularly when impulse voltages of short duration are used, although the discharges shown in Figs. 1–3, and notably the argon discharge shown in Fig. 3, show that discharge effects take place at the cathode. The latter authors[21] reject the streamer theory, for uniform field and for point-plane gaps.

Calculations of the field at the plane electrode in point-plane gaps during D.C. corona discharges have been made by Loeb and Meek[24]. Negative-point discharges were studied and it was shown that fields of ∼ 30 kV./cm. or more might be established at the plane electrode.

We wish to thank Prof. J. M. Meek, Mr. W. Hopwood and Dr. R. F. Saxe for many discussions on streamer mechanisms. One of us (H. M. G.) wishes to acknowledge financial support from the Electrical Research Association and also from the Stoke-on-Trent Education Committee.

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SUPERPOSITION EFFECTS IN MULTIPLE-BEAM INTERFERENCE FRINGES

By AUDREY M. GLAUERT*

Royal Holloway College, University of London

THE Fizeau fringes given by a pair of flats, placed at a small angle to each other, are straight, lying parallel to the edge of the wedge. If the flats are silvered and the monochromatic illumination is correctly collimated, the fringes are formed by multiple reflexions and are very sharp[1]. If, however, an ordinary thin microscope coverslip is introduced between the flats the appearance of the fringes alters. In the area occupied by the coverslip the fringes are distorted and modulated to a considerable extent (Fig. 1, × 12).

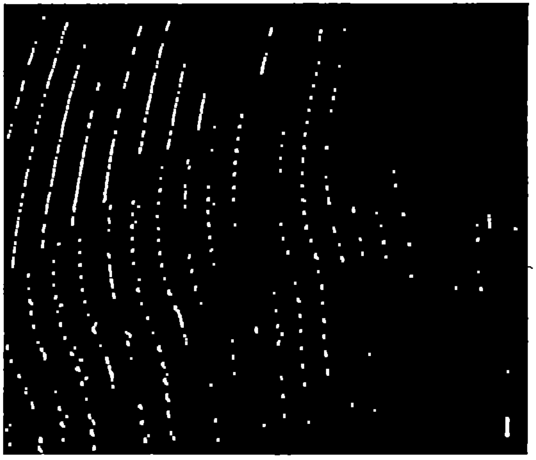

Fig. 1

Corresponding results are obtained if a thin unsilvered slip of mica is placed between the flats: but further unusual effects also occur. Owing to the birefringence of the mica, each fringe is doubled, the light forming the two components being polarized in mutually perpendicular directions. A striking phenomenon is that the two components of a fringe are not modulated in a similar manner in all regions. One component may be practically straight at a place where the other is distorted, while in other parts of the field the effect may be reversed. In some regions both components will appear straight or both curved. This difference in behaviour seems to indicate that the modulation is dependent upon the state of polarization of the interfering light. The effect is illustrated in Fig. 2 (× 15). In (*a*) both sets of fringes are present, whereas in (*b*) and (*c*) a 'Polaroid' has been introduced to exclude one or other of the components. In Fig. 3 (× 12), half the field is covered by the modulated fringes, while the other half shows the 'contour' fringes formed between one side of the mica lamina and the nearest optical flat. The close connexion between the distortions of the wedge fringes and the shape of the contour fringes is clear, and suggests that the modulation effect is due to the superposition of the various fringe systems formed

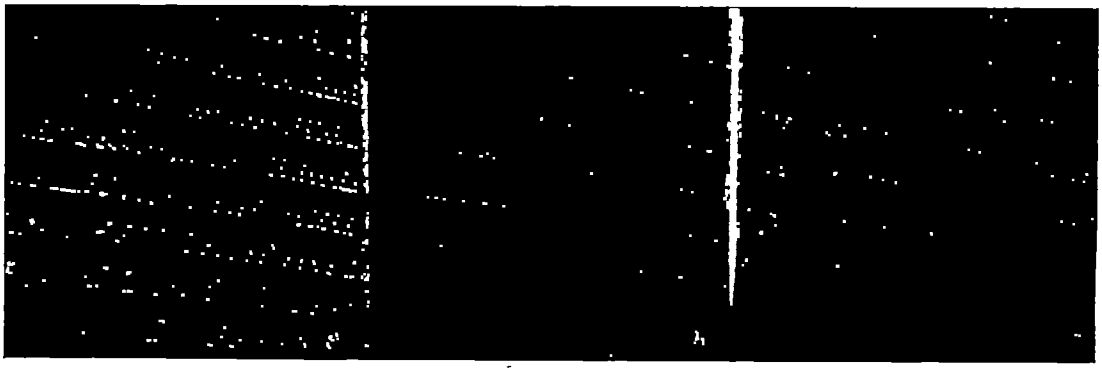

Fig. 2

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* Now at Strangeways Research Laboratory, Cambridge.

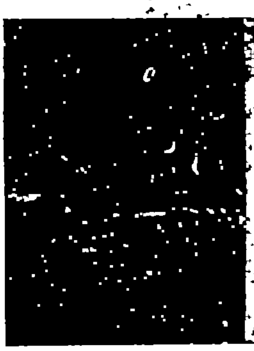

Fig. 3

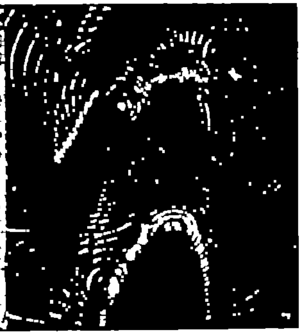

Fig. 4

between the mica and the flats. Finally, in Fig. 4 (× 9), the fringes are shown at high dispersion with the flats lying practically parallel. The right-hand side of the figure shows the contour fringes formed between one silvered side of the mica and the nearest flat, and the left-hand side those between the other silvered side of the mica and the other flat. The central region shows the modulated fringes at high dispersion. In part of the field one component of the fringes remains practically unaffected, while the other is greatly modulated. However, this effect changes considerably as the fringes cross a cleavage step in the mica which can be seen running diagonally across the figure. On the other side of the step the components are equally modulated. This change in behaviour of the modulations on crossing a step was often observed and suggests that the superposition effect is also dependent upon the thickness of the inserted lamina. This is presumably due to the fact that the relative sizes of the relevant air gaps are changed.

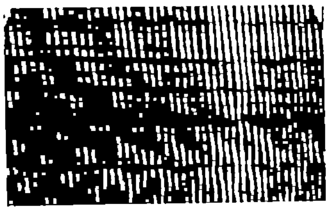

Fig. 5

The corresponding fringes of equal chromatic order[1] were also observed, and an example, obtained with a mica lamina, is given in Fig. 5. Again the fringes are modulated, and it is noticeable that the fringes at different wave-lengths do not have similar shapes. This is unusual for fringes of this type.

The full explanation of the effects described here remains obscure, but as it is no longer possible to continue the investigation it was thought best to communicate the results in their present form. They have importance, particularly with respect to interference experiments carried out to study the structure of biological material. It is often proposed to place a specimen under examination in a suitable fluid between silvered optical flats, in the hope that the resultant fringes will give some indications as to structure and form. The present results show that the greatest care must be taken in the interpretation of such interferograms, and they illustrate the ease of production of artefacts. [June 13.

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RACIAL STUDIES

UNESCO's two recent pamphlets, "Race and Psychology" and "The Roots of Prejudice"*, have only their topic in common. Dr. Klineberg's essay is exactly what one would expect from the leading authority on the subject he discusses—a concise statement, rich in usefully selected data, leading to the conclusion that there is "no relation between race and psychology". He admits, of course, that "individuals and families are not equally endowed", and he recognizes the importance of heredity in accounting for differences in mental ability; but he insists that there is "no evidence" for the view that "races or ethnic groups differ in their psychological inheritance. . . . As far as we can judge, the range of capacities and the frequency of occurrence of various levels of inherited ability are about the same in all racial groups."

This is now the prevailing opinion among serious scholars, though an influential minority still rejects it. But, whether one agrees or not, the value of easy access to a factually presented argument for this belief is evident. Students and teachers will certainly find it useful, while those who indulge in racial opinions should at least be discomfited by it.

Dr. Rose's opinionative discourse, on the other hand, is of interest chiefly as an example of the unscientific lengths to which a synthesis embracing recent psychiatric theories, restricted personality studies, uncontrolled speculations and American idealism can be pushed. There are more facts about the nature of prejudice in the records of ancient civilizations, and more about its psychology in Antarah, Ibn Khaldun and Vico, than in the entire body of influencing factors and half-truths sometimes described as "the psychology of race relations"; but Dr. Rose's approach does not include their consideration.

Ibn Khaldun, for example, suggests slavery as a major source of prejudice against Jews and Negroes, and those who know the history of these groups will appreciate his point. Dr. Rose's thinking, however, shapes the astonishing statement that "prejudice was not particularly associated with slavery" in the United States. He prefers the metonymic explanations of the day: "Frustration explains the force behind prejudice. But it does not explain why certain minority groups are chosen as scapegoats. To explain this, psychologists help us out with another theory—the 'symbolic' theory. This theory is based on the important fact that one thing can stand for something else in the unconscious mind."

This process of substitution or symbolization produces unfavourable attitudes against substitutes for "important things in the culture" which engender inadmissible fears, dislikes and rebelliousness. For example, "some people will not admit that they would like to rebel, and these are usually the ones who would most like to do so. They pretend that they adore their parents at all times, that they have 'pure' feelings about sex and religion and so on. Since this is not *really* the case, they have to give vent to their rebel feelings in some way. And they do so by having prejudices against minority groups." Why *certain* minorities are selected, if they are, we are not told, except in terms of fears of large numbers, power and "spying for foreign governments".

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* (1) "Race and Psychology." By Otto Klineberg. Pp. 39. (2) "The Roots of Prejudice." By Arnold Rose. Pp. 41. (Paris: Unesco, 1951; London: H.M. Stationery Office.) 1s. 6d. each.

It would be carrying criticism too far (perhaps it would be fear of psychiatry) to deny that such explanations represent facets of truth. In fact, the defect of Dr. Rose's propaganda lies not so much in their use as in the manner of their employment: they are out of proportion, without historical pattern, and suffused by a kindergarten brightness that can only be tiresome to adult minds. Moreover, over-anxiety to make a case provokes the very questions he tries to avoid. Thus, when he says that prejudice "has not been universal, in the sense that all cultures or all people have displayed it", the absence of supporting examples tempts disbelief. When he adds that "there is no example of a whole people advancing themselves or their civilization on the basis of it", one is inclined, while making full allowance for the degenerative effects of slavery and xenophobia, to provide him with the examples he has missed.

Another illustration of historical *naïveté* is his classification of intergroup tensions into three distinct types. "One is political in motive" and is "based on a struggle for power"—a popular cliché concealing a complex of economic motivations. The others arise more mysteriously from religious differences and racism, the latter being "largely a modern phenomenon . . . rare until its modern development less than two centuries ago as a perversion of early biological science . . .". Actually, it is an elementary historical fact that all the great religious conflicts have been essentially political, while racism is an ancient phenomenon associated with the structure of the State. Even the new racism goes back to the transformation of mercantile adventures into regular overseas trade towards the end of the sixteenth century; and it has no causative connexion with biology, though it found a rationale in the prevailing (not the perverted) biological thought of the nineteenth century. Therefore, to say that racism is "an independent cause of prejudice today" is to put the cart well before the horse.

Dr. Rose is equally original in other directions. Ignorance, he says, of the costs of prejudice to the prejudiced themselves is a "contributory root" of prejudice, which is a distorted way of saying that such ignorance is a factor assisting the maintenance of prejudice. Nor is his accounting of the financial cost impressive outside the genialities of American business. It is true that prejudice affects man-power efficiency and aggravates social problems, but it is equally true that: (1) no economic system supports situations evidently hostile to itself; (2) the losses caused by the prejudices of a ruling group are slight compared with its gains; and (3) every reduction in prejudice must substantially increase the cost of social reforms. In other words, the appeal to profit is manifestly absurd in a society where the makers of profit know a good deal more about it than Dr. Rose.

To swell the appeal with idle, if unintentionally revealing, speculations is no more than a further invitation to surgery. Perhaps it can be allowed, very doubtfully, that it "is probable that in the long run imperialistic countries could have gained even greater economic advantages if they had not employed prejudice, discrimination and violence"; but in that case they would have ceased to be imperialistic. For no imperial nation has ever been able to maintain its rule without prejudice, and every imperialism has begun to decline the moment it has been compelled to relax its prejudices to the point of admitting selected 'natives' to its own educational resources, culture and social opportunities. A benignly unprejudiced imperialism would be a historical anachronism.

The final judgment on "The Roots of Prejudice" must be that it tells us little about prejudice and less about its roots. It is written by an ideologue, whose excursions in search of originality and moral purpose merely produce over-simplifications that conceal or twist historical truths in accordance with a false empiricism. But Dr. Rose should not be blamed. He is a product, like prejudice, of circumstances, including the complications of academic sterility analysed by Veblen and Robert Lynd.

Unfortunately, the same tolerance cannot reasonably be extended to Unesco. Its policy on intergroup tensions, despite many good results, lacks co-ordinated vision. Consequently, its expensive propaganda is often unscientific, contradictory and confusing—a regrettable situation which is not likely to improve until it is realized that the reduction of "race problems" is beyond the reach of anti-racial journalese. Dr. Klineberg's advantage in providing an instructive exception lies in long personal experience of a subject that has matured; and if Unesco's other humanistic concerns were entrusted to authorities of like stature they would benefit accordingly. Moreover, critical direction would include the promotion of basic studies on those aspects of "the race question in modern science" that are modern enough but not yet scientific. The alternative is to become an advertising agency for dubious scholarship and apparently good intentions.

CEDRIC DOVER

EFFECTS OF DDT UPON DIFFERENT SPECIES OF MOSQUITOES IN MALAYA

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THE reactions of *Anopheles maculatus* to DDT in window-trap huts have been shown to be very different from those of *Culex fatigans*[1,2]. With a dose of 200 mgm. DDT per sq. ft. as a wettable powder, it is nearly six months before the mortality of *Anopheles maculatus* drops below 50 per cent. The same dose, even when fresh, scarcely kills any *Culex fatigans*, although for six months it drives them out of the hut into the window-trap, and prevents many from biting.

More recently, experiments with window-trap huts and DDT have been extended to other important Malayan species, vectors of malaria or filariasis. The results during the first six to nine weeks after treatment (see table) indicate a wide range of susceptibility to DDT, as if there is almost a complete reaction spectrum, with very susceptible species such as *A. maculatus* at one end, and the least susceptible such as *Culex fatigans* at the other. The terms 'susceptible' and 'insusceptible' are preferred to 'non-resistant' and 'resistant'. The latter is commonly used to describe strains of house-flies which are not killed by direct application or even injection of DDT. But if a species of mosquito escapes unharmed from a hut treated with DDT, this may be due to

Mortality of Mosquitoes Captured in Window-trap Huts, during Six to Nine Weeks after Treatment with DDT at 200 mgm. per sq. ft. as a 25 per cent Wettable Powder

Species	Control		DDT		Per cent mortality after 24 hr. due to DDT (corrected)
	No. caught	Per cent dead after 24 hr.	No. caught	Per cent dead after 24 hr.	
Anopheles umbrosus	34	16	107	86	84
Mansonia spp.*	288	17	233	75	70
Anopheles barbirostris†	86	23	107	70	61
Anopheles sundaicus	107	14	62	66	60
Anopheles letifer	69	19	68	44	31
Culex vishnui	149	16	175	26	12
Culex fatigans	188	11	1,532	12	1

* About 80 per cent were *M. longipalpis*, the remainder mostly *M. uniformis* and *annulatus*.

† The 'dark-winged' form which is a vector of malaria.

some aspect of behaviour which prevents, or allows only a very brief, contact with the treated surfaces, rather than to innate resistance. *Anopheles gambiae* is killed by five seconds contact with DDT in the laboratory[3], but may escape unharmed from a treated hut[4].

The results with *Anopheles umbrosus* and the vectors of filariasis in Malaya (*Mansonia* spp.) are encouraging, but we need to know how long this dose of DDT remains effective against them. Any period less than three months would probably be uneconomic. The results against *A. barbirostris* and *A. sundaicus* are not very good, and against *letifer* they are disappointing. During the first three weeks after treatment 80–100 per cent of *barbirostris* and *sundaicus* were killed, but from the fourth week onwards the mortality dropped rapidly to 50 per cent or less. With *A. letifer*, even when the DDT was fresh, the kill scarcely exceeded 50 per cent. The mortality of *A. maculatus* during 6–9 weeks after treatment has been similar to that of *umbrosus*, somewhat more than 80 per cent.

Despite this insusceptibility of some species, one might suppose that so long as DDT prevents many mosquitoes from biting it will not matter if the majority are not killed; the insecticide ought still to be effective in controlling disease transmitted by such mosquitoes. Unfortunately, except with species of *Culex*, the biting-rate is only slightly reduced. Among the anophelines (including *maculatus*) and *Mansonia* captured in the window-trap huts, the biting rate is only lowered by about 10–20 per cent after treatment with DDT. *Culex* reacts very differently, DDT reducing the biting-rate by about 70 per cent. The contrast is so marked that it probably reflects an important difference in behaviour. It seems likely that *Culex* rests on the walls before biting, and that the anophelines and *Mansonia* do not. This would agree with one's personal experience of the biting behaviour of these mosquitoes, anophelines and *Mansonia* usually attacking in a manner that is rapid and direct compared to the cautious approach of *Culex*. Wallace has shown by direct observation that *A. maculatus* entering a trap hut mostly attack immediately without first resting on the walls[5]. There is some evidence that DDT spraying directed against *Culex fatigans* can reduce the transmission of bancroftian filariasis[6], and presumably this is due to DDT preventing the mosquitoes from biting rather than killing them. But if species which are vectors of disease are not prevented from biting by DDT, the insecticide is unlikely to reduce disease transmission unless it actually kills the mosquitoes, especially if, like anophelines in Malaya, they normally leave houses to rest out of doors by day. Even with a species such as *Anopheles gambiae* that commonly rests indoors, and is driven out of houses by DDT spraying, it appears that DDT may be ineffective unless it actually kills the mosquito. Experiments with trap huts have shown that under certain conditions DDT does not kill *A. gambiae* nor prevent it from biting[4], and in parts of East Africa four years of DDT spraying of houses has had very little effect on malaria transmitted by *A. gambiae*[7]. BHC, however, killed *A. gambiae* in trap huts and has reduced malaria in the house-spraying experiments. BHC also kills all Malayan species of mosquitoes that have been tested, including those mentioned in the table. But, except for *A. maculatus* and *C. fatigans*, we do not yet know how long the BHC continues to kill. A dose of 40 mgm. per sq. ft. of gamma BHC lasts as long against *A. maculatus* as the 200 mgm. dose of DDT, that is, about six months; but after five to seven weeks it kills fewer than 50 per cent of *C. fatigans*, and has lost all effect against this species after about nine weeks[1].

Nair[8], working in Malaya under the rather difficult conditions that existed in 1945–46, made a three months trial of house-spraying with DDT in kerosene in an area where *A. letifer* was presumed to be the vector. He considers that DDT can control malaria transmission by *A. letifer*, but in view of the results presented here a further trial appears necessary.

A recent report by Hadaway and Barlow[9] suggests that failure of DDT against *A. gambiae* may be due, at least in part, to its adsorption into the mud walls of the sprayed houses and experimental huts. BHC is also adsorbed in this way, so that no crystals remain on the surface; but it continues to kill by virtue of its fumigant action. This interesting discovery may possibly help to explain some of the contradictory reports about DDT and *A. gambiae*; for although Muirhead Thomson's experiments with trap huts showed DDT to be ineffective[4], other workers have obtained rather different results. Differences in the DDT formulations used, as well as in the construction of the trap huts, may also have been important. No such explanation is possible for the Malayan figures presented here, for the various species were exposed to uniform conditions, and often were caught in the same hut at the same time; for example, *A. umbrosus*, *letifer* and *Mansonia*, or *A. barbirostris*, *Mansonia* and *Culex*. The huts were of almost uniform design and all were lined throughout with a brown packing-paper called 'Sisalkraft'. We must believe, then, that there are real differences among species of *Anopheles* in susceptibility to DDT when applied as a residual spray in houses, though whether due to differences of behaviour or physiology we do not yet know.

It seems most desirable that tests with window-trap huts should form part of any scheme for malaria control by house spraying with residual insecticides. Admittedly the technique is not simple; the huts can be troublesome to operate and lengthy tests are necessary, but such huts appear to be the best method of finding out what we want to know, namely, the reactions of wild mosquitoes to the insecticides when applied in habitations, and the effective duration of the doses used. It is scarcely too much to say that something of the kind is indispensable for the rational planning of spraying programmes. In view of the many factors which, it now appears, can affect the mortality-rate of the mosquitoes, for example, the insecticide, its formulation and particle size, the nature of the treated surface, the species of mosquito and its behaviour, it will be important in future to keep conditions as uniform as possible throughout an investigation and to describe these conditions fully when reporting results. It would be interesting if tests could be made in trap huts with those vectors against which DDT house-spraying has already proved effective by reducing malaria, such as *Anopheles darlingi*, *albimanus* '*maculipennis*', *culicifacies* and others. Trap huts can also yield most important information on the behaviour and blood preferences of mosquitoes. The pattern of hut and method of operation used in Malaya have been described by Wharton[10]. [June 7.

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EVALUATION OF CHEMOTHERAPEUTIC REMEDIES

THE Biological Methods Group of the Society of Public Analysts and Other Analytical Chemists held a symposium on the "Evaluation of Chemotherapeutic Substances" during October 26–27 under the chairmanship of Dr. G. M. Findlay. The chairman, in opening the discussion, emphasized the need for rapid and accurate methods of estimating the chemotherapeutic activities of the many hundreds of compounds which are now being prepared for the specific treatment of the parasitic infections of man and his domestic animals. The final and crucial tests can obviously be carried out only in man and his domestic animals; but preliminary laboratory tests are essential both for determining relative efficiency and for the accurate assay of substances already found to be effective. Improved methods are required for evaluating anthelminthics, fungicides, and compounds active against viruses.

The general problems involved in planning large-scale collaborative antibiotic assays to ensure adequate international standardization were dealt with by Dr. W. L. M. Perry. The relationship between technique and results, the 'over-accurate' assay, the homogeneity of estimates and the validity of the combination of results were discussed. At present, few laboratories use exactly the same technique for antibiotic assays. Dr. J. Ungar described the various types of *in vitro* and *in vivo* tests which must be carried out before a compound can be used in man. Acute systemic and local toxicities, as well as chronic toxicities, must be ascertained in several species of laboratory animals. The absorption and distribution in the tissues, normal and inflamed, and the mode of excretion are points of importance, as are the likelihood of sensitization and the interaction with other drugs. These remarks were illustrated by reference to 'estopen', a penicillin ester which is concentrated in the inflamed lung. Dr. J. Humphrey pointed out that, apart from good experimental design, the most important aim in assay methods involving diffusion of antibiotics into seeded agar plates is to obtain a sharp edge to the inhibition zones and a good slope. Penicillin and streptomycin give sharp edges with suitable organisms, due probably to the uptake or destruction of these antibiotics near the zone edge giving a steep concentration gradient. With the newer antibiotics the zones are less sharp. The factors determining slope are largely physical. Prof. J. M. Robson described the use of the rabbit's and mouse's eye for determining anti-tuberculous action: one great advantage is the safety of the method for all those performing the experiments. Dr. A. R. Martin discussed very fully the methods used in employing mice for screening anti-tuberculous compounds. The relation of the chick embryo test to the mouse test was described. Miss L. Dickinson gave details of anti-viral tests carried out in the developing chick embryo and in mice. Comparable results have been obtained in mice and chick embryos with the Nigg pneumonitis virus.

Dr. L. G. Goodwin described the use of weanling rats for the evaluation of amœbicidal drugs. His remarks were illustrated by a coloured film. The use of the infected rat provides a method which fulfils the essentials for a satisfactory amœbicidal test, for the infection is reproducible without fail, and untreated controls show a constant lesion; known remedies for the disease in man show a recognizable effect; the test takes only a short time and the infecting agent is derived from man and produces the same type of lesion in the rat. The only difficulty in the use of the rat is the presence of an amœba, *Entamœba muris*, which is not affected by amœbicidal drugs. Special precautions must be taken to prevent infection of the rat colony with *E. muris*.

Dr. J. D. Fulton reported on the various media used for the growth of pathogenic amœbæ *in vitro* and their possibilities for providing methods for testing amœbicidal drugs. The question was discussed whether these amœbicidal drugs act directly on the amœbæ or indirectly on the bacterial flora which provides the pabulum for the amœbæ. The possibility of using *Trypanosoma cruzi* in place of bacteria for the nutrition of the amœbæ was described. Dr. E. M. Lourie pointed out that refined statistical methods are invaluable for biological standardization, but in the search for new compounds of value clinically they are useless if inappropriate experimental procedures are used. In Africa, in the control of trypanosomiasis, mass treatment is giving way to mass chemoprophylaxis, and new compounds are being devised for this purpose. There is therefore urgent need for a simple and rapid method for screening compounds in regard to their prophylactic activity. There is difficulty in standardizing trypanocides of the melaminyl series by chemical or physical means. Standard preparations of these substances are required, and batches intended for use in man should be biologically tested in relation to these standards.

The various laboratory tests, with monkeys, birds and mice, employed for the evaluation of anti-malarial compounds, were described by Dr. D. G. Davey. Regard must be had for the fact that, except possibly in the case of *Plasmodium malariæ*, none of the malarial parasites in man has been established in laboratory animals. The tests used, nevertheless, are unlikely to pass over any compound of potential value in man. Dr. Ann Bishop pointed out that quinine gives rise to little or no drug resistance, and with pamaquin only a very slight increase can be induced. Proguanil, however, readily induces resistance in *Plasmodium gallinaceum*; strains treated with sulphadiazine or sulphanilamide become resistant to themselves and to proguanil. Metachloridine also induces a high degree of drug resistance in malarial parasites. In testing for ability to produce drug resistance, experimental strains of the parasite must be maintained in a state of acute infection. Results from tests upon latent infections are not comparable and are difficult to evaluate.

Dr. F. Hawking urged that when a compound has once been shown to be effective in the laboratory, it should be tested as soon as possible in man in order to bring to light toxic reactions which cannot be elicited in laboratory animals.

IMPORTANCE OF SCIENCE IN AMERICAN EDUCATION

IN a paper contributed to *Science* (113, 2945; June 8, 1951) Ernst A. Hauser, of the Massachusetts Institute of Technology and the Worcester Polytechnic Institute, suggests that most of the advances in science in pure or fundamental research have been made by citizens of countries other than the United States or by American citizens who have received their education in Europe or by Europeans who have emigrated to the United States. In a supporting statement, Hauser quotes the president of the American Society of Mechanical Engineers, who recently declared that the American failure to recognize and respond to their particular responsibilities as citizens and human beings and their failure to understand that technical progress is not enough is the key to many of the greatest difficulties in America to-day. Recently, the United States Commissioner of Education has also directed attention to the fact that a great number of educational institutions still organize their curricula in water-tight compartments, and that all efforts to penetrate the barriers between departments are jealously resisted.

In an attempt to discover the weaknesses in the science side of American education, Hauser compares a German and an American university. In the latter the student is permitted to devote himself to a specialized branch of science or technology far too early, so that the last college years are used as preparation for an advanced specialized education, thereby cutting down the time that should be devoted to general education. Another essential difference between American training technique and that used in Europe is that Americans use systematic drilling as a method of instruction; this can provide sound knowledge, but is scarcely likely to promote self-reliant thinking and the spirit of research. The excessive use of the text-book may also be criticized because it works in the same direction. Throughout most of Europe only those who have graduated from the *Gymnasium* or *Realschule* may enrol in a university or comparable technological institute. When graduating from one of these schools, which they have had to attend for eight years (having left the grammar school at about ten or eleven), students have acquired a background of general education at least comparable to that of American students starting the junior year in college.

Hauser suggests that what is needed in American education is to offer all students a more general appreciation of what science actually stands for. With J. B. Conant he agrees that the objective should be to give a greater degree of understanding of science by the close study of a relatively few historical examples of the development of science. Case-histories, he suggests, would almost all be chosen from the early days in the evolution of the modern discipline, as, for example, certain aspects of chemistry in the eighteenth and nineteenth centuries. The advantages of this method of approach are two-fold: first, relatively little factual knowledge is required either of the science in question or other sciences, and relatively little mathematics; second, in the early days one sees in clearest light the necessary fumblings of even intellectual giants when they were also pioneers; one comes to understand what science is by seeing how difficult it is in fact to carry out pretentious scientific precepts.

Hauser also concurs with I. B. Cohen, of Harvard, who quite recently said that students could be given a general appreciation of what science stands for by making them more familiar with the human side of those to whom we owe the greatest discoveries in science, and with the circumstances that led to the accomplishments for which they are now famous.

CURRENT TRENDS IN GENERAL PSYCHOLOGY

THE programme for the morning session on August 9 of Section J (Psychology) of the British Association consisted of three papers discussing tendencies in general psychology. The discussion presents certain difficulties to anyone attempting to summarize it, in that the three papers were diverse in content. Prof. R. C. Oldfield was concerned with experiment in psychology; Prof. A. Rex Knight and Mr. A. J. Laird with motivation; while the present writer dealt with the teaching of psychology. Instead of a summary, therefore, an attempt will be made to discuss rather generally certain tendencies in present-day psychology which the papers seemed to reveal.

It is clear that, by the middle of the present century, psychology has outgrown certain early phases. These phases were first of all the period of the 'schools', when psychologists carried on the disputative traditions of their philosophical predecessors. There followed a phase of rather indiscriminate experimentation which was corrected after a time by a preoccupation with problems of method. More recently there has been a tendency for those interested in theory and experiment to dissociate themselves from the testers and statisticians, on one hand, and the clinicians, on the other. To-day, however, there is a considerable measure of unity, and experimental techniques are being used which are varied and flexible enough to cope with a wide range of problems.

Prof. Oldfield mentioned two investigations which show the present-day trend. In the first, attempts are being made to use rather complicated mathematical tools in describing the behaviour of a maze-running animal at a point of choice; and in the second, an analysis is being made, again using quite advanced mathematics, of certain visual illusions first investigated by Ames in the United States. Both these investigations are of great theoretical interest in themselves. But in addition, as Prof. Oldfield pointed out, they throw light on human behaviour in its everyday setting or in the clinic.

Prof. Knight and Mr. Laird were concerned to show that some rather naïve methodological assumptions about human motivation have led to logical difficulties. They suggested other interpretative schemes free from these difficulties. Again, it was emphasized that theoretical considerations of this kind are directly related to practical and clinical problems.

Finally, the present writer pointed out the increasing demand for professional psychologists and the inadequacy of present training methods in Great Britain to meet that demand. He suggested that the most useful development would consist in the expansion of training at the graduate level. It was agreed, however, that professional training should not be allowed to develop at the expense of fundamental research, nor should it be dissociated from the consideration of theoretical problems. Recent developments suggest that a good deal of research which has itself no directly practical aim will be of relevance in the practical field.

So far as any trend in general psychology was revealed by the three papers, it was this: that the different schools and aims and methodologies of psychology are disappearing, and the field is becoming much more unitary than was the case during the first part of the present century. J. Drever

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BRITISH MEDICINE AND THE CONTINENT, 1600–1850

A NEW exhibition at the Wellcome Historical Medical Museum—"British Medicine and the Continent, 1600–1850"—presents some interesting contrasts with the "Medicine in 1850" exhibition which it has replaced. The latter exhibition dealt with the medicine of Europe during a limited period, and was, in effect, a cross-section of medical thought. The new exhibition is designed to illustrate not so much the state of medicine at various times in different countries, as the fluctuating influence which the medical and scientific thought of the European Continent exercised on British medicine at different times, and *vice versa*.

A limited aspect of this approach was well brought out by Prof. Edvard Gotfredsen, professor of the history of medicine in the University of Copenhagen, in his address at the official opening of the exhibition, which took place before a distinguished company on October 19. Prof. Gotfredsen chose to deal with the relations between British and Danish medicine in the seventeenth and eighteenth centuries. He pointed out that in the seventeenth century medicine was very international, and that, as Latin was the international language of learning, medical students were enabled to travel all over Europe to hear famous teachers. Danish students of medicine of that time were forced to go abroad for much of their education, since a full medical education could not then be obtained at the University of Copenhagen. Of the Danish medical students who later became famous, those who visited Great Britain included Caspar Bartholin the elder, who wrote an important work on medical education and recommended foreign travel. Caspar's son Erasmus visited London and Oxford in 1647, and his brother-in-law, Olaff Worm, stayed for a year and a half in England.

The impact of Harvey's doctrine of the circulation was important in Denmark, since the new theory was introduced into that country by Thomas Bartholin, who also had considerable influence in spreading it on the Continent. The Dane, Holger Jacobæus, who later became professor of anatomy at Copenhagen, left some interesting descriptions of his life in London and Oxford. Prof. Gotfredsen also described in some detail the difficulties which arose in the Royal Society in attempts to confirm Stensen's work on the effects of ligating the descending aorta. In the first half of the eighteenth century the travels of Danish students had become less extensive, and in the second half they practically ceased. This fact was due to the improvement of facilities for clinical instruction in Copenhagen.

Prof. Gotfredsen was introduced by Dr. E. Ashworth Underwood, director of the Wellcome Historical Medical Museum, and a vote of thanks to him for his address was proposed by Sir Wilson Jameson.

The exhibition commences with the British and Continental background at the end of the sixteenth century. This extremely interesting period, which was the prologue to all that followed in the seventeenth century, was marked by the overwhelming importance of Paris, Montpellier and Padua. Of the English works of this period, mention should be made of the superb copy of the 1545 edition of the "Anatomy" of Geminus. Another rare work which is shown, and which itself had considerable influence on the Continent, was Mouffett's "Theatre of Insects", 1634. One of the rarest books shown in this exhibition is the first edition of "The byrth of mankynde"; this is the translation of the well-known book by Eucharius Roesslin. This first edition was published in 1540 and the copy shown is one of the very few perfect copies in existence.

It need scarcely be said that the section of the exhibition on Harvey contains fine first editions of his works. Harvey's influence on the medicine of the Continent is brought out by the published works of his supporters and of his opponents.

The rise of the Royal Society is shown in an interesting manner, as also are its connexions with the scientific men of the Continent. In the later sections Boerhaave and Haller are well represented by fine copies of their works and a number of relics. The influence of the Hunters dominates the second part of the period dealt with, and in this connexion many will be interested in the extra-illustrated edition of Jesse Foot's "Life of Hunter". This contains many original wash drawings which illustrate events in the life of John Hunter.

The later sections of the exhibition contain books and exhibits which are now classics of the late eighteenth and early nineteenth century developments of the sciences which form the fundamental basis of modern medicine.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

The Term 'Regular Solution'

In 1920[1] I directed attention to the fact that the solubility of solids, plotted as a logarithm of mole fraction against reciprocal temperature, gives a family of curves in the case of solutions "where no molecular changes are involved". In 1927[2] I designated such solutions as 'regular' and in 1929[3] I discussed the thermodynamic significance of this regularity, stating, in part: "From our picture of a regular solution as one in which orienting and chemical effects are absent, and in which the distribution and orientations are random, just as in an ideal solution, we may conclude that the probability of X_2 [species 2] is the same in the two solutions [ideal and actual] and, therefore, that the difference in entropy is zero. We cannot expect this conclusion to hold unless the random distribution of molecules persists. We may expect further that a small correction should be applied to take care of the change in entropy accompanying changes in volume, given by $(\partial S/\partial V)_T = (\partial P/\partial T)_V$; or we may state our principle in the following form. A regular solution is one involving no entropy change when a small amount of one of its components is transferred to it from an ideal solution of the same composition, the total volume remaining unchanged."

I referred to the possibility of expressing the partial molal enthalpy (of component 2) by the Margules series, $bx_1^2 + cx_1^3 \ldots$, but showed that the behaviour of many solutions can be adequately expressed by the first term alone. It became evident, soon after[4], that the mole fraction should be replaced by the volume fraction, and the coefficient b was evaluated in terms of the pure components.

The term 'regular solution' has now come into general use, but not always in conformity with the above definition. For example, Guggenheim[5] uses it as follows: "We now turn to a class of mixtures called *regular mixtures* or *regular solutions* defined by the properties $\log f_1 = wx^2/RT$—wherein w is not merely independent of the composition but independent of the temperature.—The name *regular solution* was first used by Hildebrand." Rushbrooke[6] writes a certain partition function and says, "A solution for which the partition function is given by equation (8) is known as a *regular solution*". Longuet-Higgins[7] states, "This theory [of regular solutions] assumes that in a liquid mixture (*a*) the molecules are arranged in a regular lattice, (*b*) that the separate liquid components have ordered structures of the same type and (*c*) that the intermolecular potential energy is the sum of contributions from nearest neighbours in the lattice, the contribution of two neighbouring molecules depending only on their chemical nature".

I cite these differences not for the purpose of asserting my rights as the inventor of the term but to urge that so useful a concept, to which a simple definite meaning was originally attached, should not be robbed of its significance by different writers re-defining it each in his own way. I have no objection to a re-definition that may appear desirable in the light of present knowledge; but it should be made by general consent.

One question does arise in connexion with the original definition, wherein ideal entropy and random distribution of molecules were regarded as equivalent. We have since learned from a succession of investigators, culminating with Flory and Huggins[8], that the entropy of mixing molecular species of significantly different size, even though randomly mixed, is not the ideal entropy; therefore, we should decide whether to attach the term 'regular solution' to one or the other of these concepts. Prof. Scott and I, in our "Solubility of Nonelectrolytes" (third edition), have used it to mean ideal entropy, for example, the partial molal entropy of transfer $\bar{S}_1 - S_1^0$ from pure liquid to solution of mole fraction x_1 is $\bar{S}_1 - S_1^0 = -R\ln x_1$. This is more restricted than the other definition, but except for solutions of high polymers, it holds well enough for many purposes and permits expressing the activity coefficient in terms of the enthalpy. The Flory–Huggins equation involves certain assumptions that prevent it from being regarded as an accurate expression of the concept of complete randomness. To define the regular solution in terms of ideal entropy better fulfils the function of a useful reference state, well explained by Scatchard[9]: ". . . The student should be taught that thermodynamics deals with differences, that the number of differences to be considered can be reduced greatly by the use of reference states, that the magnitude of the differences can be reduced by the use of deviation functions, and that the choice of reference states and of deviation functions is entirely a matter of convenience, which should not be allowed to reduce the accuracy of any calculation . . .".

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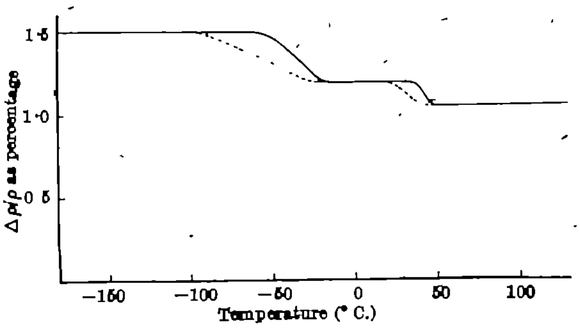
Change of Resistivity of Gold by Cold-working at Liquid-Air Temperature and its Recovery by Temporary Heating

Some time ago Molenaar and Aarts[1] observed that the increase of the resistivity of copper, silver and aluminium wires, caused by a plastic deformation at liquid-air temperature, decreased on keeping the wires at room temperature. The recovery of the resistivity was not accompanied by a recovery of the mechanical properties. The stress–strain curve at liquid-air temperature was not changed by this temporary heating.

We have now measured the recovery of the resistivity of gold wires. A gold wire, which had been soft-annealed, was stretched approximately 7 per cent at liquid-air temperature and its resistance measured. This elongation caused a relative increase of the resistivity of about 1·5 per cent. The wire was then warmed up to different temperatures, at



which it was kept for some time. After this treatment the resistance of the specimen was measured again at liquid-air temperature.

The accompanying graph shows the recovery of the resistivity as a function of the 'heating temperature'. The curve drawn is for a heating time of 2 min., while the dotted line gives the results for a heating time of 5 min. (The curves are quantitatively rather rough, as the time necessary for bringing the wire to the 'heating temperature' cannot be neglected.)

It is evident that two processes occur. At about − 50° C., the extra resistivity starts to decrease from 1·5 to about 1·2 per cent, and at about + 35° C. from 1·2 to about 1·05 per cent, when the heating time is 2 min. For a heating time of 5 min., both recovery steps start at lower temperatures.

The stress–strain curve is not changed by this heating.

As a possible explanation of these results, we suggest, following an idea of F. Seitz[2], that the extra resistivity which disappears at about + 35° C. (20° C.) is due to vacant lattice sites, while that which disappears at about − 50° C. (− 100° C.) is due to conglomerates of two or more vacant places. These vacant sites are formed during the cold-working. The absence of any change in the mechanical properties suggests that the dislocations, which are responsible for the strain-hardening, do not change at these temperatures.

We wish to thank the Delftsch Hoogeschool Fonds for its financial support.

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Elastic Constants of Alkali Halide Crystals

ADOPTING the simple Born model for an alkali halide crystal, in which the ions are regarded as held in their respective positions by the electrostatic and the repulsion interactions between the ions, one may readily calculate the velocities of propagation v of long acoustic waves of wave-length λ along the principal directions [100], [110] and [111], and hence along any direction, in the crystal:

$$v^2 = \sum_n (A_{1n}\Delta^2_{1n})/(m_1 + m_2), \qquad (1)$$

where m_1 and m_2 are the masses of the two ions, $2\pi\Delta_{1n}/\lambda$ denotes the difference in phase of the acoustic wave at any two ions 1 and n, and $\sum\limits_n$ denotes summation over all the ions, except 1, in the crystal. (If D is the distance up to which the electrostatic interactions remain significant, λ is regarded as sufficiently large in comparison with D that $\cos(2\pi D/\lambda)$ can be put equal to $1 - \frac{1}{2}(2\pi D/\lambda)^2$.)

$$A_{1n} = (\psi'/R_{1n}^0)(1 - Q^2) + \psi'' Q^2, \qquad (2)$$

where $\psi(R_{1n})$ is the interaction energy between the two ions 1 and n, separated by a distance R_{1n}, and ψ' and ψ'' are its differential coefficients with respect to R_{1n} at its equilibrium value R_{1n}^0. Q is the cosine of the angle between R_{1n}^0 and the direction of displacement of the ions under the acoustic wave. Since the values of v^2 for different directions of propagation and corresponding directions of displacement are also known in terms of the elastic constants c_{11}, c_{12} and c_{44}, we obtain, by comparing them with the values obtained from (1), expressions for the elastic constants in terms of the interactions between the ions. We shall denote by ε_{11}, ε_{12}, ε_{44} the contributions to c_{11}, c_{12}, c_{44} respectively from the electrostatic interactions, which are of long range, and by ρ_{11}, ρ_{12}, ρ_{44} the contributions from repulsion interactions, which are assumed to fall exponentially with the increase in the distance of separation of the interacting ions. In view of the short range of these repulsion interactions, we regard them as confined to the immediate neighbours only.

Let us first consider a crystal of the sodium chloride type, and take the co-ordinate axes along the cubic axes of the crystal, and the origin at the equilibrium position of ion 1. It is found that the ε's and the ρ's can be expressed in terms of the following two series, in which ξ, η, ζ are integers, which, multiplied by d, the sodium–chlorine distance, define the co-ordinates of all the lattice points:

$$\Sigma(-1)^{\xi_n+\eta_n+\zeta_n}/(\xi_n^2 + \eta_n^2 + \zeta_n^2)^{1/2} = -\alpha, \text{ say}, \qquad (3)$$

which can be recognized as the Madelung series, and

$$\Sigma(-1)^{\xi_n+\eta_n+\zeta_n}(\xi_n^4 + \eta_n^4 + \zeta_n^4)/(\xi_n^2 + \eta_n^2 + \zeta_n^2)^{5/2} = -\chi, \text{ say}, \qquad (4)$$

which also is a known series[1]. It is further known that $\alpha = 1{\cdot}748$ and $\chi = 3{\cdot}139$. The values of the elastic constants thus calculated, which refer to very low temperatures, are given in the following table in terms of $e^2/(12d^4)$, in which e is the electronic charge. δ in the table is a number such that d/δ gives the distance over which the repulsion interaction drops to $1/e$ of its value ($\delta = 9$ in the case of sodium chloride).

	11	12	44
ε	$2\alpha - 6\chi$	$-5\alpha + 3\chi$	$-\alpha + 3\chi$
ρ	$2\alpha\delta$	2α	-2α
c	$2\alpha(\delta + 1) - 6\chi$	$-3\alpha + 3\chi$	$-3\alpha + 3\chi$

Since the interaction forces have been assumed to be central, c_{12} naturally comes out equal to c_{44}, though ε_{12} and ρ_{12} are not separately equal to ε_{44} and ρ_{44} respectively. The final values for the c's are the same as those obtained by Kellermann[2] and also agree with the experimental values. Our values of ε_{12}, ε_{44} and of ρ_{12}, ρ_{44}, however, differ from his.

Similar expressions are obtained from the cesium chloride type of crystals, in terms of two series α' and χ' that are similar to (3) and (4).

It is remarkable that for the sodium chloride type, c_{11} and c_{44}, as also the corresponding ε's and ρ's, depend on the lattice constant alone. This result, however, does not hold for the cæsium chloride type.

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Calibration of Geiger-Müller Liquid Counters by the Radioactivity of Potassium-40

IN recent clinical radioactive tracer studies using sodium-24, phosphorus-32 and iodine-131, it was found desirable to have a reliable and convenient radioactive standard, of similar beta- and gamma-ray energy, easily reproducible, of negligible radioactive decay and with adequate carrier protection against exchange reactions upon the glass walls of Geiger–Müller liquid counters[1]. The radioactive isotope, potassium-40 of normally occurring potassium, is present to one part in 9,000 and has a half-life of $12 \cdot 7 \pm 0 \cdot 5 \times 10^8$ years[2] with a beta-ray spectrum of maximum energy 1·33 MeV. and a gamma-ray of energy 1·5 MeV.

Some time ago, Barnes and Salley described[3] a method for the analysis of potassium by its natural radioactivity, using a Geiger–Müller liquid counter calibrated with standard potassium solutions. The time required, from statistical theory, for a measurement with probable error of ± 1 per cent for a 4 *N* potassium chloride solution in a 20-ml. counter was about 70–80 min. In my early experiments, concentrated solutions of potassium chloride were used for calibrating counters. Later it was found that concentrated solutions of potassium carbonate gave nearly three times the counting-rate of concentrated potassium chloride. The most convenient compound from the point of view of solubility and potassium concentration was found to be potassium carbonate, which at 20° C. has a solubility of 112 gm. per 100 ml. water.

A type *M6* 10-ml. Geiger–Muller liquid counter filled with standard potassium carbonate solution gives 550 counts/min. with the counter enclosed in a protective lead screen. The background count is by comparison 15 counts/min. Other solutions, of potassium bromide and iodide, have also been tried, but, owing to the lower solubility and small concentration of potassium, give lower counting-rates. Solutions of potassium hydroxide may be used to give a 20 per cent greater counting-rate than potassium carbonate, but are much less convenient in manipulation.

It is therefore suggested as a basis of international standardization of Geiger–Müller liquid counters that they may be calibrated with standard potassium carbonate solutions with an accuracy of ± 1 per cent in 8 min. counting time.

A standard solution can be made up from 100 gm. analytical reagent potassium carbonate anhydrous (after heating to 200–300° C.) dissolved in 100 ml. distilled water. The advantage over standard solutions of cobalt-60 hitherto used[4] for counter standardization is that there is low cost, and the carbonate is universally available, has negligible radioactive decay and gives no residual activity in the counter due to adequate carrier protection.

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Propagation of Very-High-Frequency Radio Waves

DURING the period autumn 1949 – spring 1950, a series of measurements of field-strength from a very-high-frequency airborne transmitter was made at the Royal Aircraft Establishment. The main purpose of the investigations was to examine the field-strengths obtained in varying weather conditions with one end of the propagation path at a height of 40,000 ft. above the earth (the other end being at a height of 90 ft.) and to compare them with the field-strengths calculated from conventional ray-theory for a smooth spherical earth for both ordinary and four-thirds earth radius. For this purpose the two frequencies 280·2 and 386·6 Mc./s. were chosen.

In the curves of field-strength, plotted against distance between transmitter and receiver for those cases where the indirect ray was reflected from land, the observed minima were in some cases shallower than the calculated values, as could be expected for reflexion from a rough surface, but in no case were they deeper. Fig. 1 is a typical curve for land reflexion. In all instances, however, where the indirect ray was reflected from the sea, as in Fig. 2, the observed minima were considerably deeper than the calculated values, and this feature was also present

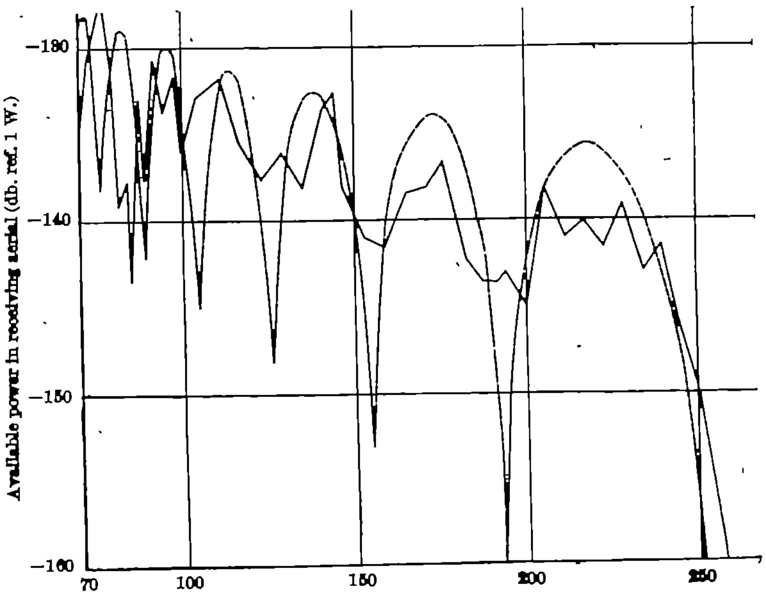

Fig. 1. 386·6 Mc./s., over land: ----, calculated; ——— measured

in two observations made with the transmitter at a height of 10,000 ft.

It was also noted that in about 90 per cent of the observations there was closer agreement between curves of observed and calculated field-strengths for both land and sea reflexion of the indirect ray, when the earth's radius was taken at its ordinary value rather than the conventional four-thirds value to allow for 'normal' atmospheric refraction.

The permittivity and conductivity of earth were taken as 10 electrostatic units and 10^{-13} electromagnetic units respectively, and, for sea, as 81 e.s.u. and $4 \cdot 6 \times 10^{-11}$ e.m.u. respectively, in the calculation of reflexion coefficients. The abnormally deep minima in the case of sea reflexion are equivalent in some cases to an apparent increase in reflexion coefficient by a factor of 2·25, and the discrepancy between observed and calculated values decreases with decrease in the angle of incidence of the indirect ray on the sea; that is, it attains a maximum value with maximum distance between transmitter and receiver.

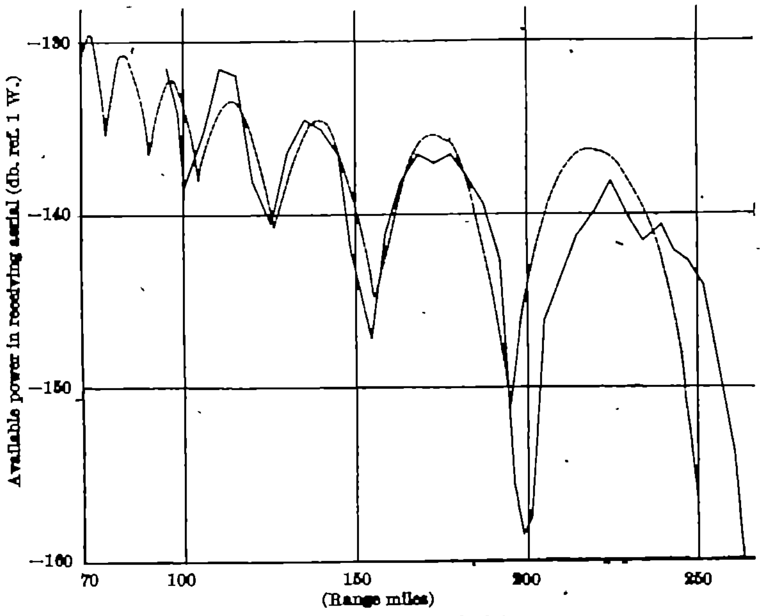

Fig. 2. 386·6 Mc./s., over sea: ----, calculated; ——, measured

The topography of the cliff site chosen for the investigations over sea was such that no reflected ray from local objects or land-masses could account for the additional energy necessary to produce the large apparent increase in reflexion coefficients; and any abnormal increase in atmospheric refraction would have tended to produce shallower minima, since angles of incidence at a given distance would have been reduced and thereby reduced the corresponding reflexion coefficients. Any inertia in the recording instruments employed would also have tended to make minima shallower.

The weather conditions during the investigations varied from settled, anticyclonic types to low-pressure, unsettled weather with considerable variation of temperature, humidity and wind.

Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

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Reduction of Static Electrification by means of Inhibiting Compounds

In connexion with the problem of static electrification in the processing of nylon fibre, we have undertaken a study of the factors involved in the reduction of static charges by means of 'antistatic agents'.

The work of Coehn[1] and Richards[2], coupled with that of Gill and Alfrey[3], indicates that such electrical charges are generated by the the transfer of electricity between two bodies of different dielectric constant, induced by a natural field which sets up a contact potential at the interface when the bodies are brought into contact. The transfer takes place in a direction such that the contact potential is neutralized, and the charges become evident only on subsequent separation of the two bodies. The high voltages encountered are due to the drop in capacity of the system on separation of the bodies according to the well-known law, the charge actually remaining the same as when they were in contact.

An apparatus was constructed which gave reasonably quantitative measurements of the electrostatic effect of rubbing nylon yarn against a metal surface. A 2-gm. hank of nylon was rubbed back and forth over three metallic rods by means of an eccentric revolving at 60 r.p.m. The outer rods were of steel and connected to earth. The central rod was of brass and connected to one terminal of a voltage-measuring device, the other terminal of which was earthed. The relative humidity of the surrounding atmosphere was controlled to 29 ± 1 per cent. In operation the voltage was read after 60 strokes of the hank. Under controlled conditions, voltage measurements were consistent within 2 per cent. The earthed steel rods contributed considerably to the reproducibility of the results. They appeared to restore the nylon to a standard electrical state after each passage over the brass rod.

Figs. 1 and 2 show the results obtained for five liquids when applied to nylon in increasing amounts. When a new liquid was to be tested the rods were cleaned with acetone. Two types of curve will be noted. The smooth curves in Fig. 1 show a variation with the dielectric constant (*D*). The liquid having the higher constant seems to be the more effective at small amounts on the yarn in reducing the genera-

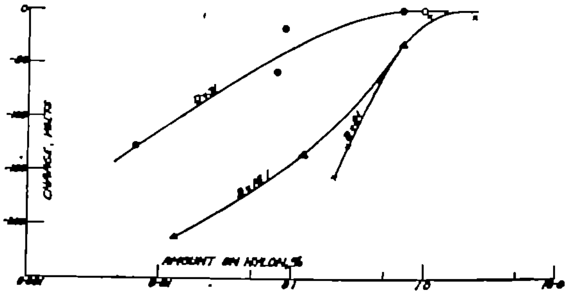

Fig. 1. Effect of dielectric constant *D* on charge

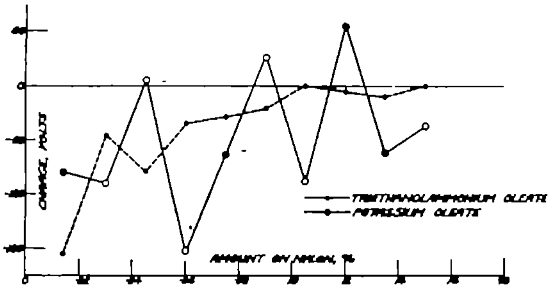

Fig. 2. Effect of surface activity on charge

tion of electrical charges. It may be that water owes its effectiveness for this purpose to the comparatively high dielectric constant ($D = 81 \cdot 5$). Liquids of the surface-active type appear to give a second class of curve. Two examples, chosen from a large number, are illustrated in Fig. 2. These curves follow the general trend of those of the first class, but show a peculiar periodicity, often with a reversal of sign of the electrical charge. This would seem to be an expression of the existence of molecular layers, since the change in amount of liquid between the peaks and valleys on the curve approximates to that required to deposit a monomolecular layer on the nylon. From the reversals in sign it would seem that the dipoles are oriented alternately in direction. Electrical charge is finally eliminated when the layer of antistatic agent is sufficiently thick to allow the outer surface to behave as an isotropic liquid. This effect is illustrated by triethanolammonium oleate. Potassium oleate, on the other hand, appears to be laid down in much more rigid layers and, in the example given, is not present in sufficient quantity to behave as an isotropic liquid. The most effective of this class of antistatic agent seem to be those which combine (*a*) a dipole of such a strength as to limit the field due to the nylon within several layers of the surface, and (*b*) a degree of surface activity which allows random orientation at small amounts.

The experimental results allow us to speculate on the mechanism by which antistatic agents function. If a body, covered by a film of antistatic agent, meets a second body, a thin film of antistatic agent separates the two. The antistatic agent limits the fields of the bodies to a short distance within the film, so that interaction of the fields is impossible and no contact potential is created within the body of the film. If, on subsequent separation, the division takes place within this section of the film, then no significant static charge results since, in effect, like materials have been separated. The more effective the antistatic agent is in limiting the field the more effective it is in reducing static charges.

Examination of the curve for potassium oleate seems to give information on the mechanism of generation of static electricity as well as that concerning antistatic action. It will be noted that considerable voltages are indicated at points where the influence of the nylon must be comparatively small. These voltages seem to be due to dipoles fixed in position by orientation with the nylon acting as a support only. Therefore, one might conclude that one type of generation of static electricity, at least, is due to the action of dipoles in fixed orientation at or near the interface of bodies in contact.

The advice and criticism of Dr. J. H. Michell is gratefully acknowledged. We are indebted to Canadian Industries, Ltd., for permission to publish this communication. A detailed account of the work will be published elsewhere.

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Temperature Dependency of Half Line-Width in Ferrite

An experimental investigation of half line-width in ferromagnetic resonance absorption at various temperatures has been carried out by Bloembergen[1], using some ferromagnetic metals. The results were compared with the theory by Van Vleck[2].

In order to clear up the real nature of half line-width in the ferromagnetic resonance experiment, it is desirable to investigate the temperature dependency of line shape in an insulator.

In the present work, half line-widths have been determined for some ferrites, $MgOFe_2O_3$, $CuOFe_2O_3$, $MnOFe_2O_3$ and $NiOFe_2O_3$, in a resonance experiment over a temperature-range of − 195° to the Curie point, using thin specimens in the form of disks, and a wave-length of 3·2 cm.

The results for these materials show almost the same tendency with varying temperature; the changes of line-width for $MgOFe_2O_3$ and $CuOFe_2O_3$ only are shown in the accompanying tables.

$MgOFe_2O_3$. Curie point, 432° C.

Temp. ° C.	−190	−130	−110	−82	−50	16	51	79	124	164	204	242	281	320	356	390	398
Line-width (Oe.)	840	680	640	588	502	435	388	338	316	270	240	200	160	157	116	98	97

$CuOFe_2O_3$. Curie point, 430° C.

Temp. ° C.	−176	−145	−122	−99	−87	−65	−50	−20	20	62	102	110	147	210	260	310	362	400	410
Line-width (Oe.)	800	700	609	550	520	482	465	420	350	315	258	265	240	200	190	170	137	122	122

Generally speaking, the half line-width decreases monotonously with increase of temperature; the line-width becomes narrower at temperatures near the Curie point; afterwards the resonance suddenly disappears above the Curie point. The results are quite contrary to the case of ferromagnetic metals.

Details of the apparatus and procedure will be published in *Sci. Rep. RITU*.

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Hüttig's Adsorption Isotherm

Three years ago, Hüttig[1] derived a multilayer adsorption isotherm which in most cases agrees with experiment up to higher relative pressures $x = p/p_s$ (where p_s is vapour pressure of the liquid adsorbate) than the Brunauer–Emmett–Teller[2] isotherm. Hüttig's formula, however, is not in accord with the kinetic assumptions implied in the derivation and does not explain the entire failure of the theory at very high pressures (x greater than 0·8).

The kinetic assumption underlying Hüttig's theory is that *all* molecules of each layer may evaporate, whereas in the Brunauer–Emmett–Teller theory only uncovered molecules are allowed to do so. Hüttig's mechanism of desorption is rather unrealistic from the point of view of the multilayer model in which the adsorbed molecules are arranged in vertical chains. To permit a lateral evaporation of covered molecules, these vertical chains must be arranged rather loosely, and one can scarcely assume that such an arrangement would be in a stable equilibrium. Further, if a covered molecule evaporated from the lower part of a vertical chain, this chain would collapse or at least re-arrange itself, so that the net result would again be evaporation from the top of the chain.

This difficulty can be removed in the following way. We consider a surface on which adsorption occurs only at localized centres separated from each other by surface regions with negligible attractive power for the adsorbate. The distance between the centres should be at least one or two molecular diameters. Then the vertical chains of the multilayer model turn over into the surface, where they form essentially two-dimensional clusters around the localized centres. In this model the concept of several layers loses its meaning. We can distinguish only between the molecules adsorbed on the localized centres (first layer) and additional molecules (higher layers). We shall, however, retain Hüttig's formalism in which the different layers are distinguished. It appears that for this model Hüttig's mechanism of evaporation is quite satisfactory. A proof of this assumption can be derived, however, only from a rigorous statistical treatment of the model. The statistical equivalent to Hüttig's formalism will be investigated elsewhere.

Quite independent of the special condition of desorption, there is still another, much more general, argument for the proposed cluster model. It has been shown by Halsey[3] that two-dimensional condensation within the first layer occurs earlier than the formation of higher layers in all cases where the surface centres are close enough together to exclude the cluster model suggested here. Hence it appears that this latter model is the only one which fits the formalism of Brunauer–Emmett–Teller or Hüttig.

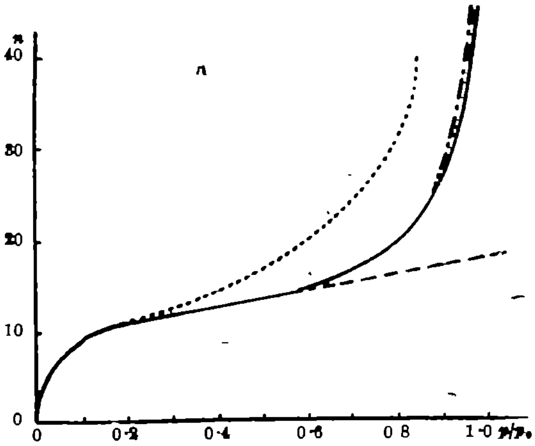
Concerning the failure of Hüttig's isotherm for very high pressures, we assume that this failure is the result of the simplification that the affinity constants K_1 and K (see equation 1) or, in other words, the conditions of evaporation, do not depend on the number of adsorbed molecules. This simplifying assumption can be modified in a semi-empirical way by the following considerations. The clusters, which are essentially two-dimensional at low pressures, will gradually overlap and grow vertically to the surface if the pressure is increased. The result will be that a certain fraction n' of the n adsorbed molecules will be entirely enveloped by other molecules, and hence unable to evaporate. If we put $n' = nx^s$, Hüttig's velocity of desorption $K_i''n$ is transformed to $K_i''n(1 - x^s)$ and the affinity constant $K_i = K_i'/K_i''$ is transformed to $K_i/(1 - x^s)$. Introducing this expression into Hüttig's formula (1) (where n_s is number of surface centres),

$$\theta = \frac{n}{n_s} = \frac{K_1 p}{1 + K_1 p}\,(1 + Kp)\,; \qquad (1)$$

and putting $K_1 p = Cx$ and $Kp = x$, we obtain:

$$\theta = \frac{Cx}{1 + Cx - x^s} \cdot \frac{1 + x - x^s}{1 - x^s}. \qquad (2)$$

Equation 2 is the formula for the cluster isotherm in the notation of the Brunauer–Emmett–Teller theory. It is a generalization of formulæ which are the limiting cases for $s = 1$ (Brunauer–Emmett–Teller) and $s = \infty$ (Hüttig). Since in Hüttig's theory the number of chains containing s adsorbed molecules is about $n_1 x^s$ (n_1 is number of molecules in the first layer), s can be interpreted as the average number of molecules necessary to envelop entirely a molecule of the first layer. Hence the reciprocal of s measures the tendency of the essentially two-dimensional clusters partly to grow vertically to the surface. $1/s$ is zero for Hüttig's isotherm; this involves restriction to entirely two-dimensional clusters and the finite number $2n_s$ of adsorbed molecules for $p = p_s$.



——, Experimental; – – – –, Hüttig; . . . . , Brunauer–Emmett–Teller; —·—·, cluster-isotherm

Adsorption isotherms for the system H_2O–$BaSO_4$ at 273° K.

The agreement between formula (2) and experiment is found to be very satisfactory. This can be seen from the accompanying graph, which is characteristic of a large number of cases. The parameter s, which is 5 in this case, has been found to assume values between 2 and 12 in other systems and to increase with temperature.

Details of this work will be published elsewhere.

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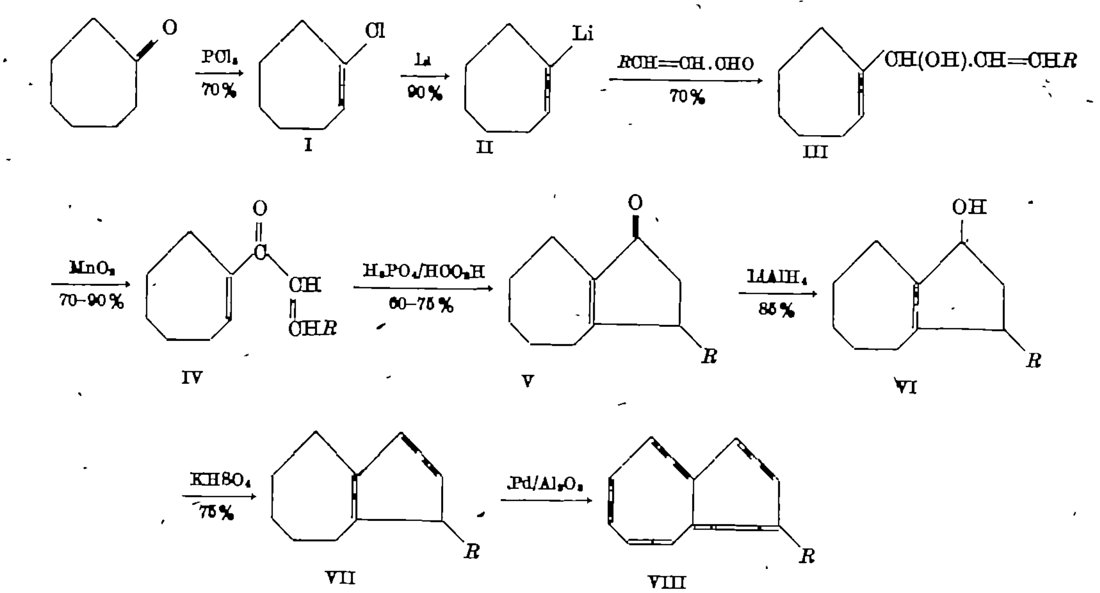
A New Route to Azulenes

Although several syntheses of azulene (VIII; R=H) and azulene derivatives have been described[1], investigations on the chemistry of this non-benzenoid aromatic system have been hampered by the fact that the procedures hitherto available do not readily lend themselves to the preparation of azulenes on more than a relatively small scale. We have recently developed a new synthesis, based on the method of alkenylation with lithium alkenyls[2], which offers some advantages in this respect.



The new synthesis is illustrated here for azulene itself and for 1-methylazulene. 1-Chloro*cyclo*heptene (I), prepared by treating *cyclo*heptanone with phosphorus pentachloride[3], is readily converted into 1-*cyclo*heptenyl lithium (II) by reaction with lithium metal in ether suspension[4]. The lithium alkenyl undergoes the usual addition reaction with acraldehyde or crotonaldehyde, to give the dialkenylcarbinols (III; R=H or Me)[4]. Oxidation of the latter with manganese dioxide in petrol suspension[5] affords the dialkenyl ketones (IV; R=H) (b.p. 61°/0·5 mm., n_D^{21} 1·5138; found: C, 80·4; H, 9·7; $C_{10}H_{14}O$ requires C, 80·0; H, 9·4 per cent), 2 : 4-dinitrophenylhydrazone (m.p. 198°), and (IV, R=Me) (b.p. 84°/0·4 mm., n_D^{25} 1·5166; found: C, 80·6; H, 10·1; $C_{11}H_{16}O$ requires C, 80·4; H, 9·8 per cent), 2 : 4-dinitrophenylhydrazone (α-form, m.p. 118°; β-form, m.p. 129°). Treatment of the ketones (IV) with a mixture of phosphoric and formic acids[6] at 90° resulted in smooth cyclization to the octahydroketoazulenes (V, R=H), $\lambda_{max.}$ 2410 (ε 12,300) and 2910 A. (ε 85) in ethanol; semicarbazone, m.p. 238° (reported[7,8] m.p. 238° and 235–236°) and (V, R=Me) (b.p. 77°/0·4 mm.; n_D^{20} 1·5118; $\lambda_{max.}$ 2440 (ε 9200) and 3000 A. (ε 65) in ethanol; found: C, 80·4; H, 9·8; $C_{11}H_{16}O$ requires C, 80·4; H, 9·8 per cent), 2 : 4-dinitrophenylhydrazone (m.p. 236°). Reduction of the octahydroketoazulenes with lithium aluminium hydride in ether at 0° gave the hydroxyoctahydroazulenes (VI, R=H) (b.p. 64°/0·1 mm., n_D^{18} 1·5132; found: C, 79·1; H, 10·9; $C_{10}H_{16}O$ requires C, 78·9; H, 10·6 per cent) and (VI, R=Me) (b.p. 80°/0·4 mm., n_D^{21} 1·5058; found: C, 79·5; H, 10·9; $C_{11}H_{18}O$ requires C, 79·5; H, 10·8 per cent), 3 : 5-dinitrobenzoate (m.p. 87°). Dehydration of the alcohols (VI) by distillation from potassium bisulphate and dehydrogenation of the resulting dienes (VII) with a palladium–alumina catalyst[9] afforded azulene (VIII, R=H) and 1-methylazulene (VIII, R=Me). The latter gave an *s*-trinitrobenzene adduct (m.p. 155°, undepressed on admixture with an authentic specimen kindly provided by Prof. Pl. A. Plattner[7]).

Other methods of effecting the last step are under investigation, and details of this work will be published elsewhere in due course.

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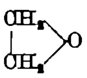
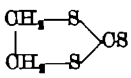
Some Trithiocarbonate Derivatives of Carbohydrates

Ethylene oxide (I) and its simple analogues react with carbon disulphide and potassium hydroxide in methyl alcoholic solution to give cyclic compounds, containing three atoms of sulphur, which are termed trithiocarbonates. Culvenor, Davies and Pausacker[1] described the transformation of ethylene oxide into ethylene trithiocarbonate (II), and of *cyclo*hexene oxide into *cyclo*hexene trithiocarbonate. Furthermore, although this transformation has not yet been carried out, these compounds should readily undergo reductive desulphurization



I



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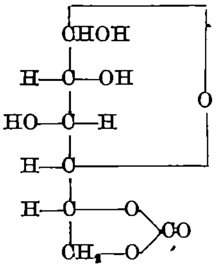

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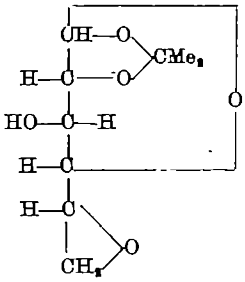
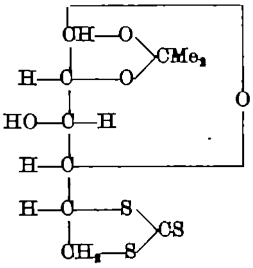
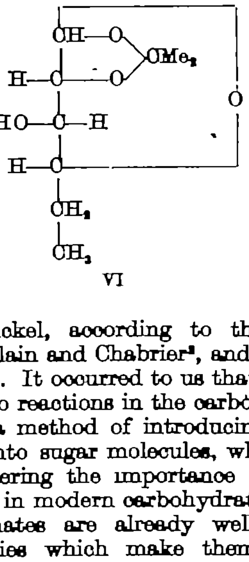


IV



V



VI

with Raney nickel, according to the method of Bougault, Cattelain and Chabrier[2], and afford ethane and *cyclo*hexane. It occurred to us that the exploitation of these two reactions in the carbohydrate series might lead to a method of introducing two vicinal deoxy groups into sugar molecules, which might be of value considering the importance now assumed by deoxysugars in modern carbohydrate chemistry.

Sugar carbonates are already well known and possess properties which make them particularly useful in synthetic work, because the carbonate group is stable to mildly acidic conditions but labile to alkaline reagents. Haworth and Porter[3] prepared glucofuranose 5 : 6-carbonate (III) in 1929 and used it to prepare crystalline glucofuranoside derivatives. It is anticipated that trithiocarbonates may also find uses in synthetic sugar chemistry, not only as protective groups but also as a means whereby thiol groups may be introduced into sugar molecules.

We have now found that three ethylene oxide derivatives of carbohydrates readily yield trithiocarbonate derivatives, and that these undergo smooth reductive desulphurization to furnish the corresponding dideoxy compounds.

1 : 2 - *iso*Propylidene 5 : 6 - anhydroglucofuranose (IV), on treatment with carbon disulphide and potassium hydroxide in boiling methyl alcohol, furnished 1 : 2-*iso*propylidene 5 : 6-dideoxyglucofuranose trithiocarbonate (V), melting point 179·5–180·5° (found: C, 40·8; H, 4·52; S, 32·3; $C_{10}H_{14}O_4S_3$ requires C, 40·8; H, 4·76; S, 32·6 per cent). This, on reductive desulphurization with Raney nickel in boiling ethyl alcohol, afforded 1 : 2-*iso*propylidene 5 : 6-dideoxyglucofuranose (VI), melting point 78°, $[\alpha]_D^{11}$ $-31·4°$ (in chloroform) (found: C, 57·4; H, 8·5. $C_9H_{16}O_4$ requires C, 57·4; H, 8·5 per cent). 1 : 3-2 : 4-Diethylidene 5 : 6-anhydrosorbitol and 1 : 2-3 : 4-di-*iso*propylidene 5 : 6-anhydromannitol serve as examples of hexitol derivatives which may participate in this reaction. The sorbitol derivative gave rise to 1 : 3-2 : 4-diethylidene 5 : 6-dideoxysorbitol 5 : 6-trithiocarbonate as yellow needles of melting point 182–183·5° (found: C, 43·0; H, 5·37; S, 30·7; $C_{11}H_{16}O_4S_3$ requires C, 42·8; H, 5·2; S, 31·2 per cent), which was smoothly transformed, by treatment with Raney nickel, into 1 : 3-2 : 4-diethylidene 5 : 6-dideoxysorbitol, melting point 84·5–85·5°. This was clearly identical with the compound, melting point 85–86°, prepared by Bladon and Owen[4], by the treatment of 5 : 6-ditoluene-*p*-sulphonyl 1 : 3-2 : 4-diethylidene sorbitol with sodium iodide followed by hydrogenation of the corresponding 5 : 6-sorbitoleen produced. The mannitol anhydride afforded 1 : 2-3 : 4-di-*iso*propylidene 5 : 6-dideoxymannitol 5 : 6-trithiocarbonate, melting point 95–96° (found: C, 46·5; H, 6·04; S, 28·8; $C_{13}H_{20}O_4S_3$ requires C, 46·4; H, 5·95; S, 28·6 per cent), which, on reductive desulphurization gave 1 : 2-3 : 4-di-*iso*propylidene 5 : 6-dideoxymannitol as a liquid distilling at 90° (bath temperature)/0·05 mm. and showing $[\alpha]_D^{18}$ $+11·5°$ (in alcohol) (found: C, 62·9; H, 9·2; $C_{12}H_{22}O_4$ requires C, 62·6; H, 9·6 per cent).

All three trithiocarbonate derivatives were beautifully crystalline solids of bright yellow colour showing a strong absorption band in the ultra-violet region of the spectrum at λ 3160 A. (ε max. 13,500–15,000).

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Tetrabromothiophene from 2-Bromothiophene by means of Sodium Acetylide in Liquid Ammonia

In the course of our investigations on acetylenic compounds in the thiophene series[1], it was desired to synthesize 2-thienylacetylene directly from 2-bromothiophene and 2-chlorothiophene by means of sodium acetylide in liquid ammonia. Although it is known that arylations via this method are unsuccessful when applied to halides in the benzene series[2a,b], no experiments are recorded in the literature with heterocyclic compounds. In view of the greater reactivity of the thiophene nucleus, it appeared worth while to attempt this reaction.

2-Bromothiophene was prepared according to an earlier description[3], the sodium acetylide by known methods[2a,b], and the 2-chlorothiophene used was a commercial product.

While 2-chlorothiophene did not react and the starting material was recovered quantitatively, 2-bromothiophene reacted vigorously. To the prepared sodium acetylide in liquid ammonia the calculated amount of 2-bromothiophene was added by drops. The reaction mixture was stirred for four hours and hydrolysed with water. When sodium acetylide was prepared without using a catalyst (hydrated iron nitrate), the reaction mixture turned from colourless to light brown and finally, after hydrolysis of the mixture, to black. There was also present a large amount of free carbon. Under analogous conditions, when employing 2-chlorothiophene, no free carbon was noticed. After isolation of the reaction product with ether, there resulted a crystalline substance and we regained some starting material. From 50 gm. (0·32 mole) of 2-bromothiophene we obtained 10–14 gm. of the crystalline substance, 13 gm. (0·08 mole) of recovered 2-bromothiophene, and 2 gm. of a high-boiling oil, probably a mixture of di- and tri-bromothiophene. The yield of the crystalline substance was 35–45 per cent, depending on the method of preparation of the sodium acetylide. The yield was greater when the sodium acetylide was prepared via sodium amide using an iron nitrate catalyst.

The substance, recrystallized from dilute ethanol, gave white needles melting at 114° C. The analysis gave the following results: calculated for C_4Br_4S: C, 12·02; Br, 80·00; S, 8·04; found: C, 12·31; Br, 80·25; S, 8·44. The molecular weight determined by the Rast method was 380 ± 12. The product was identified as tetrabromothiophene, in that it did not depress the melting point on admixture with an authentic specimen prepared according to the method of Volhard and Erdmann[4].

Further investigations on this type of reaction are being carried out.

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Urea as a Solvent

Although urea is an inexpensive laboratory chemical, its solvent properties do not appear to have been fully appreciated by chemists. Nevertheless, it may well prove to be one of the most versatile solvents known. Maintained at its melting point of 132° (conveniently done, if so desired, by refluxing with xylene with which it is immiscible) its decomposition is very slow. It then combines the solvent properties of water with that of alcohols.

Of approximately a hundred and twenty common inorganic chemicals, the only water-soluble compound which could not be dissolved in urea was sodium silicate. On the other hand, iodine proved to be very soluble.

In general, ions in urea solution possess their familiar colours, save that cobalt solutions are blue. Powerful oxidizing and reducing agents are, of course, decomposed; nevertheless, alkali metal chromates, dichromates and ferricyanides are surprisingly stable, the last-named much more so than in formamide solution.

Common inorganic precipitation reactions can be carried out in urea solution; precipitates of sulphur, copper, mercury, silver, mercurous chloride, mercuric iodide, barium sulphate, thallium iodide, silver chloride, bromide and iodide, silver chromate, magnesium and barium carbonates, copper ferrocyanide, heavy-metal sulphides, nickel dimethylglyoxime, etc., were readily obtained.

Urea dissolves methyl orange, phenolphthalein and litmus readily—the colouring matter is rapidly dissolved from litmus paper, giving a blue or red solution depending upon the acidity. Sodium carbonate is easily soluble and can be titrated with such acids as sulphuric, sulphamic or oxalic. With phenolphthalein, sodium carbonate gives a deep red solution below 140°; at 150° the colour is discharged but returns reversibly on cooling. Ammonium salts of strong acids give strongly acid solutions when hot which reversibly become alkaline on cooling. Alkali hydroxides are soluble but produce carbonate fairly rapidly. Acid solutions attack metals, evolving hydrogen.

Urea proved an excellent solvent for all save a small number of common organic chemicals. Among those with low molecular weights only hydrocarbons were insoluble. Nitro, amino and carboxy groups confer increasing solubility in the order given. Hydroxy compounds, ketones, esters, anilides, amino-acids, substituted hydrazines, etc., are readily soluble and decomposition is rare. Often the organic compound is miscible with molten urea in all proportions. Gluten, dextrin, sodium alginate, gum arabic, soap, etc., dissolve readily.

In the laboratory, urea is a valuable tool for dissolving sparingly soluble compounds. (1) A 5 per cent solution of N-phenylanthranilic acid in molten urea is cooled and powdered. For use as an oxidation-reduction indicator, 0·5 gm. of the solid is added to a solution, when the urea instantly dissolves, leaving the indicator as a finely divided suspension in the liquid. (2) So-called 'soluble' starch dissolves in urea to give a highly viscous clear solution. If a 5 per cent solution is cooled and powdered, the product is ideal for use in titrations involving iodine. It dissolves almost instantly to give a clear colourless solution which is still highly sensitive to iodine, giving the familiar blue colour.

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A Rapid Method for the Determination of Nucleic Acid Components by Paper Partition Chromatography

Methods for the analysis of small amounts of nucleic acids and their components by paper partition chromatography have been described by Vischer and Chargaff[1] and Chargaff *et al.*[2]. Photographic methods for their identification on paper have also been used[3,4], based on the specific absorption in the ultra-violet range of the spectrum of the nucleic acid components. The present communication describes a simple and sensitive method for rapid analysis in routine work.

Hydrolysis. The purines, adenine and guanine, and the pyrimidine nucleotides, cytidylic acids and uridylic acids, were obtained by acid hydrolysis of yeast nucleic acid (1 hr., 1 *N* hydrochloric acid, 100° C.).

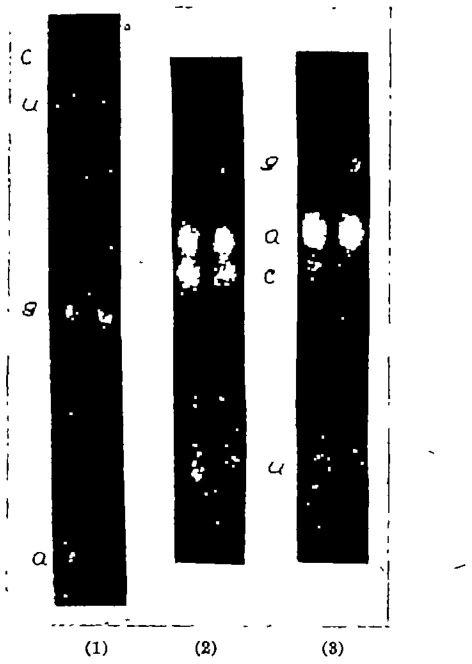
Separation. Spots containing 50–150 γ nucleic acid were prepared on filter paper (Munksell OB) by an Agla micropipette. Butanol was used as a solvent in the following two solutions: (*a*) *N*-butanol (4), dioxane (1) and distilled water (1), the spots on the paper being neutralized by gaseous ammonia; (*b*) *N*-butanol (4), diethylene glycol (1) and 1·5 *N* hydrochloric acid (1). Table 1 shows the R_F values found.

Table 1. R_F VALUES

	Solutions	
	a	*b*
Adenine	0·64	0·29
Guanine	0·37	0·18
Cytidylic acid	0 09	0·35
Uridylic acid	0·17	0 63

A suitable time for separation on paper strips 40 cm. long was found to be 18 hr. After drying the paper strips for two hours at 80–90° C., photography was carried out in the ultra-violet range.

Optical equipment. Monochromatic light of wavelength 257 μμ and 275 μμ was generated between rotating cadmium electrodes of an ultra-violet microscope constructed according to Köhler. A quartz condenser of numerical aperture 0·3 and a 6-mm. monochromat of numerical aperture 0·35 corrected for 257 μμ or 275 μμ (Cooke, Troughton and Simms) was used. 60 cm. from the exit pupil of the objective a drum was fastened to a stand, with its axis perpendicular to the incident light and within the homogeneous field of illumination. The drum is 13 cm. in diameter and 12 cm. wide, provided with a fold at the edges, and it is rotated by a crank. Paper strips 5–10 cm. wide were photographed against a blue-sensitive photographic paper of similar width. Paper and film were braced by two strips of brass, the distance between which could be varied. Thus, paper up to 40 cm. in length could be photographed continuously. Uniform exposure was obtained by rotation of the drum for 60 sec. at 257 μμ and for 30 sec. at 275 μμ.



Paper strips 5 cm. broad photographed in the ultra-violet (1) With butanol–dioxane–distilled water as solvent at 257 μμ, (2) and (3) with butanol–diethyleneglycol-hydrochloric acid at 275 μμ and at 257 μμ. In both instances 65 γ yeast-nucleic acid was subjected to separation *a*, *g*, *c* and *u* refer to adenine, guanine, cytidylic acid and uridylic acid respectively. Note increase in sensitivity at 275 μμ

Results. Photographs of some chromatograms are reproduced in the accompanying figure. The sensitivity of the method for purines and pyrimidines in γ per cm.[2] can be seen from Table 2.

Table 2

Adenine	0·35
Guanine	0·55
Cytosine	0 75
Uracil	0 45
Thymine	0 60

By using the cadmium band at 275 μμ the value for cytosine can be halved.

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Identification of Sulphonamides on Paper Chromatograms

THE recent communication on this subject by R. Robinson[1] has prompted me to record some observations made about two years ago on this subject.

Butanol – acetic acid solvent was found the most satisfactory of many solvents tried, being prepared by mixing *n*-butanol, acetic acid and water in proportions 50–15–35 by volume. The mixture is homogeneous and very slightly under-saturated with water at room temperature, it is easily prepared and gives reproducible R_F values which are almost identical with those obtained with the equilibrated solvent suggested by Partridge in 1948.

R_F-values found range from 0·55 (sulphaguanidine) to 0·85 (sulphamerazine). Some good separations are obtained; for example, the three components of sulphatriad can be demonstrated in the urine of a patient on treatment with this drug.

Detection of the sulphonamide spots makes use of the diazo- and coupling reaction carried out in alcoholic solution to minimize spreading of the spots. Nitrous acid solution is sprayed on the dried paper, followed after one minute, by a 1 per cent solution of dimethyl-α-naphthylamine or similar coupling reagent. The sulphonamides show as red or pink spots of the azo colour, one microgram being readily detected.

No spreading of the spots occurs and quantitative measurements have been carried out quite successfully using the method described by Fisher *et al.*[2].

The nitrous acid solution is prepared as follows: 0·1 gm. of sodium nitrite in 1 ml. of water is shaken with 10 ml. of *n*-butanol, and 0·3 ml. concentrated hydrochloric acid added with shaking. The mixture is allowed to stand for a few minutes before use; solid sodium chloride may separate. The solution is stable for several days.

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Phenolases in the Echinoid, *Diadema antillarum* Philippi

Diadema antillarum possesses an abundant black pigment which shows the chemical and histochemical properties of melanin, and is concentrated in epidermal chromatophores[1]. In view of much evidence from other forms of a relationship between the occurrence of melanin and phenolases, evidence of such enzymes in *Diadema* was sought.

Cœlomic fluid removed from the animal forms a colourless slimy clot of aggregated cœlomic amœbocytes, which rapidly changes to red, and then, as in '*Thyone*'[2], slowly becomes brown or black. In *Diadema*, the process involves oxidation, since it is hastened by aeration and prevented if the fluid is exposed in nitrogen. The pigment produced has the characteristics of melanin.

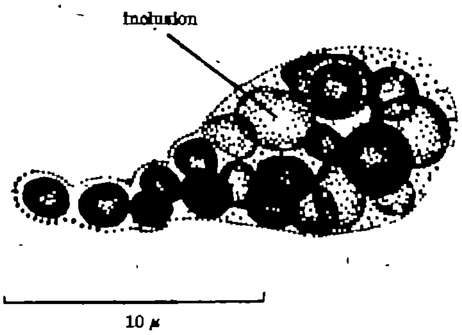
Darkening is inhibited by boiling and by 0·0003 *M* potassium cyanide, and thus appears to be an enzymatic process involving oxidases. Phenolases are indicated by the character of the colour change, and the production of coloured oxidation products by the action of the cœlomic fluid on phenolic substrates such as 1-tyrosine, dihydroxyphenylalanine, pyrocatechol, *p*-amino phenol, quinol and pyrogallol, buffered within the *p*H range 6·5–7·4. The reactions are accelerated by detergents. As reported by Pugh and Raper[3] for mealworm phenolases, the enzyme system does not act on quinol at *p*H 7·0 unless the solution is dilute (0·0002 *M* in *Diadema*).

Other features of these colour reactions indicating participation of phenolases are activation by ultra-violet light and inhibition by 0·0002 *M* potassium cyanide and hydrogen sulphide. 3 *M* Ethanol and 4 *M* methanol are usually inhibitory, though not invariably so. It is highly significant that darkening of the clot in cœlomic fluid is similarly affected by these factors, and further, it is usually, but not always, inhibited by *p*-benzyl-hydroquinone ('agarite alba').

The enzymes are not part of the cytochrome–cytochrome oxidase system, since they are soluble in water, unaffected by 0·002 *M* sodium azide at *p*H 7·3 and only slightly affected by acetone.

There is thus evidence of both monophenolase and polyphenolase activity in the cœlomic fluid.

Both activities are shown by the clot alone, and both are markedly increased when it is removed from the fluid and later replaced in the same fluid which has been boiled and cooled. This indicates the presence of a heat-labile inhibitory factor in the fluid, which could be associated with a system of low oxidation–reduction potential, for the potential of the fluid is lower than that of the amœbocytes.



Living amœbocyte from a freshly formed clot of cœlomic fluid showing spheroidal inclusions

Darkening of the clot on exposure to air is due to blackening of spheroidal or discoidal cytoplasmic inclusions in the amœbocytes (see diagram), which occurs whether the inclusions be *in situ*, or free, following breakdown of the amœbocytes after centrifuging and shaking. They therefore appear to play an essential part in pigment production, embodying enzyme, substrate, or both. The fact that they also blacken after intra-cœlomic injection of dihydroxyl-phenylalanine in sea water affords further indication that they contain the enzyme system. A varying proportion of the inclusions are bright red; but the significance of the red pigment in relation to their subsequent blackening is obscure. Should it transpire to be an echinochrome, it may prove of importance in view of the participation of these and similar compounds in reversible oxidation–reduction systems (Cannan[4]), and the importance of such systems in regulating melanogenesis[5].

A full account of the investigation will be published elsewhere.

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Potentiation by Adrenocorticotrophin of the Diabetogenic Action of Growth-Hormone Preparations

THE adrenocorticotrophic hormone is not a potent diabetogenic agent in the intact cat[1], in contrast to growth hormone. Its influence on the diabetogenic activity of growth-hormone preparations in the intact cat has now been studied, as briefly reported elsewhere[2].

The growth-hormone preparations were derived from ox anterior pituitary glands, and included crude extracts and purified products[3]. The growth-hormone content of the former was assayed in adult female rats[4]. The adrenocorticotrophic hormone preparation employed in the present experiments was derived from pig pituitary glands, and had a potency 2·5 times that of the Armour standard (ascorbic acid depletion). Both preparations were given subcutaneously, at different sites, to intact adult male cats fed on a meat diet, the intake of which varied little from day to day[5]. In each test, treatment was continued until a glucose excretion exceeding 5 gm. in 24 hr. ('5-gm. response'[5]) had been induced. The growth-hormone preparation was given once daily, and the other preparation usually three times daily (during eight hours).

In a given cat there is an inverse relationship between the dose of a diabetogenic preparation and the period of treatment required to induce the '5-gm. response'[5]. Thus, in control experiments with a crude extract in cat 231 (tests 1 and 2, Fig. 1), a daily dose of 6 mgm. (expressed as growth hormone) was effective in three days, and one of 2 mgm. (trebled after six days) was effective only after eight days of treatment. When, however, the growth-hormone preparation was given at a daily dose of 2 mgm. in conjunction with adrenocorticotrophic hormone, the response was obtained in only three days. Since the subsequent control test showed that the sensitivity of the cat to the growth-hormone preparation alone had not changed, it was concluded that the adrenocorticotrophic hormone had potentiated its diabetogenic action. Tests 5 and 6, in conjunction with the preceding tests, indicate that adrenocorticotrophic hormone given at a reduced dose, only once daily, still had some potentiating action.

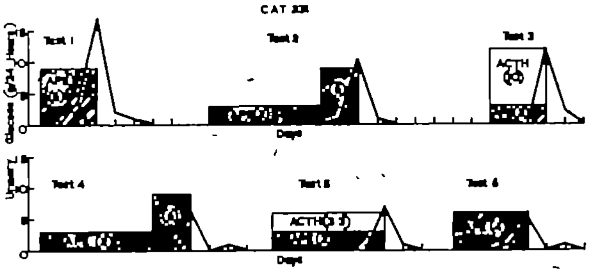

Fig 1

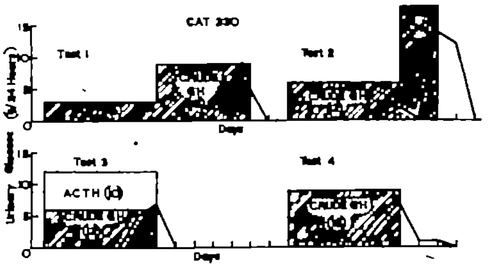

Fig 2

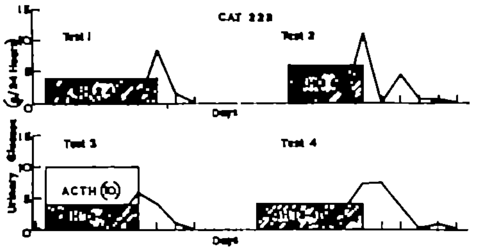

Fig 3

Potentiation experiments using adrenocorticotrophic hormone (*ACTH*) with: (1) crude anterior pituitary extract (*APE*) in cat 231; (2) a crude growth-hormone preparation (= crude *A* fraction of Wilhelmi *et al.*[3]) in cat 230; (3) a purified growth-hormone preparation in cat 222. Period of treatment denoted by rectangle, the height of which is, for each cat, proportional to the daily dose (also indicated numerically). Doses expressed as mgm. of growth hormone (*GH*) or, in the case of adrenocorticotrophic hormone, as mgm. of Armour standard

In cat 230 (Fig. 2), with a crude growth-hormone preparation, 12 mgm. given with adrenocorticotrophic hormone (test 3) was as effective as 18 mgm. given without the latter with respect to the period of treatment required to induce the response. A smaller, but probably significant, potentiating action of adrenocorticotrophic hormone was observed in cat 222 (Fig. 3) with a purified growth-hormone preparation. In this experiment, 2·4 mgm. of growth hormone given with adrenocorticotrophic hormone (test 3) was more effective than 2·4 mgm., but less effective than 3·6 mgm., of growth hormone given alone.

It is concluded that the diabetogenic action of growth-hormone preparations in the intact cat may be augmented by adrenocorticotrophic hormone given simultaneously. While the investigation was in progress, Engel and co-workers[6] briefly reported that growth hormone is diabetogenic in the force-fed rat if adrenocorticotrophic hormone is given simultaneously, although growth hormone alone is not a potent diabetogenic agent in the rat.

My experiments were performed during the tenure of a Beit Memorial fellowship. The costs were largely defrayed by a grant from the Medical Research Council to Prof. F. G. Young, to whom I am indebted for his interest and encouragement. Thanks are expressed to Drs. I. M. Bunding, E. E. Hays and J. R. Mote, of Armour and Co., Chicago, for providing adrenocorticotrophic-hormone preparations, and to Prof. A. E. Wilhelmi for advice on the preparation of growth hormone. For technical assistance, thanks are expressed in particular to Mr. M. Snowdon.

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Low Toxicity of the Diphtherial Culture Filtrate and its Relation to the Absence of Tyrosine in the Medium

I HAVE already shown[1] that the diphtherial culture filtrate harvested from the chemically defined media (A.M.C. and A.M.T. medium) containing two (asparagine, DL-methionine) or three amino-acids (asparagine, DL-methionine and L-cystin) as a nitrogen source had a very low toxicity for guinea pigs, while it showed a high degree of flocculation units.

While searching for the causes of this phenomenon, it has been observed that the presence of tyrosine in culture medium plays an important part in controlling the toxicity of the diphtheria toxin produced. Typical results are given in Table 1. It will be seen that the median lethal dose per flocculation unit of the culture filtrate harvested from the medium containing tyrosine is about 35–100, whereas it is only 3–18 when tyrosine is absent.

Table 1. EFFECT OF THE PRESENCE OF TYROSINE IN MEDIUM ON THE TOXICITY OF THE CULTURE FILTRATE OF *C. diphtheriae*

Tyrosine (0·1 gm./l. of medium)	Exp. No.	Toxin content (Lf./ml.)	Toxicity (M.L.D.)	M.L.D./Lf.
Absent	1	20	100	5
	2	30	100	3
	3	28	100	4
	4	56	1,000	18
	5	60	500	8
	6	90	500	5
Present	1	10	1,000	100
	2	20	1,500	75
	3	17	1,500	88
	4	28	1,000	35
	5	40	2,000	50
	6	45	2,000	45

The A.M.T. medium used throughout this work was prepared by my method[2] with careful adjustment of starting pH (7·0) and iron concentration (1–2γ/30 ml. of medium), and its composition was as shown in Table 2. Tyrosine dissolved in phosphate buffer (pH 7·0) was added to the medium just before inoculation (0·1 gm./litre of medium).

Table 2

Asparagine	5·0 gm.
DL-Methionine	0·3 gm.
Sod. thioglycollate	0·5 gm.
Pot. dihyd. phosphate	5·0 gm.
Calcium chloride	1 0 gm.
Sodium chloride	4·0 gm.
Maltose	12·5 gm.
Sod. lactate	1·75 gm.
Mueller's II solution (ref. 3)	2·0 ml.
Aqua redest.	1,000 ml.

After inoculation with the pellicle from a four-day old culture of a sub-strain (adapted to the synthetic medium mentioned above) of *P.W.* No. 8 (Toronto Harvard) strain and eight or nine days incubation at 33–35° C., flocculation units and median lethal dose for guinea pigs (250–260 gm.) belonging to a vigorous stock were determined.

In 1943, Seki[4] described his finding that the removal of the crystalline (tyrosine) formed during the preparation of casein acid-hydrolysate tends to decrease the toxin content (from the estimation of median lethal dose) of the culture filtrate harvested from the casein hydrolysate medium; and Linggood and Woiwod have recently shown that tyrosine is present in toxin but not in toxoid hydrolysate of diphtheria on two-dimensional paper chromatograms[5]. Therefore, the possibility of an intimate connexion between the toxic group of diphtheria toxin and tyrosine present in the culture medium may be supposed, but the intrinsic significance of tyrosine is not yet clear. Further work to find the actual mechanism involved is now in progress. This will be published in detail later.

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[1] Yoneda, M., *Nagoya J. Med. Sci.*, 14, No. 2 (in the press, 1951).

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Factor *Rb* Activity in Human Plasma

FACTOR *Rb* is a protein-like, heat-labile requirement of the nematode *Rhabditis briggsae* Dougherty and Nigon, 1949, for growth and reproduction under axenic conditions[1,2]; chick embryo and mammalian liver have been shown to be good sources of it, and some activity has previously been noted in human whole blood and plasma[2].

It is of interest to report now that, when properly supplemented, human plasma has been shown, by recent work, to be a good source of factor *Rb*. The plasma used was obtained through the courtesy of Dr. Karol A. Hok, of the Cutter Laboratories, Berkeley; it was irradiated, lyophilized material, pooled from many donors and with approximately 0·4 per cent sodium citrate included as an anticoagulant. Water was added to restore the original volume, and the liquid was sterilized by Seitz filtration. Part of the sterile product was dialysed under sterile conditions against three changes of a large volume of distilled water. Both the dialysed and undialysed material were tested as sources of factor *Rb*. This was done by adding to each of a series of *Neurospora* growth-tubes 1 ml. of one of the plasma preparations and 1 ml. of an autoclaved liver preparation made by homogenizing horse liver with an equal weight of distilled water, centrifuging the product at 20,000 *g*, autoclaving the supernatant fluid, homogenizing the product, recentrifuging at 20,000 *g*, and sterilizing the clear supernatant by passing it through a Seitz filter.

The foregoing media have uniformly supported the production of vigorous cultures inoculated with a few dozen tiny larvæ. These results are in contrast to limited growth (maturation without successful reproduction) of larvæ placed in plasma supplemented with certain known ingredients[2].

The newer results are particularly significant for the development of a defined medium for *R. briggsae*, because the protein constitution of human plasma is the best known of any complex biological material[3]. It will now become possible to test the plasma protein fractions already available and probably to determine in which of these the factor *Rb* activity resides. This has a great advantage over extending the tedious fractionation of liver protein already carried out[2,4]. It may supply a rationale for the failure of peptic digestion to release factor *Rb* activity in non-protein form from liver protein[5].

The foregoing preliminary results are reported at this time by reason of the fact that further investigations on plasma protein will probably be delayed for more than half a year by projected travel abroad.

Note added in proof. My student, Douglas F. Keith, has recently been able to show that factor *Rb* activity is apparently confined to those plasma fractions rich in β-globulins (fractions III and IV). He is now testing subfractions of these fractions, particularly as supplemented only by known ingredients (that is, vitamins, salts, etc.).

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The Rabbit Lumbrical: a New Isolated Mammalian Nerve–Muscle Preparation

THE rat diaphragm phrenic nerve preparation[1] enabled mammalian muscle to be studied under precise conditions of drug and ion concentration, but is insensitive to decamethonium (*C*10). The object of this communication is to describe a new isolated mammalian nerve–muscle preparation which does not suffer from this disadvantage. Several muscles in the feet of rabbits and cats are suitable; but the medial lumbrical of the rabbit's hind foot has been found most satisfactory. It is usually about 18 mm. long and 1 mm. in diameter under physiological tension.

A rabbit is killed and bled, and the skin removed from one hind leg. It is very adherent on the plantar surface of the foot and must be carefully removed, since the nerve is immediately beneath it.

The long, very fine tendon of insertion of the medial lumbrical which passes around the medial side of the second digit is secured by a piece of silk and cut distally. Next the plantaris tendon passing to the second digit is separated and removed, allowing the lateral side of the muscle to be freed back to its origin from the junction of the medial two tendons of flexor digitorum longus.

The tibial nerve is dissected distally to the point where it splits into a sheaf of branches which turn diagonally to cross the plantaris tendons, and gently retracted laterally, to allow the medial plantaris tendon to be carefully separated and removed. The medial side of the muscle can now be freed up to its origin, and the part of the tendon from which the muscle arises is cut out with the muscle attached. This lumbrical is occasionally vestigial or absent, and variations in the nerve supply sometimes occur.

Directly and indirectly elicited contractions are equal in height provided the nerve is undamaged, although there may be some degree of temporary initial block, presumably due to anoxia during the dissection.

Using a weight-loaded lever designed to act ballistically, records of the order of 8 cm. in height are regularly obtained.

A gas mixture consisting of 95 per cent oxygen and 5 per cent carbon dioxide is used, and the temperature is maintained at 39° C. The preparation is sensitive to both *d*-tubocurarine and decamethonium. The reaction to decamethonium and sensitivity to both drugs are, however, very dependent on temperature and ionic concentration. At a stimulus-rate of about eight a minute, the preparation continues to contract without reduction in height or neuromuscular block for prolonged periods of time.

This investigation was supported by a grant from the Research Committee of the University of California Medical School, San Francisco.

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[1] Bülbring, E., *Brit. J. Pharmacol.*, 1, 38 (1946).

Selenium Toxicity associated with an Irish Soil Series

For a number of years a disorder in livestock has set a considerable farming problem in a district in County Limerick. In horses, this disorder in its severe form is shown by the loss of hair from mane and tail, with alteration in the growth, and eventually loss, of hooves. Horses affected in this way 'go down', while the less severe form of this condition is reflected in hoof deformation.

In cattle there is also alteration in the growth of hooves, with eventually the sloughing off of the old hooves and in some cases loss of the tail. The cattle thus affected show poor condition.

Due to loss and alteration of the growth of hooves, affected cattle find difficulty in moving about and in some cases assume a kneeling position when grazing.

An examination of soil and herbage samples has revealed nothing unusual with regard to major or minor elements, while blood samples analysed by Dr. O'Moore of the Veterinary Research Laboratory showed normal levels of sugar, phosphorus, calcium, magnesium and copper. Due to the similarity of this condition to that described by American workers[1,2] as typical of selenium toxicity, soil and herbage samples were examined for selenium content by the method of Dr. W. O. Robinson[3], whose advice[4] we gratefully acknowledge.

These analyses have shown that the selenium content of soil from affected fields varies between 30 and 324 p.p.m., whereas samples from immediately adjoining healthy soils gave values of less than 2 p.p.m. The selenium content of mixed herbage samples from affected areas gave values varying from 150 to 500 p.p.m., the latter figure being obtained from the soil showing the highest selenium content. Analyses of herbage samples from immediately adjoining non-affected fields gave values less than 1 p.p.m. By comparison with American figures for highly selenized areas, the selenium level of soils reported here is extremely high, while that for herbage is well above the limit of 5 p.p.m. stipulated as being marginal for toxicity, especially when it is considered that the analyses were on ordinary mixed-herbage samples. There would seem to be no doubt, therefore, that this condition is due to selenium toxicity.

The soils affected are low-lying valley soils in a glaciated area where the underlying rock strata consist of Upper Carboniferous Limestone. They are dark grey fine sandy loams to medium loams with the organic carbon content varying from 5 to 15 per cent and ranging in reaction from slightly acid to alkaline. In general, drainage is somewhat impeded and manganese deficiency in cereals is a problem on some of these soils. Rainfall at 40 in. a year is moderately high. From this description it can be seen that the affected soils differ considerably from those described for seleniferous areas in the United States. The normal soils at higher elevation in this area are brown to grey-brown fine sandy loams to medium loams, quite fertile, and from the data so far available do not appear to have been selenized.

There is evidence to suggest that the formation of affected soils has been considerably influenced by wash from Yoredale Beds (Avonian shales) which lie immediately to the west of the affected area. From Geological Survey data available, it would appear that these beds contain considerable deposits of iron pyrites, a circumstance of importance when explaining the presence of selenium, as from the American work it would appear that pyritiferous shales may be rich sources of selenium.

Preliminary botanical examinations carried out have failed to reveal anything unusual in the composition of the herbage, especially in relation to the occurrence of selenium accumulators, of the pasture swards of affected areas.

Experimental work on a field- and laboratory-scale is proceeding, and the results will be published elsewhere in due course.

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R. O'Connor
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Committee of Agriculture,
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Heat Tolerance in European Breeds of Cattle Exposed to High Environmental Temperatures

Messrs. A. L. Badreldin, M. M. Oloufa and M. Abdel Ghany have reported observations on heat tolerance of cattle at Giza (*Nature*, 167, 856; 1951).

In the Singapore Dairy Farm, where more than six hundred head of Ayrshire, Holstein and Shorthorn cattle are kept as a commercial dairy herd, it has been possible to record rectal temperatures and respiration-rates of groups of fifty cows at hourly intervals for periods of seven days throughout the past nine months.

It is considered that the comparison of average air temperatures, etc., with average rectal temperatures and respiration-rate cannot produce information of much value. Clinical evidences of heat intolerance develop only when the rate of heat production within the body exceeds the rate at which heat can be lost to the exterior. The critical environmental temperature productive of a state of adverse heat exchange varies with the degree of air movement and ventilation. Further, the magnitude of the effects of exposure to high temperatures is dependent upon how far the critical temperature is exceeded and for how long.

In this herd, where normally air movement is negligible, rectal temperature commences to rise when that of the surrounding air reaches 78° F.; after one hour's exposure it averages 101·78° F. but after four hours exposure it averages 102·23° F. Two hours exposure to a byre temperature of 94° F. results in an increase to 104·45° F. If heat loss is assisted by hourly sprinkling with water and blast fans, byre temperatures of up to 89° F. cause no appreciable rise in rectal temperature.

Respiration-rate at all temperatures below 78° F. never exceeds 50 per minute; but above that temperature it rises progressively to 130 per minute at 94° F.

Accurate figures for pulse-rates of groups of cattle are extremely difficult to obtain, due to the disturbance necessitated during such mass examinations. However, indications are that pulse-rate is not depressed during heat stress unless it is severe, and that the converse is normally the rule.

It has been impossible to demonstrate any correlation between humidity and temperature regulation.

Preliminary findings on fifty-seven head of cattle would indicate that the chloride-level of the blood plasma rises during exposure to high environmental temperatures, tending to support the supposition that in European types of cattle water-loss is by evaporation through the lungs and diffusion through the skin rather than by direct sweating.

J. Dobinson

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Tone Sensation produced by Repetitive Trains of Auditory 'Click' Stimuli

It is well known that a sensation of continuous tone may be produced by presenting to the ear regularly repeated trains of sinusoidal waves, although each train may consist of only a few oscillations followed by a relatively long 'blank' period[1]. I have observed that a sensation of tone may arise by the presentation of trains of very short pulses, each pulse of duration of 0·20 m.sec., and each train consisting of two such pulses only. The pulse duration quoted is that measured on a cathode ray oscilloscope across the output of the amplifier, no suitable instrument being available to monitor the air pressure wave-form as produced by the loudspeaker. The pulses were derived from an electronic stimulator, and were locked to the time-base at predetermined times, each being independently adjustable. Hence, for each time-base two pulses were obtained, the separation of which in time could be varied from zero (coincidence) to 10 m.sec. The time-base repetition-rate could be varied from 10 to 100 per sec. Within this range, at any given rate of repetition, progressive separation of the pulses gave rise to a sensation of falling pitch, and approximation caused a rising pitch. At a separation of 1 m.sec., the sensation was that of a 1,000-cycle per sec. tone, as matched against a known frequency source; at a separation of 2 m.sec. the tone was 500 cycles per sec., at 4 m.sec. 250 cycles per sec., and so on. Since the tone sensation dependent on the pulse separation was heard against a background due to the frequency of repetition of each pulse (the time-base repetition-rate), only those derived tones of frequency considerably higher than the frequency of repetition could readily be detected and matched against the standard frequency source.

A simple theoretical interpretation of the phenomenon, based on the local resonator theory of auditory perception, may be offered. We assume that the first pulse of each pair, being of short time-duration compared with the tone sensation being studied, and having an abrupt initial rise, produces shock excitation of a wide band of resonators extending over the normal auditory spectrum. The second pulse arriving after an interval t will tend to augment the amplitude of resonators which have just completed integral numbers of complete cycles, that is, those of natural periods t, $t/2$, $t/3$, etc. Resonators of period $2t$ will be suppressed, having completed half a cycle and receiving the second pulse in antiphase. Resonators of other periods will be either only partially or not affected. Since of those which are selectively augmented (periods t, $t/2$, $t/3$, etc.) the decrement due to frictional losses will be progressively higher for the higher harmonics, the fundamental (t) and lower harmonics will predominate, giving a tone sensation identified as of period t (frequency $1/t$). The theory predicts that inversion (phase reversal) of the second pulse should result in selective augmentation of resonators of period $2t$, and suppression of those of period t. Preliminary experiments indicate that this occurs, in that the tone sensation falls in pitch by an octave when the second pulse is suddenly inverted. Since the tone sensation derived depends upon repetitive presentation of trains of two pulses (that is, a single presentation gives no sensation of the tone described), the observation seems to suggest a relatively slow decrement of the energy stored in a given resonator, which is not completely dissipated before the arrival of the next train in a sequence. This offers further support to the view of Pumphrey and Gold that the resonator elements of the cochlea possess a high Q factor. It is intended to modify the apparatus in order to study the phenomenon over a wider range of conditions.

W. T. Catton

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 19

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Light Electrical Engineering and the Mechanical Engineer" (to be opened by Mr. T. E. Goldup).

Manchester Literary and Philosophical Society (in the Great Hall, College of Technology, Manchester), at 5.30 p.m.—Sir John Cockcroft, F.R.S.: "The Industrial Applications of Atomic Energy and its Products" (Joule Memorial Lecture).*

South-East London Technical College (at Lewisham Way, London, S.E.4), at 7 p.m.—Mr. P. Grodzinski: "Diamonds in Physical Instruments".

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—M. André Liotard: "French Explorations in Antarctica".

Tuesday, November 20

Chadwick Public Lecture (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Prof. William Holford: "The Health of Cities—Some Problems arising from Congestion and Overbuilding" (Bossom Gift Lecture).*

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. F. E. Zeuner: "Dating the Past". (Further Lectures on November 27, December 4 and 11.)

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Symposium on "Voluntary Sterilization" (Speakers: Dr. C. P. Blacker, Mrs. Moya Woodside, Mr. Cecil Binney).*

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. F. C. Williams, F.R.S., Dr T. Kilburn, Mr. G. C. Tootill, Mr. G. E. Thomas and Dr. A. A. Robinson: Papers on "Universal High-Speed Digital Computers"; Prof. F. C. Williams, F.R.S., and Mr. J. C. West: "The Position Synchronization of a Rotating Drum".

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. D. M. Newitt, F.R.S.: "Recent Trends in Chemical Engineering".

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. A. W. Downie: "The Scientific Basis of Medicine, 13, Antibodies and Immunity to Virus Infection".* (Further Lectures on November 23, 27 and 29, December 4, 6 and 11.)

Manchester Geographical Society (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Major William Cross: "Reflexions upon Amazonian Exploration".

Textile Institute, Yorkshire Section (joint meeting with the West Riding Section of the Society of Dyers and Colourists, at the Midland Hotel, Bradford), at 7.15 p.m.—Dr. C. S. Whewell: "The Finishing of Cloths containing Wool and Synthetic Fibres".

Wednesday, November 21

Royal Microscopical Society (in the Great Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Exhibition of "How Industry is Using the Microscope".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Prof. L. Dudley Stamp: "The Reclamation of Abandoned Industrial Areas".

Institution of Post Office Electrical Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. W. P. Nicol: "Telecommunications in Aviation".

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Scientific Papers.

British Institution of Radio Engineers (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. R. C. Mildner: "Developments in High Frequency Transmitter Cables".

Manchester Metallurgical Society (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. W. Ramsden: "Spectrographic Analysis".

Society of Chemical Industry, Corrosion Group (joint meeting with the Birmingham and Midlands Section, in the University Mason Theatre, Edmund Street, Birmingham), at 6.30 p.m.—Mr. J. Welsh: "Corrosion in Gas Burning Appliances".

Oil and Colour Chemists' Association, London Section (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. F. Chapman: "Petroleum Chemicals and the Paint Industry".

Scientists for Peace (at the small Conway Hall, Red Lion Square, London, W.C.1), at 8 p.m.—Prof. J. B. S. Haldane, F.R.S., and Prof. C. F. Powell, F.R.S.: "The Threat to Science"

Wednesday, November 21—Thursday, November 22

Iron and Steel Institute (at 4 Grosvenor Gardens, London, S.W.1), at 10 a.m. each day.—Autumn Meeting.

Thursday, November 22

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. A. E. Smailes. "The Geographical Study of Towns".*

University of London (at the Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5), at 3 p.m.—Dr. W. Grey Walter: "The Relationship between the Electrical Activity of the Brain and Adaptive Behaviour".*

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. I. H. Burkill: "Habits of Man and the Origins of the Cultivated Plants of the Old World" (Hooker Lecture).

British Ornithologists' Union (at the Zoological Society of London, Regent's Park, London, N.W.8), at 5.30 p.m.—General Meeting; at 6 p.m.—Dr. A. J. Cain: "Selection and Evolution in the Parrot *Trichoglossus*".

Institution of Electrical Engineers, Utilization Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. W. Fordham Cooper: "Electrical Control of Dangerous Machinery and Processes, Part 3, Remote Supervisory Control".

Research Defence Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Sir Wilson Jameson, G.B.E. "Research and Administration—a Profitable Partnership?" (Twentieth Stephen Paget Memorial Lecture).

Royal Aeronautical Society (at St. Mary's College, Cheltenham), at 7.30 p.m.—Mr. A. N. Clifton: "Problems of Transonic Flight".

Textile Institute, Macclesfield, Leek and District Section (at Conlowe, Ltd., Canteen, Congleton), at 8 p.m.—Anne M. Buck: "History of Costume".

Friday, November 23

Library Association (at Chaucer House, Malet Street, London, W.C.1), at 11 a.m.—Discussion on the Library Association Working Party's Interim Report on "The Co-operative Provision of Books, Periodicals and related Material in Libraries".

British Society of Rheology (at the Institute of Physics, 47 Belgrave Square, London, S.W.1), at 2.30 p.m.—Mr. J. Evans: "The Strength of Soils in relation to the Performance of Cross-Country Vehicles"; Mr. P. Payne: "Some Problems in applying Soil Mechanics to the Action of Cultivation Implements".

Physical Society, Acoustics Group (at the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 4.30 p.m.—Discussion on "The Acoustics of the Royal Festival Hall" (to be opened by Mr. P. H. Parkin and Mr. W. A. Allen).

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "Earth Tides". (Speakers: Prof. Harold Jeffreys, F.R.S., Prof. R. Tomaschek, Dr. B. Baars and Dr. R. H. Corkan.)

Chemical Society, Newcastle and Durham Section (in the Chemistry Building, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. R. P. Linstead, F.R.S.: "The Transfer of Hydrogen between Organic Compounds" (Bedson Club Lecture). (All Fellows are invited.)

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. Llewellyn Young: "The Control of Boilers Fired by Solid Fuels in Suspension".

Manchester Statistical Society, Statistical Methods Study Group (at the Albert Hall, Peter Street, Manchester), at 5.30 p.m.—Mr. G. H. Goode: "Technical Problems in calculating the Retail Price Index Number".

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. A. A. Miles: "The Scientific Basis of Medicine, 14, Bacterial Aspects of Immunity".* (Further Lectures on November 27 and 29, December 4, 6 and 11.)

Geographical Association, Manchester Branch (in the Geography Room, Central High School for Boys, Whitworth Street, Manchester), at 6 p.m.—Mr. N. G. Fisher: "The Influence of Geography on Foreign Policy" (Presidential Address).

North-East Coast Institution of Engineers and Shipbuilders (at the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6.15 p.m.—Dr. J. H. Richards: "An Analysis of Ship Vibration using Basic Functions".

Television Society (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. K. J. Easton: "Television Distribution by Wire".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. J. A. Ratcliffe, F.R.S.. "Radio-Astronomy".

Saturday, November 24

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Sir Richard Winstedt: "The Malay Races down the Centuries".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned.

Assistant Lecturer in Metallurgy, and an Assistant Lecturer in Physics, at Rotherham Technical College—The Director of Education, Education Offices, Rotherham (November 24).

Experimental Officer, Grade III, in the Long Range Weapons Establishment, Adelaide, to be responsible to a Senior Scientific Officer for the work of a team engaged in the application of photo and cine theodolites, instrument recording cameras and other special cameras, to ballistics and other aerodynamic problems—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (November 24).

Head of the Textile Department, Bolton Technical College—The Chief Education Officer, Education Offices, Nelson Square, Bolton (November 24).

DEPUTY FISHERIES AND POLLUTION OFFICER—The Clerk to the Devon River Board, The Castle, Exeter (November 30).

SENIOR LECTURER IN CIVIL ENGINEERING (Structures) at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 7).

SCIENTIST, Grade II (with a good university honours degree or equivalent in chemistry or physics, chemical engineering or fuel technology) on the staff of the Director of Scientific Control at London headquarters—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/393 (December 8).

SCIENTISTS, Grade III (with a good honours degree, or equivalent, in science, mathematics or engineering) for operational research posts in the Field Investigation Group of the Directorate of Scientific Control—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/395 (December 8).

STATISTICIANS at a Ministry of Supply research establishment in the South of England for duties involving statistical advice on the design and results of experimental work in microbiological research, particularly in the fields of bacteriology and experimental pathology, biophysics and biochemistry—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4102/51 (December 13).

READER IN CLINICAL VETERINARY MEDICINE at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 15).

LECTURER IN GEOGRAPHY at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 31).

TUCKER-PRICE SCIENTIFIC RESEARCH FELLOWSHIP, for research in mathematics, science or an allied subject—The Secretary, Girton College, Cambridge (January 15).

ASSISTANT LECTURER IN THE DEPARTMENT OF MATHEMATICS—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

BOTANIST (with honours degree) to undertake the investigation of marine ecological problems—The Secretary, Institute of Seaweed Research, Inveresk, Midlothian.

ELECTRICAL ENGINEERS (Experimental Officer grade) at the Royal Aircraft Establishment, Farnborough, for work on aircraft electrical generating equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.425/51A.

ELECTRICAL ENGINEERS AND PHYSICISTS at a Ministry of Supply research and development establishment near London—SENIOR SCIENTIFIC OFFICERS. ELECTRICAL ENGINEERS (Ref. D.390/51A) with special qualifications in radio communications and experience in the engineering of development prototypes, PHYSICIST (Ref. A.245/51A) with experience in electronic circuitry for research into the measurement of high-speed transients, and a PHYSICIST (Ref. 246/51A) with experience of optical and electronic techniques, and with an interest in fluid mechanics, for work on aerodynamics problems including wind tunnel investigations; SCIENTIFIC OFFICERS. ELECTRICAL ENGINEER or PHYSICIST (Ref. D. 392/51A) with interest in the application of electronic methods to optical instrumentation techniques, and an ELECTRICAL ENGINEER or PHYSICIST (Ref. D.391/51A) for work on high-speed electronic calculating machine—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

ELECTRICAL AND MECHANICAL ENGINEERS and PHYSICISTS (Experimental Officer grade), with experience in (*a*) generation and distribution of electrical power in aircraft, (*b*) general electronics, communication or radar, (*c*) aircraft structure and associated mechanical problems, or (*d*) servo mechanisms and automatic actuators, at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.483/51A.

ENGINEER (with specialized experience in electronic engineering, servo mechanisms, or fine mechanisms including hydraulic devices) at a Ministry of Supply establishment at Malvern, to take charge of a team of engineers investigating engineering and design problems, working with scientific staff on development of ground radar equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.482/51A.

ENGINEERING OFFICER (Wireless) IN THE POSTS AND TELEGRAPHS DEPARTMENT, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Engineering Officer (Wireless), 4/58'.

EXPERIMENTAL and ASSISTANT EXPERIMENTAL OFFICERS at the Ministry of Supply Factory, Capenhurst, Chester, for research work connected with the construction and operation of an atomic energy factory—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

GRADUATE LECTURER IN ELECTRICAL ENGINEERING at Lincoln Technical College—The Chief Education Officer, City Education Office, 4 Lindum Road, Lincoln.

HEAD OF THE DEPARTMENT OF ENGINEERING AND MINING at Wakefield Technical College—The Director of Education, 27 King Street, Wakefield.

HEAD OF THE ELECTRICAL ENGINEERING DEPARTMENT—The Registrar, Loughborough College, Loughborough, Leics.

HORTICULTURAL SUPERINTENDENT—The Principal Agricultural Officer, Lancashire County Institute of Agriculture, Hutton, Preston.

LECTURER (with a university degree in engineering, or equivalent qualification, and practical experience in the electrical industry) IN THE ELECTRICAL ENGINEERING DEPARTMENT—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1.

MECHANICAL AND ELECTRICAL ENGINEERS (New Construction) in the Public Works Department, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Mechanical Electrical Engineer 4/220'.

PHYSICAL CHEMISTS IN THE DIVISION OF ATOMIC ENERGY (Production), Research and Development Branch, Culcheth, Warrington, to assist in research on corrosion, electrochemistry, thermochemistry, surface chemistry and constitution of alloys—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

PHYSICISTS at a Ministry of Supply research establishment in Berkshire for work of a research and development character concerned with the use of radioactive materials, radiation measurements and health physics—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.538/51A.

SCIENCE OF ENGINEERING GRADUATES to do research on some aspects of the flow of liquids through porous surfaces—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Tenth Report of the Commissioners for the Exhibition of 1851. Pp. 41. (London: Royal Commission for the Exhibition of 1851, 1951.) [49

National Physical Laboratory Notes on Applied Science, No. 1: Gauging and Measuring Screw Threads. Pp. vi+109+7 plates. (London: H.M. Stationery Office, 1951.) 5s. net. [49

Committee for Commonwealth University Interchange. Report for the Two Years ending 31st March 1951. Pp. 16. (London: British Council, 1951.) [49

British Society for the Promotion of Vegetable Research. First Annual Report 1950 (October 1949–September 1950). Pp. viii+60. (Wellesbourne, Warwick: National Vegetable Research Station, 1951.) [59

Northern Advisory Council for Further Education. Fourth Annual Report, 1950–1951. Pp. 43. (Newcastle-upon-Tyne: Northern Advisory Council for Further Education, 1951.) [59

Other Countries

United States Department of the Interior: Geological Survey. Bulletin 955-D: Gold Placers and their Geologic Environment in North-western Park County, Colorado. By Quentin D. Singewald. (Contributions to Economic Geology, 1947.) Pp. vi+103–172+plates 8–17. 1.25 dollars. Bulletin 962-D: Tin Deposits of Durango, Mexico. By Ward C. Smith, Kenneth Segerstrom and Reinaldo Guiza, Jr. Pp. iv+155–204+plates 32–40. n.p. Bulletin 963-D: Photo Interpretation of the Terrain along the Southern Part of the Alaska Highway. By Hugh M. Raup and Charles S. Denny. (Mineral Resources of Alaska, 1945–46.) Pp. iv+95–136+plates 9–16. 55 cents. Bulletin 964-D: Geology and Mineral Resources of the Maimón-Hatillo District, Dominican Republic. By A. H. Koschmann and Mackenzie Gordon, Jr. Pp. v+307–360+plates 18–19. 75 cents. Bulletin 964-B: Quicksilver Deposits of Chile. By J. F. McAllister, Hector Flores W., and Carlos Ruiz F. (Geologic Investigations in the American Republics, 1949.) Pp. vi+361–400+plates 20–30. 75 cents. Bulletin 969-A: Diamond-Drill Exploration of the Dillsburg Magnetite Deposits, York County, Pennsylvania. By Preston E. Hotz. (Contributions to Economic Geology, 1949–50.) Pp. iv+28+10 plates. 70 cents. Bulletin 969-B: Corundum Deposits of Gallatin and Madison Counties, Montana. By S. H. Clabaugh and F. C. Armstrong. (Contributions to Economic Geology, 1949–50.) Pp. iii+29–53+plates 11–16. 75 cents. Bulletin 969-D: The Blewett Iron-Nickel Deposit, Chelan County, Washington. By Carl A. Lamey. (Contributions to Economic Geology, 1949–50.) Pp. iii+87–104+plates 17–19. 65 cents. Bulletin 974-C: Frost Action and Vegetation Patterns on Seward Peninsula, Alaska. By D. M. Hopkins and R. S. Sigafoos. (Contributions to General Geology, 1950.) Pp. iii+51–101+plates 2–8. 40 cents. Bulletin 976-D: Geophysical Abstracts 143, October–December 1950 (Numbers 12340–12513). By Mary C. Rabbitt and S. T. Vesselowsky. Pp. iii+211–286. 20 cents. (Washington, D.C.: Government Printing Office, 1950–1951.) [59

United States Department of the Interior: Geological Survey. Professional Paper 221-E: Geology of the Fort Smith District, Arkansas. By T. A. Hendricks and Bryan Parks. (Shorter Contributions to General Geology, 1949.) Pp. iii+67–94+plates 13–18. 1 dollar. Professional Paper 221-F: Pleistocene Shore Lines in Florida and Georgia. By F. Stearns MacNeil. (Shorter Contributions to General Geology, 1949.) Pp. iii+95–108+plates 19–25. 1 dollar. Professional Paper 221-H: The Habits and Adaptation of the Oligocene Saber Tooth Carnivore, *Hoplophoneus*. By Jean Hough. (Shorter Contributions to General Geology, 1949.) Pp. iii+125–138+plates 26–31. 40 cents. Professional Paper 229: Mica and Beryl Pegmatites in Idaho and Montana. By W. C. Stoll. Pp. v+64+9 plates. 1.50 dollars. (Washington, D.C.: Government Printing Office, 1950.) [59

United States Department of the Interior: Geological Survey. Water-Supply Paper 1030: Quality of Surface Waters of the United States, 1946. Pp. vii+486. 1.25 dollars. Water-Supply Paper 1104: Quality of Water of the Gila River Basin above Coolidge Dam, Arizona. By John D. Hem. Pp. vi+230+2 plates. 1 dollar. Water-Supply Paper 1113: Surface Water Supply of the United States 1948, Part 3, Ohio River Basin. Pp. xiii+750. 1.75 dollars. Water-Supply Paper 1115: Surface Water Supply of the United States 1948, Part 5, Hudson Bay and Upper Mississippi River Basin. Pp. xi+464. 1.25 dollars. Water-Supply Paper 1118: Surface Water Supply of the United States 1948, Part 8, Western Gulf of Mexico Basins. Pp. ix+372. 1 dollar. Water-Supply Paper 1124: Surface Water Supply of the United States 1948, Part 14, Pacific Slope Basins in Oregon and Lower Columbia River Basin. Pp. viii+274. n.p. (Washington, D.C.: Government Printing Office, 1950–1951.) [59

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PROVISION OF FURTHER EDUCATION

THERE are already clear indications that mounting costs alone will necessitate in the near future some careful scrutiny of educational expenditure in Great Britain and some re-determination or assessment of priorities, even if it is possible to maintain the votes from Parliamentary funds at their present level for current expenditure, quite apart from capital grants. One such pointer at the university-level is the plain warning given in the last annual report of the University of Oxford that deferment of building applications will be for longer periods in future, and the admission that the joint building committee of the University and the colleges has already been compelled to choose between the new Inorganic Chemistry Laboratory and the next stage of Nuffield College. The Workers' Educational Association has examined some of the issues in its recent pamphlet on educational expenditure, and the postponement of the county colleges scheme received adverse comment at the Association's conference at Harrogate in October. The statement regarding the mounting cost of school text-books, which the Educational Group of the Publishers Association has prepared, directs attention to a factor which affects education at all levels, although it presses chiefly on the estimates in the schools.

In this situation, with the severe limits which the rearmament programme is likely to set for some years to come to the proportion of the national resources of Britain which can wisely be allotted to education, it is imperative that there should be careful forethought and searching discussion over the whole field before action is taken. Although in education, as elsewhere, there may well be opportunities, and especially on the administrative side, for numerous small economies appropriate to a time of austerity or emergency, which in the aggregate might prove substantial, it is essential that such economies should not be taken without regard to possible repercussions elsewhere. Otherwise educational policy may well become unbalanced, and quality and standards may be sacrificed to quantity, with perhaps irreparable damage to long-term interests. At least a hint of this possibility is given in the Statement on Higher Technological Education issued in September.

If such consequences are to be avoided, educational bodies of all kinds should be looking ahead and deciding for themselves what pruning would be wise, what measures or developments could safely be postponed, and what expansion is imperative even at the present time. The argument for such expansion should be developed so that the case can be cogently urged and presented against the background of other claims for full consideration at the appropriate level for approval and action. This is clearly being done in some quarters, as the report from the University of Oxford already mentioned shows; but what is less certain is that proper regard is being had to the inter-relationships of education policy at the different levels and the opportunities that may exist for readjustment and possibly economy by some co-operative action.

The survey of the English universities and adult education which has recently been made by Mr. S. G. Raybould, director of the Department of Extra-mural Studies in the University of Leeds, and published by the Workers' Educational Association*, is timely for two reasons. First, it provides an excellent exposition of the fundamental importance of adult education for the effective functioning of our Parliamentary institutions and indeed of democracy in general, and shows the dependence of good adult education upon education policy and practice at all levels from the universities to the primary schools. It is a resultant of numerous factors, and this survey is a welcome reminder of the need for caution in dealing with a complex situation. Secondly, Mr. Raybould's survey emphasizes the need for a thorough re-consideration of the place of the universities in extra-mural work, and the nature and extent of their contribution to adult education. It is clear from his book that some universities at least are far from having given the thought and attention which this work demands: they are not even clear as to whether or not extra-mural work or adult education are appropriate functions of a university. If the universities are not clear as to the justification for an expenditure which Mr. Raybould estimates elsewhere as of the order of half a million pounds in 1949–50, mistakes—possibly disastrous mistakes—are likely to be made at a time of retrenchment.

The extra-mural work of the universities in Britain has been twice reviewed in this century in published reports: first, in the report of 1909, under the title "Oxford and Working class Education", which contributed largely to the development of the university tutorial class and the institution of university joint committees for tutorial classes in every university in the country, and ten years later in the final report of the Adult Education Committee of the Ministry of Education. Many of the recommendations of the latter Committee, including that for the establishment at each university of an extra-mural department with an academic head, have since been implemented. There is now only one English institution of university rank without such a department; but no reports of comparable standing, reviewing developments and assessing needs in relation to thoroughly considered and clearly stated principles, have appeared during the past thirty years; and it is clear that, apart from the present emergency, some such review is urgently needed to guide the expansion of university work in this field and to resolve the doubts and hesitancies of some universities by facilitating both general agreement as to the proper functions of the universities in this field and the common policy they might pursue.

References in the reports of the University Grants Committee indicate that the question has not been entirely overlooked. The report for the quinquennium 1929–30 to 1934–35, which accepted the view that adult education is an integral part of the normal activity of the universities, with a legitimate claim on their interest and financial support, recognized even then that new factors like broadcasting were changing the educational background. In the subsequent report issued in 1948, and again in Sir Walter Moberly's book "The Crisis in the University" a year later, the arguments against university participation in adult education were set forth succinctly. The position of the universities in relation to their regions, against which their extra-mural work now increasingly tends to be focused, have been set forth in general terms in Bruce Truscot's "Redbrick and these Vital Days", in Prof. B. Dobrée's Earl Grey Memorial Lecture in 1943 and in articles in *The Universities Quarterly*. There has not, however, been the detailed examination of present arrangements and performance which could contribute much to establishing the soundness or unsoundness of the criticism of university participation in this field.

Mr. Raybould recognizes that any such examination cannot be entirely conclusive, because only in part is the examination of statements of fact possible: even such facts as can be assessed do not necessarily indicate adequately what might be possible, and some of the most important elements for a qualitative judgment cannot be readily communicated in words, except possibly to those with first-hand acquaintance with adult education in practice. The quantitative aspect, too, is important at this juncture, and Mr. Raybould has attempted in his book to bring together information on the relations between extra-mural and internal work, the nature and duration of courses and the kinds of tutors employed, and to put it alongside the criticisms advanced in the University Grants Committee's report and Sir Walter Moberly's book.

Attention is rightly directed by Mr. Raybould to the help which the universities might give appropriately by promoting systematic thought and inquiry about adult education as a distinctive branch of study; but this alone is not enough. There was never a time when there was greater need at the Ministry of Education for more imagination, creative thinking, vision and energy, if an adequate education policy is to be implemented. This is essential to ensure not merely that the growing generation is adequately trained to play its part in the complex world of to-day, but also that the proper balance is maintained between the different levels of education, the best use made of our limited resources of materials, and proper provision made for further education, on which both industrial efficiency and productivity and equally the smooth functioning of democratic institutions depend. This is not a matter which concerns the Ministry alone; the universities and the University Grants Committee and industry have their own parts to play. But the critical part is that of the Ministry of Education; and however fully the universities respond to Mr. Raybould's challenge, the future of adult education, and the extent of its contribution to technical efficiency and productivity and the functioning of our democratic institutions, will depend largely on whether Miss Florence Horsbrugh, the new Minister of Education, brings to her office more than administrative ability; she must have also the vision and grasp of essential issues, the firmness of decision, and the energy in action which are required alike to resist sectional pressure and to promote the policy which the country needs. Educational policy is of such critical importance, and the damage which unwise retrenchment can do is so great and irreparable, that the exclusion of the Minister of Education from the new Cabinet will be viewed with regret by all who appreciate what is at stake. It cannot but make Miss Horsbrugh's task more difficult in securing either the right economies or the increased spending which in technical education, and especially in technological education, is imperative even to-day.

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* The English Universities and Adult Education. By S. G. Raybould. Pp. xviii+169. (London: Workers' Educational Association, 1951.) 7s. 6d.

LECTURES ON THEORETICAL PHYSICS

Vorlesungen über theoretische Physik

Von Prof. Arnold Sommerfeld. Band 1: Mechanik. Vierte, neubearbeitete Auflage. Pp. xii+276. 18 D. marks. Band 2: Mechanik der deformierbaren Medien. Pp. xv+376+4 plates. 18 D. marks. Band 3: Elektrodynamik. Pp. xvi+368. 18 D. marks. Band 6: Partielle Differentialgleichungen der Physik. Pp. xiii+332. 18 D. marks. (Wiesbaden: Dieterich'sche Verlagsbuchhandlung, 1947–1949.)

A CYCLE of lectures on theoretical physics is a normal feature in a Continental university. The lectures, which would be attended in general by mathematicians and physicists, form a three-year cycle; each section is made self-consistent. The present series is based on such a cycle, given by one of the greatest teachers of theoretical physics. In Great Britain, where theoretical physics is just beginning to be recognized as a separate subject, some of this material would appear in lectures on applied mathematics, some as part of a physics course and some of it not in any undergraduate course. These books, therefore, cannot serve directly as texts for any of the standard courses, but they provide many ideas that could be incorporated with advantage. The emphasis is always on the physical concepts. Mathematical techniques are developed, where they are necessary, with Sommerfeld's characteristic skill, but they are never allowed to become aims in themselves.

The course on mechanics covers, in one semester, what would take about two years in a British honours course. Of necessity, therefore, it is somewhat short on points of detail, but what is omitted is mostly manipulation. Statics, as such, occupies only about five pages, and this in my opinion represents a correct assessment of its didactic value. There is a good selection of examples which provide a welcome change from the 'ladder-leaning-against-a-wall' type. This is followed by a section containing detailed and instructive comments on the solutions of each problem.

In the second volume hydrodynamics and elasticity are treated together. Thus the general principles can be treated in a concise and transparent way. The emphasis is very strongly on the general principles, in this case somewhat at the expense of mathematical techniques. In the later sections on hydrodynamics, such relatively advanced problems as boundary layers and turbulence, as well as supersonic flow and shock waves, are mentioned, whereas the treatment of the theory of potential flow is brief and the method of complex variables has been completely omitted.

Vol. 3 builds up Maxwell's equations from the familiar integral theorems, giving enough examples to bring out the significance of each term in the equations, and the later chapters then show how one solves them. Here again, potential theory is passed over quickly, whereas those problems the solutions of which involve new physical principles are discussed at length. Relativity and the Lorentz theory of the electron are covered fully, and there is a short chapter on the equations for moving media.

In the preface to Vol. 6, on the differential equations of mathematical physics, Sommerfeld refers to "the pre stabilized harmony" between what is interesting mathematically and what is relevant physically; and, in fact, this volume illustrates particularly well his attitude to mathematics, in his insistence on correlating his mathematics with the physical situation at every step. In every case the object of a mathematical argument is not to provide rigorous proof, though he is quite capable of rigour where the validity of a step is in doubt, or where one has to guard against dangerous exceptional cases. But the chief interest is always in showing a new concept to be reasonable, because it corresponds closely to a significant feature of the physical situation, and to be useful for getting practical results. Fourier series and integrals are discussed together. The general properties of partial differential equations, including their characteristics, are summarized and illustrated by a full discussion of problems in heat conduction. A chapter on spherical harmonics and Bessel functions is followed by a discussion of eigenvalue problems in general, and the last chapter, by way of illustration, covers the classical theory of radio waves, to which Sommerfeld has made so many basic contributions.

To me these volumes represent an almost perfect choice of topics for a basic course on theoretical physics, though I must admit some prejudice in this matter, having learnt most of my theoretical physics from Sommerfeld's lectures. It is not clear whether the missing two volumes on optics and on thermodynamics and statistics are to be published; it would be a serious loss if before his death Sommerfeld had not carried the work on these to a point where others could complete it. I shall eagerly await an English translation of this series, so it can be made available to at least some English-speaking undergraduates.

R. E. PEIERLS

ELEMENTARY GENETICS

Elementary Genetics

The Physiology of Descent. By Wilma George. Pp. vii+172. (London: Macmillan and Co., Ltd., 1951.) 10s. 6d. net.

WRITING an elementary book on genetics is certainly a difficult task: a large number of essential facts, the theories that unify them and some speculations as to future developments have to be concentrated into less than two hundred pages. None of the previous few books of this kind succeeded in striking a sound balance and the present one is no exception. In one important respect, however, it distinguishes itself, namely, the large amount of relevant and well-chosen factual information which it conveys very successfully. For this reason alone this book constitutes a valuable contribution. The non-specialist student who wishes to gain a general idea of the experimental evidence on which genetics is based will find the answer here. The choice of appropriate examples is definitely an original and useful feature of this book. Also commendable is the stress laid upon the part played by genes in morphogenesis and in particular the way in which this matter is treated in a chapter on gene-interaction.

Other good features are the treatment of mutation, including a summary of the biophysical approach, and that of the genetic aspects of evolution, compressed into two clear chapters. Statistical methods appear not once in the whole book, a matter which may be regretted even by those, like the reviewer, who consider statistics as a useful, indeed indispensable, evil. Among the serious shortcomings of the book is a lack of critical attitude which leads to confusion about the fundamental concepts of genetics. For example, clear definitions of gene, allele and locus are not given, and these terms are used inconsistently.

Despite these shortcomings this book is an attempt to produce something which is badly needed, and it is certainly the most successful of these attempts.

G. Pontecorvo

FREUD'S "TOTEM AND TABOO"

Totem and Taboo

Some Points of Agreement between the Mental Lives of Savages and Neurotics. By Sigmund Freud. Authorized translation by James Strachey. Pp. xi+172. (London: Routledge and Kegan Paul, Ltd., 1950.) 14*s*. net.

IT is interesting to re-estimate the value of a work originally published nearly forty years ago. This book of Freud's first consisted of four essays published in *Imago* and represented his earliest attempt to apply psycho-analysis to problems of social psychology. The book aimed at arousing the interest of a wide circle of educated readers, and succeeded. The reaction, on the whole, except among those already attuned to psycho-analytic concepts, was one of acute shock. This was so among anthropologists as much as any, since the main themes taken for analysis—incest, exogamy, taboo, magic and totemism—were important to anthropological theory, and Freud used much anthropological material in his analysis, while going far beyond the bounds of the then range of anthropological thought.

On re-reading the book after a lapse of time one finds the shock much reduced. There are the same ethnographic lacunæ and mistaken generalizations, the same feeling of unreality about the mental lives of the 'savages' in whom Freud saw so many points of agreement with neurotics. Any treatment is bound to seem defective if it includes such statements as that originally totems were inherited only through the female line (p. 107); that totemism constitutes a regular phase in all cultures (p. 108); that the desire to break taboos is always unconscious (p. 31); that in primitive men the process of thinking is still to a great extent sexualized (p. 89); that primitive men are uninhibited, thought passing directly into action (p. 161). Further, the hypothesis of the break-up of the primal patriarchal horde by the killing of the father and eating his remains is just as ludicrous as ever, when put forward as a *historical* occurrence and the basis of the commemorative act of the totemic meal.

But there is more strength and subtlety of argument in the book than anthropologists were originally prepared to credit it with. Even the fantasy of the murder of the patriarchal father may have a certain suggestiveness if looked at not as history but as hinting at a possible set of symbolic elements in totemic rites. Freud's own critique of the totemic theories of the time is usually shrewd and, in its stress on the need for examining emotional rather than rational characteristics of the phenomena, on sound lines. His support for the arguments against explaining horror of incest in terms of innate instinct was powerful, and well directed. His frank admission of ignorance as to origins of various savage customs is refreshing. Where in part he is vulnerable is where he forgets his own dicta—as in suggesting that the Australian 'marriage-classes' originated in deliberate legislation to prevent incest when the influence of the totem rules began to wane.

Modern social anthropology would not agree with Freud that it is precisely the incestuous factor in the mother-in-law and son-in-law relation that provides the motive for the avoidance that so frequently is customary between them. Compatibility of social rather than sexual elements in the total social situation is the line of explanation now advanced. Yet in Freud's citation of impulses involved in the situation of ambivalence—reluctance of the mother-in-law to give up her daughter, distrust of the stranger to whom the girl is to be handed over, impulse to retain the dominant position in her daughter's house, man's determination not to submit his wife to another authority than his own, etc.—there is much valuable suggestion for further study. Relations between social anthropology and psychology are still ill-defined and unstable. But in any resolution of them the work of the psychoanalysts must be taken very seriously into account. It is very useful, then, to have this new translation of the pioneer work.

Raymond Firth

THE SMITHSONIAN INSTITUTION

The Smithsonian

America's Treasure House. By Webster Prentiss True. Pp. 306+64 plates. (New York: Sheridan House; London: George Allen and Unwin, Ltd., 1950.) 27*s*. 6*d*. net.

"THE best blood of England flows in my veins; on my father's side I am a Northumberland, on my mother's I am related to Kings, but that avails me not. My name shall live in the memory of man when the titles of the Northumberlands and the Percys are extinct and forgotten."

So wrote James Smithson, a lonely Englishman and a bachelor, in the late eighteenth century. But Smithson was a chemist of note and a wealthy man in his own right, and it is perhaps one of the most unexplained acts in the cultural history of Great Britain that induced this Englishman to make provision in his will for the establishment in Washington, D.C., of the Smithsonian Institution for the increase and diffusion of knowledge among men. How conscientiously the American nation has carried out the spirit and letter of this will is now known to the world, though it is strange that it should have been left until 1951 for Mr. Prentiss True to tell this fascinating story. But even after Smithson's bequest, it was the remote chance of the death of his nephew some six years later, leaving no child, that gave Washington the glorious opportunity of establishing such a chain of cultural centres.

The United States National Museum with its thirty million objects is perhaps the best known museum in the world. On the other hand, it is seldom realized that nine other organizations, including the National Air Museum, National Gallery of Art, National Collection of Fine Arts, Freer Gallery of Art and the National Zoological Park are centred around the Smithsonian Institution. Has one man ever created such a focus of learning and knowledge and by a stroke of the pen benefited so many millions of his fellow men, chiefly in a country which he had never visited or apparently in which he was not particularly interested ?

The largest part of this vast organization is the United States National Museum, with its six Departments—Geology, Zoology, Botany, Anthropology, Engineering and Industries, and History. Mr. True deals in separate chapters with the work of these Departments, and in a popular and entertaining manner shows how the Museum has made each subject appeal to the general public and yet at the same time provide material for investigation by specialists. In other words, the Museum is both an exhibition and research centre.

In lesser detail, the author outlines the work of the Bureau of American Ethnology, where the history of the American Indians is recorded ; fascinates his readers by a description of the wild animals in the Washington Zoo ; discusses the rich collections of the National Gallery; and finally relates the many services of the Smithsonian which make available scientific and cultural knowledge in the United States to scholars all over the world.

The book will be read with a touch of envy by those in Great Britain, though coupled with gratitude that the chosen country has fulfilled to the uttermost the vision of James Smithson, the lonely English bachelor. To describe it as an attractive and well-illustrated account for the lay reader and full of suggestive ideas for the museum specialist sums up this entertaining book. F. S. WALLIS

JAPANESE MONOGRAPH OF LICHEN CHEMISTRY

Chemistry of Lichen Substances

By Prof. Yasuhiko Asahina and Assoc. Prof. Shoji Shibata (University of Tokyo). Pp. viii+300. (Tokyo: Published in Japanese by the Kawade Shobo Co., 1949.) 480 yen.

WILHELM ZOPF in a classic treatise[1] was the first worker to summarize all the work on the lichen metabolic products then known—some 148 compounds had already been isolated, characterized and named by Zopf, Hesse and other workers—and he attempted to systematize them by a chemical classification. Prof. Y. Asahina reviewed the field in 1939 in an article entitled "Flechtenstoffe"[2] in the light of some one hundred publications from his research school at the University of Tokyo. Later, Prof. T. J. Nolan, of the National University of Ireland, Dublin, surveyed all the lichen compounds the chemical constitutions of which had been established, using Asahina's classification with some slight modifications[3].

Recent work on the isolation and chemistry of these interesting compounds has been carried out by Prof. Alexander Robertson, first at the London School of Hygiene and Tropical Medicine and then at the University of Liverpool, and by Prof. T. R. Seshadri, of the Andhra University, India. Interest in lichen products has been stimulated lately by numerous investigations of their anti-bacterial properties with special emphasis on their activity as inhibitors of the tubercle bacillus. (See a review by Prof. F. Bustinza, University of Madrid[4].)

This new book by Profs. Asahina and S. Shibata, the first to summarize completely the field of the chemistry of the lichen metabolic products, is a valuable addition to our knowledge of the naturally occurring compounds. Although written in Japanese, it should be of considerable use to English-speaking scientific workers by virtue of its very many structural formulæ and complete literature references. I understand that a translation into English is being contemplated.

This publication, of some three hundred pages, has been written in three sections. Part 1 gives a brief historical sketch of lichen investigations ; a classification of lichen substances into their chemical groups ; while a third chapter deals with the methods of extraction, isolation and purification of the various metabolic products.

Part 2 describes in their groups the lichen source, history, properties, and the structural and degradative chemistry of some seventy-six pure compounds which have had their chemistry more or less completely elucidated. The following compounds, not covered in Prof. Nolan's review, are now described : rangiformic acid ; the depsides erythrin, hiascic acid and hypothamnolic acid ; pannarin (a depsidone) ; the anthraquinone pigment fallacin ; lichexanthone ; two dibenzofuran compounds didymic acid and strepsilin ; and the nitrogen-containing bitter substance picrorocellin. Diploicin, an unusual chlorine-containing depsidone, isolated along with several other chlorinated compounds from the lichen *Buellia canescens* (*Diploicia canescens* Dicks), is but scarcely mentioned on p. 122 and should have received more fuller treatment in view of the work of Nolan and his collaborators. Diffractaic acid and α-collatolic acid, names assigned to two lichen acids by Prof. Asahina, should be discarded since they are known (and stated) to be identical with the compounds already fully described by Zopf (*loc. cit.*) as dirhizoninic acid and lecanorolic acid, respectively.

Part 3 consists of chapters discussing the relationships between lichen substances and fungal metabolic products, with particular reference to the hydroxymethylanthraquinones ; some biogenetic interpretations of the formation of lichen compounds ; and finally some work which has been recorded on the antibacterial properties of numerous lichen products and their derivatives. Author, species and subject indexes are given in English as well as Japanese.

J. C. DACRE

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[1] "Die Flechtenstoffe in chemischer, botanischer, pharmakologischer und technischer Beziehung" (Jena: Verlag von Gustav Fischer, 1907).

[2] *Fortschr. Chem. organ. Naturstoffe*, 2, 27 (1939).

[3] See "Lichen Substances" in "Thorpe's Dictionary of Applied Chemistry", 7, 284 (London: Longmans, Green and Co., 1946).

[4] *Endeavour*, 10, 95 (1951).

A BIOLOGICAL APPROACH TO PLANT VIRUSES

By Dr. J. S. KENNEDY

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VIRUS workers were recommended by Pirie[1] not to try to maintain a precarious position on either of two stools—the chemical, treating viruses as molecules, or the biological, treating them as organisms—but rather to "settle comfortably on the floor", that is, adopt a biochemical approach. The purpose of this article is to suggest a broader biological approach to plant viruses. The bare answer to the question 'What are viruses ?' will undoubtedly be biochemical, and fundamentally important, but still bare and incomplete. A biological approach to viruses would be through their relations with the whole system—biochemical, physiological and ecological—of which they form a part.

Plant virus research has not, in fact, developed in such an all-round biological way. It was agricultural practice which directed attention to the problem in the first place, and workers on the more practical side have had to pay continued attention to the wider relations of viruses. But the theoretical background for their work is provided by a research trend which has been narrowing on to the virus itself. "The isolation of tobacco mosaic virus by Stanley in 1935," as K. M. Smith[2] has said, "was the key that opened the door to the study of the virus itself, quite apart from the disease it may cause." Thereafter, as Bawden and Pirie[3] have said, "most work so far has been directed toward obtaining apparently homogeneous preparations with the highest infectivity", as if viruses could best be understood in isolation. Study of the means and conditions of virus spread continues apart, as if it could make no comparable contribution to virus theory. Nevertheless, biochemical work has led to the conclusion that "the ability to spread, or to be actively infective, is the one character that clearly distinguishes viruses from other cell constituents" (Bawden[4]); and although insects provide the commonest known means of spread, it is symptomatic of the way virus theory has developed that these vectors are regarded as *nothing but* vectors. They are presented as unequally efficient, but essentially *indifferent*, 'accidental' collectors and deliverers of virus. "There is very little evidence," writes K. M. Smith[5], "to suggest that an arthropod vector of viruses is in any way affected by the virus it may transmit. Even where there is good evidence that the virus multiplies inside the body . . . the insects do not seem to be adversely affected." Or Bawden[4]: "Most workers have failed to find any significant differences between infective and non-infective individuals of vector species. . . . Infective individuals live as long and breed as freely as non-infective". The assumption implicit here is that what is pathogenic to one organism, the plant, is of no biological significance to the other, the insect, if it is not pathogenic of that too; so that the virus is nothing but a pathogen, intrinsically.

There is, of course, a third possibility. The vector might be importantly affected—might even gain—from its carrying of plant pathogens, not necessarily through a direct physiological action of the virus in its body, but ecologically, through an indirect effect of the virus *via* the host plant. But there is no room for such an idea so long as ecological aspects of the problem are considered under the one-sided headings of 'spread' or 'transmission' and omitted from the consideration of insect–virus relations[4,6]. Although Leach's[7] eleven-year-old plea for more work on the biology of insect–virus relations has not been rejected as unsound, it has been passed over.

The general grounds for such a plea seem more than adequate. Most plant viruses depend on insects for their spread, and as Bawden[4] says, "New vectors of plant viruses are constantly being discovered and there is no doubt that many viruses for which the only methods of transmission now known are grafting or sap inoculation are also transmitted by certain insects". Secondly, there is a considerable measure of specificity in virus–vector relations, even if it is not as great as was thought. Thirdly, the vector's role in transmission is not merely mechanical, carrying the virus as an accidental contaminant on its body, but a more subtle and little-understood one. That is so, not only with 'persistent' viruses having a 'latent period' in the insect, but even with the 'non-persistent' ones which can be transmitted very quickly indeed. Fourthly, Black's[8] work has now left little doubt that at least one plant virus can be multiplied and maintained through many generations in its insect vector feeding on apparently healthy plants, thus blurring somewhat the distinction between the 'independent' viruses and the phytotoxic secretions elaborated by many insects. Some of these secretions cause systemic pathological changes in the plants[8], and the toxicity of the insects may vary with the kind and stage of growth of the plant previously fed upon and may even be intensified by breeding successive generations of insects on a susceptible plant[9]. As Leach[7] said: "Numerous cases have been cited of the evolution of an association of insects and microorganisms for mutual benefit. There is no convincing reason why association of insects and viruses may not have arisen in a similar manner. . . . The question of whether a virus-infected plant is a more favourable host than a healthy plant for the insect vector has been given very little attention in virus studies. . . . The problem offers a fascinating field of research, and its solution should be of fundamental significance in the fields of both plant and animal pathology."

Leach was then able to cite only one case, unlooked-for but documented, of benefit to the vector, and to suggest another as probable. Carter[10], studying the populations of *Thrips tabaci*, the vector of the virus of yellow spot disease of pineapples in Hawaii, on alternative hosts, in particular the weed *Emilia sonchifolia*, which is also susceptible to the disease, noticed that "populations on diseased *Emilia* are consistently higher than those on healthy *Emilia*. . . . The explanation for this is probably that while healthy *Emilia* normally grows rapidly, matures and dies, diseased plants may persist for a longer time with a mass of curled leaves affording satisfactory shelter for *Thrips tabaci*. It seems to be demonstrated that when *Emilia* functions as a reservoir of the yellow spot virus it is also a more suitable host for *Thrips tabaci*." Carter[11] also found that high humidity was unfavourable to *Eutettix tenellus*, the vector of sugar beet curly-top virus. Diseased plants are stunted, forming more open stands than the dense luxuriant growth of healthy plants. Hence, Leach suggested, "if the leaf hoppers were not vectors of the curly-top virus, the sugar beets would grow normally and in all probability would not be a favoured host of the leaf hopper".

Since then, another case concerning leaf hoppers has been worked out in some detail by Severin[12], who was deliberately seeking an effect of the disease, aster yellows, through the plant, celery, on a number of vector species. He found that the insects developed faster, lived longer and reproduced more on the diseased than on the healthy plants. In most cases the difference was quite clear-cut, the insects dying off in a few days when put on healthy plants, but building up flourishing colonies when put on diseased ones. "There are numerous leaf hopper species," Severin says, "which live on diseased celery and asters, but when transferred to healthy plants they die." These plants, then, are not ordinarily suitable hosts for these insects, but by means of the virus, the insects can make them suitable—if not for the individuals first infecting a plant, then for later arrivals. Even if that action were originally accidental on the insects' part, it is difficult to believe that it would remain so for long.

Two further cases recently brought to light concern the most notorious plant virus vector, the aphid *Myzus persicæ* (Sulzer), and the important potato diseases, leaf-roll and severe mosaic, which are among those caused by viruses this insect transmits. Arenz[13] has shown experimentally that the vector multiplies substantially faster on potatoes with either of these diseases than on healthy ones.

The latest case concerns the black bean aphid, *Aphis fabæ*, and here the benefit of the plant disease to the vector appeared not as an isolated observation but as a particular application of a general principle running throughout these insects' host-relations. The principle is that the aphids feed and reproduce poorly, if at all, even on their favourite host plants, if the insects are confined to fully functional, robust green leaves which have ceased growth and not yet entered upon senescence. They thrive, on the other hand, on the same leaves while they are actively growing or senescing[14–16]. The aphids have not only 'botanical' preferences which confine them to specific kinds of plant, but also 'plant physiological' preferences which confine them to the more nutritious stages or parts of those plants. It follows that altering the physiological condition in which a plant customarily is when the insect finds it in Nature, would change that plant's status as a host for the insect. For example, *Aphis fabæ* will readily colonize crocus if the plant is in active growth, before flowering, when offered to the aphid. In Nature, crocuses are well past that stage when the aphids are first on the wing. They are not, therefore, colonized by, and do not rank as hosts of, *Aphis fabæ*. But any change which brought crocuses out later relative to the aphids would enable the aphids to colonize them habitually. That in turn would facilitate the aphids' development of a 'botanical' preference for crocuses in due course.

The pathological conditions known as plant galls and virus disease also involve physiological changes which, by the same token, might be expected to benefit the insects that initiate them. Galling and virus disease typically involve either abnormally extended growth or premature senescence-like changes, or both. They tend thereby to suppress that stage in the leaf's life which is most unfavourable to the aphids. How far the relationship between insect and plant in galling is symbiotic has been a matter of lively, if inconclusive, discussion. That the insect does, in fact, live on "nutritive tissues produced especially at its order by the plant"[17] in the more elaborate, 'determinate'[18] or 'prosoplasmic'[19] galls is generally conceded. There has been more uncertainty about the more primitive, 'indeterminate' or 'cataplasmic' galls which are produced by many aphids and take the form of simple distortion, rolling or pocketing of leaves. Went[20] suggested that the "very simple malformation . . . bulging of the intercostal areas of the leaves, giving rise to the formation of pockets in which the aphids are well sheltered . . . can be explained satisfactorily by assuming auxin destruction in the phloem". Apparently he regarded this effect much as he regarded crown-gall: as purely pathological, an accident so far as the causative organism was concerned. This probably represents the general opinion concerning such 'pseudo-galls' caused by aphids.

Experiments on the pocket galls formed by *Cryptomyzus ribis* on red currant leaves[21] indicated that they were, in fact, beneficial to the insects responsible. If the benefit had been a merely mechanical, protective one, as Went suggested, it would be easier to regard it as accidental. But the galls were physiologically beneficial, since the aphids fed preferentially and reproduced faster on the lining surface of the galls even when they were everted so that the insects there were completely exposed. Experiments on sugar beet mosaic disease[21] showed that this also was beneficial to a vector, *Aphis fabæ*, of the virus concerned. On the average, the aphids reproduced nearly one and a half times faster on diseased plants than on healthy ones. Not only the mature leaves but also the growing and senescent ones were more suitable for the aphids when showing disease symptoms than when healthy. As a result, the aphids on diseased plants became overcrowded and emigrated sooner than from healthy plants, so that the virus presumably facilitates its own spread in the field by this means.

The established cases of virus diseases benefiting the vectors are still very few, and further work should clearly be concerned not merely with the effects of the diseases on their vectors but also on non-vectors. There is no *a priori* reason for supposing that only vector species benefit from a disease in the plant, any more than there is for supposing that such benefit accrues to all vectors. But it does begin to appear that the economic importance of plant virus disease may owe a good deal to the 'boosted' multiplication of infective insects; and the fact that the established cases were selected for study simply because they were economically important, and not because they seemed especially likely to show the beneficial effect, does make it no longer seem permissible to consider the role and even the origin of plant viruses without due attention to the vectors. It is true that the instability introduced into insect–plant relations by the progress of agriculture seems likely to work against the development or persistence of symbiotic associations as envisaged by Leach. But his analogy with symbiosis between higher organisms must not be pressed too far; it is doubtful whether viruses have the necessary degree of independence and permanence to rank as one of the partners in an ordinary symbiosis. Sub-cellular by nature, they may achieve that rank only conditionally and temporarily.

In those cases where galling and virus infection both are, in fact, methods by which insects 'pre-digest' plants, they would seem to complement one another, inasmuch as the one method will serve when the other will not. There is marked specificity in the relations between the aphids and the plants which respond to them by producing galls. Hille Ris Lambers[22] holds that the longer, phylogenetically speaking, an aphid has been associated with a given plant, the greater the tendency for a galling response to have developed. There is less specificity between insects and plants so far as virus disease is concerned. One virus may have many vectors and many hosts, some of which are symptomless 'carriers', and one insect may transmit many viruses. It would seem to follow that a virus causing a disease which benefits the insect vector would serve it particularly well in attacking new host plants to which it was not previously adapted. Such plants will not respond to the local, specific stimulus of the insect by the local and circumscribed type of 'pre-digestion' known as galling, because there has not been the necessary long period of mutual adaptation beforehand. Where coaxing fails, a bludgeon may succeed. Virus inoculation is a bludgeon in that sense, causing the drastic diversion of the plant's whole metabolism which is called a systemic disease. If in this way virus transmission enables the insect to cross the bridge from host plants to which it has become adapted, to new plants, the insect can then become adapted to them, too, in due course, with the eventual formation of new species, as already suggested in connexion with non-pathological physiological changes in plants.

Galling and virus disease are both abnormal diversions of the plant's metabolism, but once started the disease is more independent of the insect than the galling response. So far as we know, most virus vectors are not infective before they have pierced an already infected plant. Many plant viruses to-day do not depend on insects for their spread. These facts speak for the relative independence of viruses, and support the prevailing view that the origination of a virus may owe nothing to an insect. Yet, since both galling and virus infection can be, in effect, insect weapons, it is at least possible that the second sometimes arose from the first. The conditions for this leap, by some extension leading to partial emancipation of the insect-induced metabolic deformation of the plant, might be reproduced experimentally. Picturesquely speaking, the insect might be likened to a sorcerer evoking strange but nicely controlled plant growths, while the virus would be the sorcerer's apprentice, dependent, but notoriously undisciplined.

Bawden[4] has directed attention to the need for studies on the physiology of virus-infected plants, and it would seem worth while to make parallel studies on leaf ageing and galling as well. Growing, senescing, galled and virus-diseased leaves evidently have something in common from the aphid's point of view. If we knew what that was, we should know more not only about aphid nutrition but also about the virus disease. Viruses, according to Caspersson[23], "appear as parasites on the system for protein formation of the host cell, indicating that their own system for that is incomplete", whereas aphids are, presumably, more self-sufficient for protein formation, given an adequate supply of amino-acids. So far as mere multiplication goes, aphids and viruses may have rather similar requirements. But the virus, as Bawden and Roberts[24] have suggested with some experimental support, has an additional prior requirement before 'multiplication' can begin: re-direction of the plant's protein synthesizing processes. Parallel observations on aphid and virus might therefore help to distinguish the postulated two stages in the process of virus infection.

These are particular questions. To direct attention to them is not to assume a pre-eminent role for the insect in virus biology. The main point about even one or two cases of vectors which benefit from the disease caused by the virus they carry is that they are unexpected as a matter of principle. They have been discovered in spite, rather than because, of the existing theory. Plant, insect, virus and disease together form a biological complex involving biochemical, physiological and ecological relations. The whole and the parts have a history, and being biological that must involve adaptations. It is then through the study of their relationships, and in the expectation of adaptations, that the role of each component can be understood, and in no other way. A shift toward that general point of view, away from the cramping conception of viruses as "complete and self-sufficient systems" (as Bawden[4], an opponent of this conception, has expressed it), has been a notable result of recent biochemical work on plant viruses. Evidence is accumulating against both the older pictures of self-sufficient viruses: either as self-reproducing or as forcing the plant to produce their like[25]. The infection imposes a whole new metabolic pattern on the plant, and virus "individuality becomes merged into that of the infected cell"[4].

Superficially similar conclusions have been reached lately with regard to various animal viruses and bacteriophages. It has been found that the free phage particle "loses its identity after entering its host. . . . It merges with the bacterial organisation and with other phage particles" to form a "new entity, the phage-bacterial complex" wherein the phages are presumed to be temporarily disintegrated into gene-like fragments[26]. An analogy is the 'masking' of animal viruses in their intermediate hosts[27], or the evidence that certain bacteria may pass through a submicroscopic phase in the host[28]. But here the evidence is not mainly biochemical, and according to Luria[29] the 'ultimate goal' in phage studies is still seen as "the identification of the elementary 'replicating units' of biological material and the clarification of their mode of reproduction", on the assumption that "reproduction must involve point-to-point replication of some elementary structures responsible for the conservation of specificity from generation to generation", these units being by definition exogenous. Thus the main development in phage theory is the transfer of interest from one kind of particle to another, smaller one, and the guiding conceptions are those of formal genetics.

Plant virus research, on the other hand, has become less preoccupied with specific particles large or small. Evidence that the virus merges into the metabolism of the infected plant has not intensified the search for supposedly ultimate, inviolate particles, but has brought a change of emphasis, on to the activities of "the whole [host] cell, in which the virus is only one determining component"[4]. "To attribute any independent existence or activities to viruses may be a misconception", says Bawden[4], ". . . The purified virus may be only a part of a larger active system, and in studying the part it is important not to overlook the whole"; and Pirie[1] asks, "Is there any *a priori* reason for assuming that infection can lead to the production of only one anomalous nucleoprotein or that the ability to initiate infection in a new host is a property restricted to one ideal unique structure ? Clearly there is not." That this trend in virus theory should originate with workers directly investigating the biochemical, intracellular events is characteristic of a biological theory postulating self-sufficient entities. The closer one gets, without actually going outside the living context altogether, to the postulated ultimate particles themselves, the less self-sufficient they turn out to be. It took an even more painstaking and intimate study of living relationships to dispose of the theory of special creation, which was a theory of the same general type applied to whole organisms.

The new trend in plant virus theory is not, however, consistent. A simply biochemical approach to the problem is not yet a fully biological one, so long as the pathogens remain 'self-sufficient' in their other, physiological and ecological, relations. The arguments Pirie[1] advances for examining all the biochemical peculiarities of infected plant tissue, not restricting attention to what it is hoped will prove to be the virus itself, apply with equal force to the higher-order relations of viruses. If as Bawden says the physiology of infected plants has not received enough attention, that is partly because, if the infective agent is self-sufficient, the main thing is to isolate it ; host physiology is incidental. Even the non-'self-sufficient', biochemical approach incurs some responsibility here, inasmuch as it has led to the view that the other-than-biochemical relations of viruses may be merely incidental. It is one thing to stress the merging of virus into cell metabolism, or that viruses may have existed as non-pathogenic constituents of one plant species until implanted into another. But it is another thing to say that viruses may originate in "occasional accidents", or that, in the definition of a virus, "disease-production . . . is included largely as a matter of convenience" (Bawden[4]). From a biological point of view, to treat the fact that the known viruses cause disease as a mere matter of convenience or definition, in other words, as an accident, seems at best premature. Even if this property were acquired 'by accident' originally, the physiological and ecological consequences, in an evolving biological system, can scarcely fail to have moulded the further history of the agents in a distinctive way.

Ecology, the very arena of evolutionary change, still seems to be regarded as the least interesting, the least fundamental aspect of virus biology, although it remains a pressing concern of more practical workers. This is seen in the one-sided view of the virus–vector relationship already mentioned. Bawden's[4] suggestion that "the causing of disease may be incidental to other activities and with little permanent significance to the evolution of the agent", again seems to treat viruses as a law unto themselves. Disease-production need not be a permanent property for it to have permanent evolutionary significance. If disease-spreading can benefit the insect and thereby involve it in the evolutionary consequences already outlined, then we cannot exclude important evolutionary repercussions on the virus. An agent which, through the disease it causes, actually multiplies its own vectors, has an obvious evolutionary advantage over one that does not.

This advantage will of course be offset, in varying degree, by the evolutionary disadvantage of the disease to susceptible plants, which would set a limit to the disease-producing activity of the virus in Nature. When circumstances—such as the growing of a new crop in the district—put a premium on the insects' ability to transfer from their established host plant to a new kind of plant not at first acceptable in its healthy state, then the advantage of a disease which rendered the new plants acceptable would be especially great. Once the insect had established its 'bridgehead' among the new plants in this way, and began to become more specifically adapted to them, then the advantage to insect and virus of beneficial disease in the plants would diminish, relative to the evolutionary disadvantage of the disease to susceptible plants and through them to the insect and virus also. This hypothetical sequence is presented merely to show there is no reason for expecting virus disease to be always and everywhere beneficial to insect or virus, but that there is a neglected approach here worth exploring. Ecological circumstances can be postulated which would sometimes call out and sometimes suppress the disease-producing function. There could be a varying 'demand' on the part of the insects for disease-production by virus in plants. Starting from this end might lead to earlier and fuller understanding of the origin of some virus diseases and viruses, than starting from the 'ultimate' causes, the isolated pathogenic particles.

However, the insect's contribution here is only a special aspect of a generally recognized fact, that it is man's ecological intervention, by growing plants as crops, which creates disease problems in any event, with or without the aid of insects. This, again, is often thought of as a merely incidental effect, given a virus 'there in the first place', self-sufficiently independent of ecological conditions. Since ecological relations are the very means of evolution, they cannot be treated as incidental. If they serve to multiply and perpetuate 'given' viruses, it is in them we must look for the origin and development not only of epidemics but also of viruses.

The mysteriously self-sufficient virus particle, although expelled from the biochemical context, still lives on in the ecological context. So long as this remains an implication only, it will not be easy to carry the current movement away from the self-sufficient conception of viruses, beyond the biochemical into the other contexts. The logic of this example of what is called a particulate theory in biology needs explicit statement. A particulate theory, in this sense, is one which endows material substances, particles or processes with an unnatural degree of independence. Thus the virus itself has been dubbed 'life's enemy'—something which is scarcely likely to be an insect's friend. The term 'pathogen', a legitimate description of the characteristic effects of the particles, becomes an assertion of their absolute nature. Disease-production becomes inherent in the particle itself, as though it were not the changing relations of viruses with plants, insects and the rest of their environment which produce disease, but the viruses themselves, as Bawden has objected. Plant and insect then provide only contingent circumstances, the one a mere culture medium, the other a mere inoculation needle ; and if material things are not to be understood in their relation to their material environment, then they cannot be understood at all, except by invoking entelechies.

Of course, few virus workers, and least of all those concerned with physico-chemical characterization, would regard this as the logic of their work. Others may see it more easily, just as Schrödinger[30], who is not a biologist, sees the vitalist logic of another particulate theory, the gene theory of heredity. Particulate theories have played a large part in the history of biology, as of other sciences, because discontinuities do exist in Nature, which is mere confusion until they are discovered, and it may take a long time before further work corrects the assumption that they are absolute. Particles exist; but disappointment always follows if they are *in themselves* held responsible for the properties of the whole which is being analysed. Particles so self-sufficient that they have no necessary, but only contingent, relations are mystical particles. This is implicit in every particulate theory from the beginning, and the sooner it is recognized the less difficult is the inevitable abandonment of the theory when, as now in virus research, facts which contradict it begin to appear.

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SULPHUR FROM SEA WATER

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EVERY informed person will agree that the present stage of manufacturing industry is wasteful and cannot be viewed as other than a phase of civilization. The United States is taking thought about a shortage of water, which is being run into the sea more rapidly than it can be collected on land. The length of time that some world natural resources can be expected to last varies greatly: it is possibly a thousand years for raw phosphate, and perhaps a couple of generations for the sulphur ores collectively. Utilization of renewable supplies of raw materials must sooner or later become important. Two adaptations suggest themselves in this connexion: greater use of microbes and of products from the sea.

There is a case for regarding many inorganic raw materials, including sulphur, as microbial products or fossils[1]. There seems to be small hope of utilizing autotrophic organisms, excepting green plants; and conscious utilization of contemporary microbes must turn upon getting them to act upon organic material, wherefore sources of organic matter require consideration. With shortage of land and of food there is little scope for applying products of the soil, except possibly sulphite liquor (presuming sufficient supplies of sulphur) and sewage sludge. Neither of these is generally available.

Not only manufacturing industry will suffer from a shortage of sulphur: a more serious threat is to the supply of high-class protein, since the method of choice for making rock phosphate available to plants has involved use of sulphur, and other modes all involve increased consumption of fuel or power. For high yields of meat, dairy products, and eggs, there is no simple alternative to the association of leguminous plants, grass, and phosphate, which is essentially an intensive development of the past fifty years[2]. The characteristic function of nitrogenous manures is to yield non-nitrogenous constituents of plants[2,3].

Almost sixty years ago the interest in marine chemistry was great enough to render the idea of biological reduction of sulphates familiar to a few. Some remarkable work was done in Scotland; and the Odessa Bacteriological Station not only showed that at least in its depths the Black Sea is a vast lake of hydrogen sulphide solution[4], but also brought to light a bacillus able to produce hydrogen sulphide from sea water[5]. The summer smells of the Dutch canals induced Beijerinck to investigate a problem which lay literally at his doorstep in Delft, and in 1895 he described many characters of a bacterium able to reduce sulphates in polluted fresh water[6]. The microbiological work was extended by van Delden[7], and a similar organism was isolated from the sea; and Baars[8] broadened the concept of the sulphate radical as oxidizing agent, by showing that in presence of a suitable bacterial 'catalyst' a sulphate can be used, for example, to oxidize ethyl alcohol to acetic acid when the necessary oxygen is derived only from sulphate and water. From all this work it appeared that almost any kind of organic matter could be utilized by the bacteria engaged in sulphate-reduction, provided the carbon/nitrogen ratio of the medium were made small enough.

During the early stages of these developments in formal bacteriology, a series of events was occurring which can now be seen to have great significance in relation to production of sulphur from sea water. These instructive events were nuisances arising from pollution of British estuaries after discharge of sewage into them, in particular, near Belfast and Dublin. The occurrences were investigated by Letts and Adeney[9]; and although most of their attention was given to Belfast Lough, the findings at Dublin were additionally significant in showing the close connexion between discharge of sewage and 'spontaneous' growth of seaweed, particularly *Ulva latissima*.

The nuisance was largely due to release of sulphuretted hydrogen. Letts and Adeney made many experiments with the view of ascertaining the conditions leading to production of that gas. Bacteriological chemistry was not then sufficiently developed to offer the guiding principles we now have. The work of Letts and Adeney derives current importance less from the painstaking laboratory experiments than from their field observations. These are reasonably well known to sewage chemists, but have had little or no impact on other specialists whose co-operation is necessary for an appreciation of the facts revealed.

Points pertinent to the involuntary demonstrations at Belfast and Dublin are: (1) given organic matter, there is no difficulty in principle in inducing bacteria to produce hydrogen sulphide from sea water; (2) the chief value of sewage in this connexion is as a source of nitrogen and phosphate; these conduce to growth of weed, which provides a large bulk of organic matter *in situ*; (3) seaweed can contribute inorganic and organic sulphates in proportions together much greater than the proportion of sulphate in sea water; it probably also contains reducible organic sulphur; (4) no special cultivation of bacteria or seaweed is necessary; both will arise 'spontaneously' as elective cultures if appropriate nutrients and conditions are provided.

To point out these facts is not to suggest that an addition of sewage or of seaweed to sea water kept anaerobic will lead to production of hydrogen sulphide as easily as by adding acid to an alkaline sulphide. Work by Irvine and Gibson[10], for example, did suggest that to produce hydrogen sulphide from sea water to which a fragment of decomposing mussel flesh had been added was almost as easy as that, though a few days incubation was required. There is, however, much chemical difference between any seaweed and the other forms of organic matter used by workers in the field of sulphate-reduction. Unless the right conditions are offered for sulphate-reduction by seaweed, anaerobic digestion of weed may lead to a methane fermentation or other type in which hydrogen sulphide is not prominent.

Without wholly accepting the view of Letts and Adeney that decomposition of seaweed proceeds in two stages, it will be clear that the seaweed must undergo a preliminary microbial decomposition (of unknown nature and extent) before it can serve as source of organic matter for reduction of its own sulphates and those of sea water; other factors such as temperature, species of weed, and the ratio of seaweed to sea water are important, and their elucidation must require considerable laboratory work.

Neither the series of occurrences at Belfast and Dublin nor the laboratory work performed hitherto has done much to indicate optima for commercial production of sulphur from sea water. What the estuarial phenomena of c. 1900 did was to show that hydrogen sulphide can be released from the sea to any desired extent. These repeated large-scale demonstrations are very little known in spite of their now topical interest.

The engineering difficulties in collecting the evolved gas appear formidable; but there seems to be no relevant biological or chemical problem that cannot be tackled by present technique, and the production of sulphur from sea water by biological means may well be the easiest to solve of the future problems of supply of raw materials to industry.

The ecological chain is at least as interesting as the connexion alleged by Darwin to exist between spinsters and red clover. Sewage is not essential, and might be replaced by, say, nitro-superphosphate. Thus a roundabout route would be opened for inorganic nitrogen to be converted (so to speak) into protein for human consumption, via sulphur, phosphate, clovers, and grazing animals. The existing routes are also expensive in labour and in money, since they either depend upon mechanical cutting and processing in place of grazing, or upon expenditure to supplement or replace bacterial fixation of nitrogen from which most of our high-class protein-nitrogen comes[3]: this costs nothing except for earthy materials such as phosphate, potassium, calcium, and sulphur, which must in any event be provided. The spread of synthetic fixation of nitrogen has left the fundamentals of plant growth and protein production unaltered, and nothing could be more wrong than to imagine that agricultural application of 'synthetic nitrogen' has been a victory for the factory over biology. Putting industrial fixation of nitrogen from the air to aid sulphate-reducing bacteria in the sea may be of the type of things to come.

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OBITUARY

Prof. Otto Meyerhof, For.Mem.R.S.

OTTO MEYERHOF, who was born at Hanover on April 10, 1884, died at Philadelphia on October 6, 1951.

He began his scientific career with the study of medicine and at first was interested in psychology and psychiatry. But, particularly under the influence of his friend, Otto Warburg, he turned to physiology and biochemistry; indeed, they collaborated in a paper on the part played by cell structure in metabolism—a paper describing for the first time the application of manometric methods to respiration measurements. After he had settled in Kiel (where he went in 1912) he began the magnificent series of papers on the biochemistry of contraction of intact, isolated muscle. Like Hopkins, he felt muscle to be the material *par excellence* for study of the correlation of function and metabolism in living tissue.

Setting out from the fundamental observations of Fletcher and Hopkins and their collaborators at Cambridge, Meyerhof made a wide and exact survey of the relations of lactic acid and glycogen content, oxygen uptake, and heat and tension production in a variety of conditions. He showed for the first time the close proportionality of production of tension and lactic acid formation in anaerobic contraction; but perhaps his most important findings were concerned with oxidative recovery. Here he showed that, of the lactic acid disappearing, the equivalent of some four-fifths reappears as glycogen while the oxygen uptake accounts for complete oxidation of the remainder. Furthermore, the heat production corresponds to only one-half of that to be expected from this oxidation, so that part of the energy is retained for synthetic purposes.

This series of papers was not published until after the end of the First World War and reached Great Britain only in the early months of 1921. The excitement of their urgent translation in Hopkins' laboratory at Cambridge is a vivid memory, as well as the intense satisfaction derived from the flood of light they threw on problems continually discussed there.

Meyerhof went on for some time with his work on the whole muscle, especially in efforts to balance the observed heat production with that to be expected from the known chemical changes. Very accurate measurements gave always a deficit in the latter figure, and this was explained only after the discovery of creatinephosphate.

In 1926, two years after his move to the Kaiser Wilhelm Institute for Biology at Berlin-Dahlem, he began the work on enzymically active muscle extracts which, continued with several collaborators, was to prove so fruitful. Working with these extracts and with extracts from yeast, he followed up and extended the perspicacious but largely unproved suggestions of Gustav Embden, bringing to light new enzymic stages in carbohydrate breakdown and preparing hitherto unknown intermediates.

In 1927 the discovery of creatinephosphate and the observation (first by the Eggletons and by Fiske and SubbaRow, and then in his own laboratory) of its breakdown during contraction and resynthesis during recovery raised difficulties for the lactic acid theory of contraction. This was felt especially in two facts: first, that while creatinephosphate breakdown is a markedly endothermic reaction and while the breakdown was known to occur chiefly in the early stages of contraction, experiment so far had seemed to show proportionality between lactic acid production and heat formation; secondly, that the anaerobic resynthesis of creatinephosphate was not accompanied by heat absorption. Meyerhof at this time made an error of scientific judgment, rare for him, in his reluctance to admit the part played by creatinephosphate breakdown in contraction, apparently inclining towards the suggestion that the breakdown might not be happening *in vivo*, but was an artefact due to the treatment of the muscle in extraction. He failed, too, to attach importance to the findings of post-relaxation lactic acid formation by the Embden school. However, his experiments with Lipmann, published early in 1930, concerning the *p*H changes upon stimulation of intact muscle, left him in no doubt about the reality of creatinephosphate breakdown, and in the same year he was ready to welcome the results of Lundsgaard on iodoacetate-poisoned muscle with their clear implication that creatinephosphate breakdown is a stage nearer the muscle machinery than is lactic acid formation. He invited Lundsgaard to continue his work at Heidelberg, and the problems mentioned above were solved by combined work there.

Meanwhile Lohmann, in Meyerhof's laboratory, had made the discovery of adenosinetriphosphate in 1929, and during the 1930's Meyerhof's laboratory, together with others in Lwow, Cambridge and Berlin, cleared up the problems of the co-enzyme function of the adenylic compounds and laid the foundations for the understanding of the part played by these compounds in energy transfer. The unique contribution of the Meyerhof school here was the investigation of the heat of reaction of various stages in glycolysis and of the heat of hydrolysis of creatinephosphate, argininephosphate (a compound discovered in invertebrates by Meyerhof and Lohmann), adenosinetriphosphate and phosphopyruvic acid. Such studies led to the early realization of the important difference in nature between the phosphate bond in these compounds and in the ordinary ester linkage.

Although he was during these years mainly concerned with isolated enzyme systems, Meyerhof still turned to the muscle as a whole, for example, in the work with Möhle and Hartmann on volume changes accompanying contraction.

In 1924 he had become head of the Department of Physiology in the Institute for Medical Research in Heidelberg and remained there until 1938. One of his research workers in the latter part of this period has described his daily round, discussing without any dictatorial attitude, but with complete grasp of detail in each case, the results of yesterday and the programme for to-day. This collaborator has written: "The daily round took him from worker to worker, Japanese, French, English, Italian, Spanish, American, German. It was a stimulating event and lingered on in one's mind. The thoughtfulness of the faces of the people in the room is strongly in my memory." Meyerhof himself worked in the laboratory daily and one striking characteristic was his prodigious memory for facts and figures. He loved to show a very generous hospitality to his colleagues.

It has been said of him that his intense and single-minded concentration on the pursuit of scientific truth shut him off as behind an intangible curtain from current events. This concentration made it possible for him to stay on in Heidelberg for five years after the rise of the Nazis, without loss of personal dignity and integrity. He even during this time accepted at least one new Jewish worker, refusing to consider the possibility of outside interference with the conduct of his laboratory. But by 1938 the situation had become impossible and Meyerhof, like other scientific men of Jewish origin, was obliged to leave Germany. He was welcomed in Paris and went on with his work at the Institut de Biologie Physico-Chimique until the invasion of 1940. With the help of the Rockefeller Foundation and of friends in America, he and his wife were able to reach the United States, and he was appointed research professor of physiological chemistry in the University of Pennsylvania. His reputation was, of course, international; he had shared the 1922 Nobel Prize for physiology with A. V. Hill, and among many other honours had been elected in 1937 a foreign member of the Royal Society. After his exile he did much to help in the re-establishment of displaced scholars less well known abroad.

From 1938, Meyerhof's scientific work was concerned mainly with enzyme studies, and he devoted much attention to questions of the free-energy content of phosphorylated compounds. He continued to break new ground, as in his study with H. Green of the transphosphorylating activity of intestinal phosphatase.

An aspect of Meyerhof's interests which remained less well known to his colleagues, at least in other countries, was his work on the history and philosophy of science. He was an authority on Goethe's scientific contribution; and in 1933 he published an excellent lecture on theoretical biology in which he adopted a point of view allied to the Whiteheadian doctrine of organism, in general agreement with the biological implications which Woodger had set forth a few years before. He had a great love, too, for painting and for literature.

Such were some of the achievements and activities of one of the greatest of biochemists.

Dorothy Needham

NEWS and VIEWS

Royal Society : Medal Awards

H.M. THE KING has been graciously pleased to approve recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year as follows :

Sir Howard Florey, professor of pathology in the University of Oxford, for his distinguished contributions to pathology by his studies of the functions of mucin and by his work on penicillin and other antibiotics ;

Sir Ian Heilbron, director of the Brewing Industry Research Foundation, for his distinguished contributions to organic chemistry, notably in the field of vitamin A and polyene synthesis.

Nobel Prize for Physics : Sir John Cockcroft, C.B.E., F.R.S., and Prof. E. T. S. Walton

THE award of the Nobel Prize for Physics for 1951 jointly to Sir John Cockcroft and to Prof. E. T. S. Walton will be warmly welcomed not only by nuclear physicists but also by many others. The disintegration of elements by artificially accelerated protons was announced by Cockcroft and Walton from the Cavendish Laboratory, Cambridge, in 1932, after some years of research into methods of producing high-velocity positive ions. This work was encouraged from the start by Lord Rutherford with the specific object of obtaining a more intense source of projectiles for nuclear transmutation experiments than was provided by the alpha-particles from natural radioactive bodies. The apparatus finally used by Cockcroft and Walton developed a steady potential of about 600,000 volts and supplied currents of about 5 microamperes of hydrogen ions. The impact of these high-velocity ions on targets of light elements, notably lithium and boron, produced a copious yield of alpha-particles which were detected by scintillation screens and the measured energies of which showed that they came from nuclear transmutations. The original tube and a model of the whole apparatus are in the Science Museum, South Kensington.

The immediate importance of these experiments apart from the popular appeal of success in splitting the atom) was that they confirmed Gamow's theory of barrier penetration, according to which nuclear disintegrations might be produced by light particles of relatively low energy. The way to the study of a great variety of nuclear reactions was thus thrown open, and with the successful application elsewhere of the cyclotron and electrostatic generator in similar work, a rapid expansion of experimental nuclear physics took place. The work of Cockcroft and Walton did not in itself reveal any new fundamental properties of nuclear structure ; but it stimulated many theoretical and technical developments and thereby inevitably influenced the whole course of nuclear physics. In a narrower field it laid the foundations of the precise study of energy changes in nuclear reactions induced by charged particles. It is only fitting that the highest honour should be paid to work which has so fully the character of a pioneer investigation, in that it has been eagerly seized on and extended by others and that it is an acknowledged landmark in the history of science.

Nobel Prize for Chemistry : Profs. E. M. McMillan and G. T. Seaborg

THE award of the Nobel Prize for Chemistry for 1951 to Profs. E. M. McMillan and G. T. Seaborg directs the attention of the whole scientific world to the most spectacular advance made in inorganic chemistry for a long time, the extension of the Periodic System from element 92, uranium, to element 98, californium. Speculations about the possible existence of trans-uranium elements are old : they could not be found in Nature ; but as soon as E. Fermi and his collaborators in Rome had detected the transmuting power of slow neutrons, they applied it to uranium and seemed to obtain in this way an element higher up in the Periodic Table. These researches were continued in Paris and Berlin, and for several years it was believed that four or five successive trans-uranium elements could be synthetized by this simple method, until O. Hahn and F. Strassmann recognized that these newly formed nuclides were nothing but isotopes of well-known elements produced by the process of 'fission'. The first real trans-uranium element, of atomic number 93, was identified by E. M. McMillan and P. Abelson early in 1940. From then on progress was rapid. With the help of powerful cyclotrons and the newly constructed uranium piles, a large team of workers concentrated on the task of producing isotopes, and of studying the properties, of the elements 93 (neptunium), 94 (plutonium), 95 (americium), 96 (curium), 97 (berkelium) and 98 (californium). These researches were greatly helped by the ample means put at the disposal of the investigators in view of the great practical importance of their investigations ; it is well known that one of the trans-uranium elements, plutonium, provided the material for one kind of atomic bomb, and that it will, one hopes, soon be put to peaceful use in the operation of power plants. The award of the Nobel Prize for Chemistry to a physicist, McMillan, and a chemist, Seaborg, both of the University of California, singles out the two most outstanding names in a group of excellent research workers, and is a tribute to a type of research organization which nowhere has been brought to such perfection as in the big scientific laboratories of the United States.

Mathematics at the College of Aeronautics : Prof. G. N. Ward

THE Board of Governors of the College of Aeronautics has created a new post of professor of mathematics in the Department of Aerodynamics, and Mr. G. N. Ward, senior lecturer in mathematics in the University of Manchester, has been appointed to the chair. Prof. Ward was at St. Catharine's College, Cambridge, where he obtained first-class honours in the Mechanical Sciences Tripos. During the early part of the Second World War he worked in the Admiralty on problems involving the study of geomagnetic deviations, very-low-frequency circuits, and ultrasonics. Later he was transferred to the Engineering Division of the National Physical Laboratory, where he studied experimental and theoretical supersonic flow and designed the earliest British supersonic guided missile. Gradually he leaned more to the theoretical side of the work, and played an important part in the years following the War in building up the very extensive body of solutions which now exist to the equations of small perturbations to a supersonic stream, a field of study both of great practical importance and theoretical interest and complexity. His essay on the subject submitted in 1950 for the Adams Prize of the University of Cambridge was awarded an honourable mention. His best-known papers in the field refer to perturbation by nearly cylindrical ducts, by slender bodies of arbitrary cross-section bearing wings of small aspect ratio, and by thin wings of intermediate aspect ratio. He is particularly interested in the teaching of mathematics to engineers in such a way that they may be enabled to make full use of it in their work.

Bird Exploration Fund

THE recent institution of the Bird Exploration Fund is a joint effort by officials of the British Museum (Natural History) and private individuals to fill a need brought about by the economic conditions of present times. The days of private expeditions financed by public-spirited naturalists, which contributed so largely to the study collections of the British Museum, are now past. The importance of scientifically conducted field investigations in conjunction with collecting is widely recognized, and if the knowledge of birds by the collection of specimens is to be extended it is essential that expeditions should be continued. The aim of the newly formed Fund is to make this possible. Vested in trustees and with the official approval of the British Museum, the general purposes of the Fund are stated to be "promoting, organizing and financing in whole, or in part, ornithological expeditions to, and bird explorations in, those parts of the world where bird life is least known". Specimens are to become the property of the British Museum; but collectors who take part in the expeditions will be given every reasonable facility for work and study in connexion with such specimens. It is perhaps not generally realized that public institutions are not readily endowed with private money. The formation of a permanent Fund gives those who wish to forward the science of ornithology an opportunity, by means of their collective support, to make possible these very important expeditions and thereby enrich the national Museum. The headquarters of the Fund are at the Bird Room, British Museum (Natural History), Cromwell Road, London, S.W.7, and all donations and inquiries should be sent to the Secretary-Treasurer.

International Union for the Study of the Behaviour of Social Insects

DURING the Ninth International Congress of Entomology, the termitologists and myrmecologists present decided to set up a permanent international union for the study of the behaviour of social insects. It is intended to approach workers on the social behaviour of insects all over the world and to organize the interchange of ideas and of research programmes from the earliest pre-publication stages, and also to build up a library of reprints for reference purposes. To this end, termitologists and myrmecologists are requested to send not only a complete bibliography of their papers to date, and details of their present projects, but also two reprints of each future paper and of as many past papers as possible. An international address list will also be assembled. It is hoped that it will soon be possible to publish a journal, which at first may be limited to brief notes, but which should eventually cover the field as adequately as possible. At Amsterdam a provisional committee was formed; but a constitutional committee will in due course be elected by the members of the new union. Further information can be obtained from D. Wragge Morley, Organizing Secretary, International Union for the Study of Social Insects, 14*b* Downshire Hill, Hampstead, London, N.W.3.

Medical Research in East Africa

INTERESTING information about the health risks of East Africa is contained in two reports issued by the East Africa High Commission. The annual report for 1950 of the Virus Research Institute (pp. 32, Nairobi: Government Printer, 1951) describes the history of the Institute, its buildings and staff and the work carried out in 1950. The Institute was formerly known as the Yellow Fever Research Institute, having been founded in 1936, and was taken over by the East Africa High Commission in 1950. One section of the report deals with yellow fever and its epidemiology and immunology. A number of sections discuss other viruses, poliomyelitis and rickettsioses, and there is a section on general entomology which includes work on ticks, mosquitoes, ectoparasites of trapped mammals, the biting habits of Tabanidae and studies of the eradication of *Simulium damnosum*. The list of papers published or in the press is evidence of the activity of the staff. The annual report for 1950 of the East Africa Medical Survey (pp. 61; Nairobi: East Africa High Commission, 1951) shows that, in spite of a serious shortage of staff, both laboratory investigations and field surveys have been undertaken in the Mwanza area and on Ukara Island. The results of these are given. A feature of the report is the fact that food is rarely sufficient in quantity and lacks quality women especially suffering because of taboos of important sources of protein. A survey of insect vectors of disease is to be carried out, and an entomologist records his brief survey of the distribution of mosquitoes on Ukara Island. The report also discusses statistics so far available of the maternity histories, reproductive-rate and infant mortality-rate.

Atomic Heating System at Harwell

A BUILDING containing eighty offices at th Ministry of Supply Atomic Research Establishment Harwell, will now draw its heat direct from BEPO the large experimental atom pile. This is the first atomic central-heating plant in the world. Eventually two, and perhaps three, more buildings will also have 'atomic radiators' and the Ministry's coal consumption will be cut by at least a thousand tons a year. Afte counting all incidental expenses, the saving in coal is estimated at £2,650 a year. Costs of the installation amount to £15,000.

The constant hot water which will flow through th pipes is obtained by placing a heat exchanger in th outlet air duct of the pile's air-cooling system. Her there is a by-pass fitted with a damper which can be adjusted to vary the proportion of the air-flow passing through the heat exchanger. Hot water from the exchanger is then circulated in a closed circuit by a small pump to a secondary water-to-water hea exchanger. This supplies hot water for space heating and domestic hot water supplies. At present the ai temperature at the primary heat exchanger is 135° F. and the water itself is heated to 130°. In 1952, when modifications to the pile have been completed, thes temperatures will be substantially increased. Ther is no danger from radioactivity and the water can safely be used for washing. The heat output designe for the first building is one million B.Th.U. per hour equal to about two hundred electric fires; but fo the final installation the maximum output will b seven million B.Th.U. per hour. The total floor area now being heated is 32,000 sq. ft. and the volume of space is 330,000 cu. ft.

History of Coal

"At the Root of it All", a brochure published by the National Coal Board (Public Relations Branch), Hobart House, Grosvenor Place, London, S.W.1 (pp. 32), is the best of the numerous booklets on the British coal industry which have been issued by the Board. It is suitable for general science reading in the upper forms of secondary schools and it should prove interesting to the intelligent layman. It is succinct and factual. The script is by Mr. W. E. Dick, editor of *Discovery*, and the method employed in the booklet is historical, descriptive and statistical. The monochromatic illustrations are good, and a romantic element has been confined to a few coloured plates. The subjects discussed, which have been outlined clearly and accurately, are the formation of coal from decayed vegetation, the improvement of the steam-engine from that of Thomas Savery in 1698, and the uses of coal in the iron and steel industries, for producing electricity and in the home. Short, illustrated sections describe the use of coal in locomotion and the development of lighting by gas. Considerable attention is paid to the by-products of the gas industry: dyes, detergents, disinfectants, antibiotics, insecticides, perfumes, nylon and so on. The booklet ends with a brief account of the mining industry as it has developed, and includes a statement of the sociological aspects and problems of miners. The booklet in its brevity and objectivity is scientific in outlook and is pleasantly free from any political bias. Thus, it admirably fulfils its aim, which is to show the paramount importance of coal in modern living.

United States National Museum: Annual Report for 1949-50

The report of the United States National Museum for the year ending June 30, 1950 (pp. 141; Washington, D.C.: Government Printing Office, 1951), provides interesting reading, and a summary of its activities and acquisitions extending to more than a hundred pages is an indication of the magnitude of the work. This Museum, which is situated in Washington, D.C., and forms part of the Smithsonian Institution, has as its responsibility the classification and preservation of collections, and it is refreshing to note that this and the fundamental policies in general are still recognized. Furthermore, it is recognized that the Museum is not only a storehouse for certain objects but also that its exhibits reveal to the public "the resources of the world in which we live, the material cultures that illustrate the political, cultural and technical achievements of man and the principles that have resulted from scholarly research". These, indeed, are noble aims, and the report indicates how they are put into practice.

Conference on Evolution and Education

The group of organizations interested in the teaching of biology will hold a further joint conference on "Evolution and Education", this time at the Birmingham and Midland Institute, Birmingham, during December 7-8. At the opening session, when Sir Raymond Priestley will preside, Dr. J. B. S. Haldane will deliver an address on "The Evolutionary Process". On December 8, lecture-demonstrations will be given by Miss F. R. Elwell of the B.B.C. broadcast series, "How Things Began", and by Miss E. M. Tuke, on the "Teaching of Evolution". Miss M. Going will speak on "Classroom Problems in Teaching Evolution", with special reference to work in grammar schools. These sessions will be followed by a general discussion, to be opened by Dr. L. M. J. Kramer, over which Mr. W. J. Heasman, H.M.I., will preside. The closing address will be delivered by Prof. S. Zuckerman, speaking on the "Evolution of the Brain". The fee for admission to the conference is 10*s*. Tickets may be obtained from the British Social Biology Council, Tavistock House South, Tavistock Square, London, W.C.1.

British Region of the Biometric Society: Officers for 1952

At the recent annual general meeting of the British Region of the Biometric Society, the following officers and members of committee were elected for 1952: *Vice-President*, Dr. F. Yates; *Treasurer*, Dr. A. R. G. Owen; *Secretary*, Dr. D. J. Finney (6 Keble Road, Oxford); *Members of Committee* (1952-54), Prof. R. A. Fisher and Dr. R. R. Race.

Brazilian Geological Society: Officers for 1951-52

Officers for the term September 1951-November 1952 of the Brazilian Geological Society have been elected as follows: *President*, Prof. O. Barbosa; *Vice-Presidents*, Prof. O. H. Leonardos and Prof. F. W. Lange; *Secretary*, Prof. R. R. Franco; *Treasurer*, Prof. A. F. Barbosa; and *Director of Publications*, Prof. J. C. Mendes. Further details about the Society can be obtained from the Secretary, whose address is Sociedade Brasileira de Geologia, Alameda Glete 463, Caixa Postal 105 *B*, São Paulo.

"Epitaxis of Rubidium Iodide on a Barium Stearate Substrate Deposited on Mica"

Mr. A. A. Fuller writes, with reference to the communication under the above title published in *Nature* of September 15, p. 471: "I was unable to refer, during the course of my experiments, to the *Zeitschrift für Kristallographie*, and so missed reading an account of a series of similar experiments by Dr. R. S. Bradley (*Z. Krist.*, A, 96, 499; 1937). I regret I was therefore unable to mention this work in my communication."

Announcements

Dr. P. B. Treacy, who for three years has been working in the Cavendish Laboratory, Cambridge, has been appointed a Research Fellow of the Australian National University, Canberra, and will work in the Department of Nuclear Physics under the direction of Prof. E. W. Titterton.

The Langley Memorial Prize of the London School of Hygiene and Tropical Medicine has been awarded to Dr. J. H. Gerber, medical officer in charge, Endemic Diseases Control Unit, Kailahun, Sierra Leone, for his paper on "Bilharzia in Boajibu". This Prize is awarded by the School triennially for the best paper written by a member of the West African medical staff on tropical medicine and surgery, hygiene, entomology or parasitology.

Erratum. In Table 1 of the communication "C_{20-22} Unsaturated Acids of Butterfat" in *Nature* of July 14, p. 75, Sample *A*1, for "sap. equiv. 338·3" read "sap. equiv. 318·3".

SYNTHESIS OF POLYACETYLENIC COMPOUNDS

By Prof. E. R. H. Jones, F.R.S., Dr. M. C. Whiting, Dr. J. B. Armitage, Dr. C. L. Cook
and Dr. N. Entwistle

Chemistry Department, University of Manchester

DURING the period 1927–38, Kuhn and his co-workers[1] synthesized a wide range of conjugated polyethenoid hydrocarbons, and by correlating light-absorption properties with constitution, they not only provided a rational basis for the interpretation of the chemistry of the carotenoids, but also stimulated much fruitful discussion about the fundamental nature of conjugated systems and their photochemical excitation[2]. Recently it has become possible to prepare similar compounds in which the terminal groupings are separated by a chain of conjugated acetylenic, rather than ethylenic, linkages, the comparison of which with the corresponding polyenes is of obvious interest.

In this work our aims were to obtain these substances, including when possible the higher members of each series, by convenient methods, and to characterize them as fully as their stability permits. When the widespread natural occurrence of di- and tri-acetylenic compounds, in essential oils from species of Compositæ[3], in the seed-fat of *Onguekoa Klaineana* Pierre[4], and some Basidiomycetes[5], became evident, the programme was modified to include the preparation of fairly close analogues of some of these. The recent appearance of publications along similar lines[6], and the interest of these substances to the biochemist and, because of their linear structure and consequent simple geometry, to the theoretical chemist, make it desirable to summarize our results at this stage.

The reaction sequences employed fall into two classes. In the first a glycol is converted by reaction with thionyl chloride and pyridine into a dichloride, which on dehydrochlorination with sodamide in liquid ammonia gives a hydrocarbon containing one triple bond more than the starting material. In the special case where the original glycol is di-primary, the product, a hydrocarbon $H(C{\equiv}C)_nH$, may be converted by an excess of sodamide to a disodium derivative, which can then react *in situ* with an alkyl halide or with a carbonyl compound. If formaldehyde is used, such a sequence of reactions formally permits an indefinite progression, one triple bond being added at each stage, and this has to some extent been realized:

$$\begin{array}{l}
HOCH_2.C{\equiv}C.CH_2OH \xrightarrow{SOCl_2,Py} \\
ClCH_2.C{\equiv}C.CH_2Cl \xrightarrow{NaNH_2,H.CHO} \\
HOCH_2.C{\equiv}C.C{\equiv}C.CH_2OH \xrightarrow[NaNH_2,H.CHO]{SOCl_2,Py} \\
HOCH_2.C{\equiv}C.C{\equiv}C.C{\equiv}C.CH_2OH.
\end{array}$$

In the second class the series is ascended more rapidly; a monosodium derivative is obtained by the action of three molecules of sodamide on a diprimary dichloride, then a monosubstituted poly-yne or a poly-yne carbinol is prepared by condensation with one molecule of an alkyl halide or a carbonyl compound, and the oxidative coupling reaction employed to convert $R.(C{\equiv}C)_n.H$ to $R.(C{\equiv}C)_{2n}.R$. Alternatively, a monosubstituted diacetylene may be obtained as described above from a primary–secondary glycol, $R.CH(OH).C{\equiv}C.CH_2OH$, prepared by a Grignard reaction between an aldehyde and the *bis*-bromomagnesium derivative of propargyl alcohol.

By suitable combinations of these methods a range of dimethylpoly-ynes (I; $n = 2, 3, 4, 5$ and 6) has been synthesized.

$$\underset{\text{I}}{CH_3.(C{\equiv}C)_n.CH_3} \qquad \underset{\text{II}}{Me_2C(OH).(C{\equiv}C)_n.C(OH)Me_2}$$

$$\underset{\text{III}}{Ph.(C{\equiv}C)_n.Ph}$$

The first is well known, and the next two were briefly described in October 1949[7]; recently another synthesis of (I; $n = 4$) has been published[8a]. The hydrocarbons (I; $n = 5$ and 6) were prepared as indicated below:

$$\begin{array}{l}
CH_3.CHO \xrightarrow{NaC_4H} CH_3.CH(OH).(C{\equiv}C)_2H \xrightarrow{CuCl,O_2} \\
CH_3.CH(OH).(C{\equiv}C)_4.CH(OH).CH_3 \xrightarrow{SOCl_2,Py} \\
CH_3.CHCl.(C{\equiv}C)_4.CHCl.CH_3 \xrightarrow{NaNH_2} (I;\ n = 5) \\
HOCH_2.(C{\equiv}C)_2.CH_2OH \xrightarrow{SOCl_2,Py} \\
ClCH_2.(C{\equiv}C)_2.CH_2Cl \xrightarrow{NaNH_2,MeI} \\
CH_3.(C{\equiv}C)_3H \xrightarrow{CuCl,O_2} (I;\ n = 6).
\end{array}$$

All are crystalline solids, which (except $n < 4$) decompose below their melting points and were crystallized until their ultra-violet absorption spectra were constant. They are not dangerously explosive, and (I; $n = 4$) may even be sublimed at 50°/10^{-3} mm. Those members with $n > 3$ are very easily decomposed by light, but in the dark, or in solution even in the presence of light, they are much more stable; storage at −70° is desirable, but all can be crystallized from warm solvents.

A series of glycols of type (II) has also been obtained, using related methods; those with $n = 2$, 3, 4, 5 were isolated as crystalline solids, appreciably more stable than the dimethylpoly-ynes. The glycol (II; $n = 6$) was also prepared; but a 10 per cent concentrate could not be further purified. Many glycols of other types, especially $HOCH_2.(C{\equiv}C)_n.CH_2OH$ and $CH_3.CH(OH).(C{\equiv}C)_n.CH(OH).CH_3$, have also been made; the primary and secondary glycols are very much less stable than the corresponding tertiary glycols. The dichloride $ClCH_2.(C{\equiv}C)_4.CH_2Cl$, an intermediate in the preparation of (II; $n = 5$), is the compound most sensitive to light yet encountered in this field; it surpasses silver bromide in this respect, becoming dark blue on exposure to diffused daylight for 10–30 sec.

For the preparation of the diphenylpoly-ynes the obvious extension of one of the routes employed for the dimethyl compounds succeeded for (III ; $n = 3$), easily prepared from benzaldehyde by a route independently used by other workers[4a,4c]:

$$\begin{tikzcd}
\mathrm{Ph.CH(OH).(C{\equiv}C)_2.CH(OH).Ph} \arrow[r, "\mathrm{SOCl_2,Py}", "\mathrm{NaOEt\ or\ NaNH_2}"'] & \mathrm{(III\ ;}\ n = 3\mathrm{)} \\
\mathrm{Ph.CHO} \arrow[u, "\mathrm{NaC{\equiv}CH,\ CuCl,O_2}"'] \arrow[d, "\mathrm{BrMgOCH_2.C{\equiv}CMgBr}"'] & \\
\mathrm{Ph.CH(OH).C{\equiv}C.CH_2OH} \arrow[r, "\mathrm{SOCl_2,Py}", "\mathrm{NaNH_2}"'] & \mathrm{Ph.C{\equiv}C.C{\equiv}CH} \arrow[d, "\mathrm{CuCl,O_2}"] \\
 & \mathrm{(III\ ;}\ n = 4\mathrm{)}
\end{tikzcd}$$

The next member, (III ; $n = 4$), was obtained by the route shown; the phenylbutadiyne was also (but less conveniently) prepared from phenylbutadiene tetrabromide, a method independently used by Schlubach and Franzen[4e], and isolated as a low-melting solid.

For the preparation of (III ; $n = 6$), α-bromocinnamaldehyde was condensed with propargyl alcohol to give a crystalline glycol, readily converted to the dichloride (IV).

$$\underset{\mathrm{IV}}{\mathrm{Ph.CH{=}CBr.CHCl.C{\equiv}C.CH_2Cl}} \xrightarrow{\mathrm{NaNH_2}} \mathrm{Ph.(C{\equiv}C)_3H} \xrightarrow{\mathrm{CuCl,O_2}} \mathrm{(III\ ;}\ n = 6\mathrm{)}$$

The latter gave, after dehydrohalogenation and oxidative coupling, a surprisingly high (30 per cent) overall yield of the hexa-yne (III ; $n = 6$). This is a beautifully crystalline substance (orange needles) which is not photosensitive in the solid state and is therefore easier to handle than (III ; $n = 4$) or the aliphatic poly-yne hydrocarbons. It was fully characterized by analysis and quantitative hydrogenation.

[*Added in proof*. October 18. Since this manuscript was submitted, diphenylocta-acetylene (III ; $n = 8$) has been obtained by a process essentially similar to that employed for the preparation of (III : $n = 6$), penta-2 : 4-diyne-1-ol, being employed in place of propargyl alcohol. The photosensitive octa-yne, which forms red needles, cannot be kept undecomposed for more than a few hours at 20°, even in the dark. Two samples exploded on attempted analysis, but with a third it was possible to obtain some approximate analytical data (found: C, 95·3 ; H, 2·85 ; $C_{28}H_{10}$ requires C, 97·1 ; H, 2·9 per cent). However, light absorption data quoted below provide unequivocal evidence for the assigned structure.]

The naturally occurring polyacetylenes frequently possess ethylenic linkages in conjugation with a poly-yne chain, and often carboxyl groups as well; thus Sörensen[3d,8] has isolated from *Artemesia vulgaris* L. a compound with the structure

$$\mathrm{CH_3.CH{=}CH.C{\equiv}C.C{\equiv}C.C{\equiv}C.CO_2Me}$$

('dehydromatricaria ester').

The synthesis of model substances possessing these features was therefore attempted. Vinyl- and propenyl diacetylenes were obtained in good yield by the following route (R = H or CH_3). The anionotropic rearrangement[9] in the chlorination reaction (incomplete when R = H) and the modification in the dehydrohalogenation reaction therefore required are noteworthy.

$$\begin{aligned}
&R\mathrm{.CH{=}CH.CHO} \xrightarrow{\mathrm{BrMgC{\equiv}C.CH_2OMgBr}} \\
&R\mathrm{.CH{=}CH.CH(OH).C{\equiv}C.CH_2OH} \xrightarrow{\mathrm{SOCl_2,Py}} \\
&R\mathrm{.CHCl.CH{=}CH.C{\equiv}C.CH_2Cl} \xrightarrow{\mathrm{NaNH_2}} \\
&\underset{\mathrm{V}}{R\mathrm{.CH{=}CH.(C{\equiv}C)_2H.}}
\end{aligned}$$

The light-absorption properties of (V ; R = Me) proved to be very similar to those recorded by Castille[4] for erythrogenic or isanic acid, present in the glycerides of boleko nuts (*Onguekoa klainea* Pierre). These are now known to exclude the possibility that his compound had one of the structures (VI) which he suggests, since vinylacetylenes absorb intensely at ∼ 2230 A. (ε = 12,000)[10]. They are compatible with the hypothesis that Castille's acid was a mixture of c. 5 per cent of a C_{18} acid possessing a —CH=CH.C≡C.C≡C— grouping, and 95 per cent of (VII) (which would show light-absorption of relatively low intensity), the alternative structure suggested by oxidative degradation[4]. The former acid has recently been isolated by Dr. E. M. Meade[5].

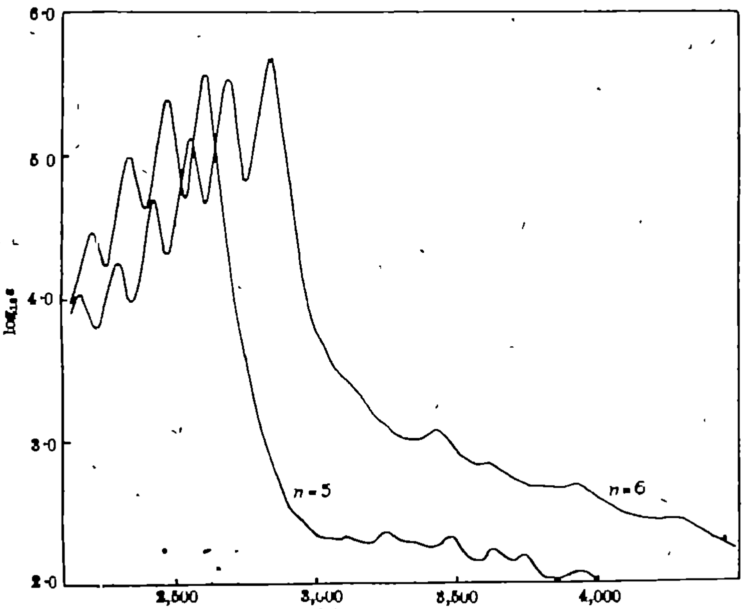
$$\underset{\mathrm{VI}}{\mathrm{H_2C{=}CH.C{\equiv}C.(CH_2)_4.C{\equiv}C.(CH_2)_7.CO_2H}}$$

$$\underset{\mathrm{VII}}{\mathrm{H_2C{=}CH.(CH_2)_4.C{\equiv}C.C{\equiv}C.(CH_2)_7.CO_2H}}$$

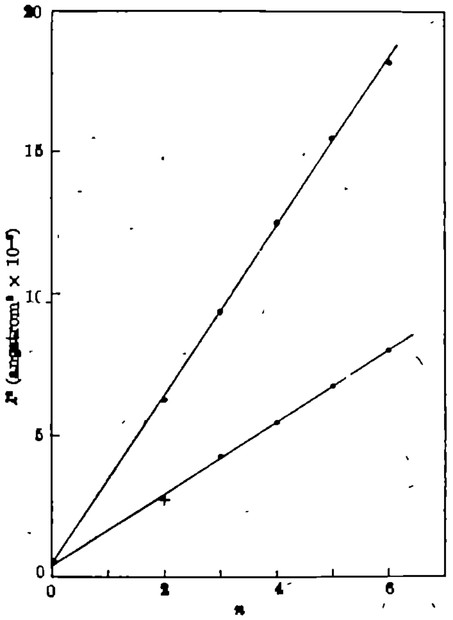
Oxidative coupling of (V, R = Me) gave (VIII ; $n = 4$); the lower members of this series have also been obtained, the diyne in two stereo-isomeric forms by oxidative coupling of the *cis*- and *trans*-forms of pent-3-en-1-yne[11], and the triyne by the route:

$$\begin{aligned}
&\mathrm{CH_3.CH{=}CH.CH(OH).C{\equiv}CH} \xrightarrow{\mathrm{CuCl\ O_2}} \\
&\mathrm{CH_3.CH{=}CH.CH(OH).(C{\equiv}C)_2.CH(OH).CH{=}CH.CH_3} \\
&\qquad\qquad \xrightarrow{\mathrm{SOCl_2,Py}} \\
&\mathrm{CH_3.CHCl.CH{=}CH.(C{\equiv}C)_2.CH{=}CH.CHCl.CH_3} \\
&\qquad\qquad \Big\downarrow \mathrm{NaNH_2} \\
&\qquad\qquad \mathrm{(VIII\ ;}\ n = 3\mathrm{).}
\end{aligned}$$

This latter (crystalline) hydrocarbon has an ultraviolet absorption spectrum almost superimposable on that of a liquid hydrocarbon isolated from *Artemesia vulgaris* L.[3d], which is possibly the *cis–cis* form of (VIII ; $n = 3$).



Light absorption of (I ; n = 5 or 6)



Light absorption of (I ; n = 2–6).
+, Price and Walsh, *Trans. Farad. Soc.*, 41, 381 (1945)

$$CH_3.CH{=}CH.(C{\equiv}C)_n.CH{=}CH.CH_3$$

VIII

$$CH_3.(C{\equiv}C)_n.CO_2H \qquad HO_2C.(C{\equiv}C)_n.CO_2H$$

IX X

On treatment with carbon dioxide, the Grignard derivatives of penta-1 : 3-diyne and hepta-1 : 3 : 5-triyne gave the crystalline acids (IX ; $n = 2$ and 3) ; while the derivatives of diacetylene and hexatriyne similarly yielded the acids (X ; $n = 2$ and 3), the former being obtained in quantity. Re-investigation of Baeyer's claim[11] to have prepared the highly unstable acid (X ; $n = 4$) has indicated that the reactions he employed do indeed lead to the formation of some of this substance, which the original work did not establish.

Light-Absorption Properties

The ultra-violet absorption spectra of the compounds prepared show many points of interest. In every case well-defined fine-structure was observed, the maxima showing a spacing of 2,000–2,300 cm.$^{-1}$ as compared with the typical polyene fine-structure spacing of ~ 1,600 cm.$^{-1}$. This provides an easy method of recognizing polyacetylenic groupings, for example, among the extracts of Compositæ examined by Sörensen *et al.*[8] and in the antibiotics nemotin, nemotinic acid, nemotin A and agrocybin[9].

In the case of dialkylpoly-ynes (the spectra of the highest members of the series are reproduced here) the most noteworthy feature is the very high intensity of absorption at short wavelengths ; (I ; $n = 6$) has $\epsilon_{max.} = 445,000$ at 2840 A., easily the highest molecular extinction coefficient yet recorded. Indeed, if the absorption intensity per unit weight (as E(1 per cent, 1 cm.)) is considered, the dimethylpoly-ynes exceed all other substances by a factor approaching 3 ((I ; $n = 6$) has E(1 per cent, 1 cm.) = 25,500 ; anthracene has (at 2510 A), E(1 per cent, 1 cm.) = 9,400, the highest value which could be found). In this region the highest maxima have molecular extinction coefficients approximating to 72,000 n, whereas the polyenes do not exceed 18,000 n.

The variation of $\lambda^2_{max.}$ with n in the dimethylpoly-ynes is illustrated below both for the first of the ultra-high-intensity bands and for the first of the medium-intensity ($\epsilon \sim 200$) bands observed at longer wave-lengths. An accurately linear relationship is observed in each case.

[*Added in proof.* October 18. Diphenyloctaacetylene (III ; $n = 8$) in ethyl acetate solution exhibited the following maxima : $\lambda_{max.}$A. 2440, 2595, 2740, 3040, 3220, 3415, 3580, 3760, 4300, 4660 and 5090 ; $\log_{10}\epsilon$ 4·42, 4·38, 4·49, 5·00, 5·36, 5·48, 5·40, 5·17, 4·09, 3·98 and 3·95 respectively.]

The ultra-violet absorption spectra of the other polyacetylenic compounds prepared will be discussed in later publications, along with infra-red spectra, but a list is given below of those of some of the

LIGHT-ABSORPTION PROPERTIES OF SOME POLYACETYLENES

(V, R = Me)	$\lambda_{max.}$(A.)	2290,	2385,	2510,	2640,	2800			
	$\epsilon \times 10^{-3}$	2·0	5·0	9·0	14·0	11·0			
(VIII ; $n = 2$)	$\lambda_{max.}$(A.)	2300,	2355,	2440,	2610,	2760,	2920,	3110	
	$\epsilon \times 10^{-3}$	31·0	30·0	23·0	8·0	14·5	21·0	17·0	
(VIII ; $n = 3$)	$\lambda_{max.}$(A.)	2450,	2590,	2690,	2890,	3055,	3250,	3480	
	$\epsilon \times 10^{-3}$	25·4	43·1	76·4	11·4	18·4	25·8	20·1	
(VIII ; $n = 4$)	$\lambda_{max.}$(A.)	2450,	2605,	2745,	2940,	3180,	3410,	3660,	3960
	$\epsilon \times 10^{-3}$	51·2	71·4	98·7	75·3	8·2	12·1	13·6	7·3
(IX ; $n = 2$)	$\lambda_{max.}$(A.)	2350,	2465,	2600,	2755				
	$\epsilon \times 10^{-3}$	1·75	3·25	4·10	1·40				
(IX ; $n = 3$)	$\lambda_{max.}$(A.)	2200,	2700,	2860,	3050,	3200			
	$\epsilon \times 10^{-3}$	62·0	2·4	2·8	2·5	2·1			

model compounds related to substances already found in Nature.

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THE HYPERGLYCÆMIC ACTION OF BLOOD FROM ANIMALS TREATED WITH GROWTH HORMONE

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THE alloxan-diabetic-hypophysectomized-adrenalectomized rat (ADHA rat) can be used for the assay of insulin in blood[1]. Since growth hormone is diabetogenic in intact[2] or partially depancreatized[3] animals of some species, the insulin content of the blood of animals treated with growth hormone was of some interest. Bornstein[4] found in preliminary experiments that the blood of ADHA rats treated with growth hormone not only failed to exhibit an insulin-like action in recipient ADHA rats, but also induced a rise of blood sugar in the recipient animals. The rat is one species of animal which does not, in the intact state, become diabetic when treated with growth hormone. In view of the results of these preliminary experiments, it was of interest to determine whether blood obtained from cats treated with growth hormone, which were either diabetic or about to become diabetic, displayed any tendency to increase the blood sugar in recipient ADHA rats.

There is some reason to associate the pancreas with the high insulin requirement of dogs with metahypophyseal-[5] or alloxan-[6] diabetes, relative to that of depancreatized dogs, and moreover the pancreatic islets (α-cells ?) are known to contain a substance antagonistic in some respects to insulin[7]. It was thus of particular interest to test portal vein blood, as well as peripheral blood, from animals treated with growth hormone, for hyperglycæmic activity in ADHA rats.

Methods. ADHA male rats weighing about 220 gm. were deprived of food for 1½ hr., by which time their blood-sugar level was about 100 mgm./100 ml. They were lightly anæsthetized (pentothal) and blood withdrawn from the tail vein for blood-sugar estimation. The sample of blood (1 ml.) from the donor animal (rat or cat) was then injected intravenously into the femoral vein of an ADHA rat, and further blood samples taken from the rat for blood-sugar estimation at 10, 20 and 30 min. after the injection. Blood sugar was estimated on heparinized blood samples by the Harding modification of the Shaffer–Hartman method. In certain experiments glycogen was determined, by the Good–Kramer–Somogyi method, on biopsy samples taken successively from one lobe of the liver with a cutting cautery.

The growth hormone was derived from ox anterior pituitary glands by either of two purification procedures[8].

In the preliminary experiments, in which ADHA donor rats were used, these animals were given 1 mgm. of growth hormone subcutaneously 24 hr. before the blood sample was taken, and a further 0·5 mgm. 1 hr. before sampling. Heparinized blood samples, obtained from the portal vein or from the femoral vein under light pentothal anæsthesia, were injected intravenously into recipient ADHA rats. Some ADHA rats received an intravenous injection of 0·5 mgm. of growth hormone in place of a blood sample.

The cats used were intact male animals, and were given daily subcutaneous injections of purified growth hormone of which, in a typical experiment, a daily dose of 10 mgm. induced a substantial glycosuria (10–20 gm./day) after five days of treatment. Where a 'prediabetic state' of the cats was investigated, only two injections of growth hormone were given.

In cat No. 237, diabetes had been induced by treatment with growth hormone in an initial test, but later this animal had become insensitive to the diabetogenic action of small doses of growth hormone, and was regarded as 'refractory'. Two injections of growth hormone were given before the blood sample

Table 1. Influence of the injection of blood from ADHA rats treated with growth hormone on the blood sugar of recipient ADHA rats (P vein = portal vein; F vein = femoral vein; significance of observation = probability (%) that the difference between the blood-sugar data for control and experimental rats is due to chance)

Donor ADHA rats			Recipient ADHA rats		
Treatment	Number of animals	Source of blood	Number of animals	Change in blood sugar (mgm / 100 ml.)*	Significance of observation (per cent)
(*a*) At 5 min. after donor blood					
Control	7	P vein	7	−4±7	
Growth hormone	8	P vein	8	+28±12	<0·1
(*b*) At 10 min. after donor blood					
Control	7	P vein	7	−4±9	
Growth hormone	8	P vein	8	+26±15	<1
	5	F vein	5	+4±7	
(*c*) At 20 min. after donor blood					
Control	7	P vein	7	+2±9	
Growth hormone	8	P vein	8	+13±13	<5
	5	F vein	5	+2±7	
(*d*) At 30 min. after donor blood					
Control	7	P vein	7	+2±14	
Growth hormone	8	P vein	8	+12±12	<5
	5	F vein	5	−2±8	

* With standard deviation of the observations.

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† Beit Memorial Research Fellow.

Table 2. Influence of intravenous injection of growth hormone on the blood sugar of ADHA rats

Time after injection of growth hormone (min.)	No. of rats	Change in blood sugar (mgm./100 ml.)*
5	7	−2±6
10	7	+1±8
20	7	+5±18
30	7	+7±14

* With standard deviation of the observations.

was taken. No injections were given to cat No. 203 with metahypophyseal diabetes.

Eighty minutes after the last growth-hormone injection (with the exception of cat 238 for which the period was 24 hr.), and 3 hr. after withdrawal of food, the cats were anæsthetized under pentothal. Blood was then withdrawn either from the pancreatico-duodenal vein or from the femoral vein, and administered intravenously to the recipient ADHA rats.

In experiments with control cats, two of which had been treated with an inactivated growth-hormone preparation, five pairs of recipient ADHA rats receiving portal blood yielded data for 10- and 20-min. samples which, on statistical analysis, established that there was no significant variation from one cat to another. This being so, the blood-sugar values in the recipient rats treated with blood from control donor cats were averaged, and the results expressed as the mean value together with the standard deviation for the individual observations. These control values formed the basis on which the significance of the results with treated cats was determined.

Results:

Donor ADHA rats. The results with donor ADHA rats are summarized in Table 1, from which it is clear that a transient but significant rise in the blood-sugar level of recipient rats was produced by the administration of portal blood from animals treated with growth hormone, but not with peripheral blood from such rats, nor with portal blood from rats treated with saline. It is also of interest that when the recipient ADHA rats received injections of growth hormone instead of blood from ADHA rats treated with growth hormone (Table 2), there was no immediate effect on the blood sugar level, although a delayed transient rise was observed in some of the animals. The hyperglycæmic action of blood from donor rats treated with growth hormone was associated with a depletion of liver glycogen in the recipient rats (Table 3).

Table 3. Influence of the injection of blood from ADHA rats treated with growth hormone on the liver glycogen of recipient ADHA rats. (Blood from portal vein. Significance of observation = probability (%) that the difference between the liver glycogen data for control and experimental rats is due to chance)

Donor ADHA rats		Recipient ADHA rats			
Treatment	No. of animals	No. of animals	Liver glycogen (as mgm. glucose/100 mgm. of tissue)		Significance of observation
			At 0 min.*	Change, 10 min. after donor blood*	
Control	5	5	1·08±0·23	−0·01±0·13	
Growth hormone	5	5	1·29±0·15	−0·47±0·18	<1

* With standard deviation of the observations.

Donor cats. Pancreatico-duodenal blood samples from intact cats in which growth-hormone diabetes had been induced, produced in recipient ADHA rats (Table 4) an abrupt rise in the blood-sugar level, although no rise was induced when blood from the femoral vein of donor cats was used. Indeed, in the experiments with diabetic cats 230 and 234, in which the rise of blood sugar in the recipient rats treated with portal blood was somewhat smaller than that for the other diabetic animals, the peripheral blood caused a fall of blood-sugar level in the recipient rats which may well have indicated the presence of insulin in the peripheral blood of the donor cats. Somewhat similar findings were obtained with blood

Table 4. Influence of the injection of blood from cats treated with growth hormone on the blood sugar of ADHA rats.
(P vein = pancreatico-duodenal vein; F vein = femoral vein; significance of observation = probability (%) that the difference between the blood-sugar data for control and experimental cats is due to chance)

Donor cats			Recipient ADHA rats								
			At 10 min. after donor blood			At 20 min. after donor blood			At 30 min. after donor blood		
Experimental condition	Reference No.	Source of blood	No. of animals	Change in blood sugar (mgm./100 ml.)	Significance of observation (%)	No. of animals	Change in blood sugar (mgm./100 ml.)	Significance of observation (%)	No. of animals	Change in blood sugar (mgm./100 ml.)	Significance of observation (%)
Control	219, 221, 232, 235, 236, 247	P vein	11	−2±9*	—	11	−3±13*	—	10	−5±19*	—
Control	219, 232	F vein	3	+4±6*	—	3	−7±7*	—	3	−9±20*	—
Pre-diabetic	243	P vein	3	−3		3	−23	<5	3	−20	<5
Pre-diabetic	245	P vein	2	−4		—	—		—	—	
		F vein	1	−18	<10	1	−6		1	−35	
Pre-diabetic	246	P vein	3	+15	<2	3	0		3	−7	
Diabetic	213	P vein	2	+42	<0·1	1	+34	<2	1	+4	
		F vein	2	+3		2	+5		2	−5	
Diabetic	230	P vein	1	+19	<10	1	+7		1	+2	
		F vein	1	−25	<5	1	−38	<5	1	−29	
Diabetic	233	P vein	2	+42	<0·1	2	+43	<1	2	+38	<5
Diabetic	234	P vein	2	+10		2	+23	<1	2	−16	
		F vein	1	−3		1	−6		1	−8	
Post-diabetic	238	F vein	2	+18	<10	2	+21	<10	2	+11	
Refractory	237	P vein	2	+4		2	0		2	−3	
Metahypophyseal diabetes	203	F vein	1	+8		1	−2		1	−4	

* With standard deviation of the observations.

from 'pre-diabetic' cats. The blood-sugar level of recipient rats was not significantly influenced by pancreatico-duodenal blood from the refractory cat, nor by peripheral blood from the cat with metahypophyseal diabetes.

Discussion. The results indicate that portal blood but not peripheral blood of animals made diabetic by growth hormone exerts a hyperglycæmic effect on recipient ADHA rats. Peripheral blood, on the other hand, sometimes causes a significant fall in the blood-sugar level of recipient ADHA rats such as might indicate the presence of insulin. These results are consistent with the view that growth-hormone treatment causes the liberation of the hyperglycæmic substance from the pancreatic islets, and that this substance, in contrast with insulin, does not reach the peripheral veins in appreciable amounts.

It must be admitted that other interpretations of these results are not ruled out by the present experiments. Since, however, pancreatico-duodenal or portal vein blood from suitable animals treated with growth hormone exerts a hyperglycæmic action in ADHA rats, the simplest hypothesis, namely, that this effect is due to the presence in portal blood of the hyperglycæmic substance from pancreatic islets, may be accepted until evidence disproving it is obtained.

We do not wish to discuss here the possibility that the influence of growth hormone on carbohydrate metabolism is mediated in part or wholly by secretion of the pancreatic hyperglycæmic factor. We do wish to point out, however, that since the factor is not confined to the pancreatic islets[7], experiments demonstrating an action of growth hormone on the carbohydrate metabolism of completely depancreatized animals[9] do not finally exclude this possibility.

Summary. Pituitary growth hormone was given to alloxan-diabetic-hypophysectomized-adrenalectomized rats, or to intact cats under conditions such that diabetes was induced. Portal blood from these animals was consistently found to exert a hyperglycæmic action when administered to recipient alloxan-diabetic-hypophysectomized-adrenalectomized rats. Such a hyperglycæmic effect was not found when growth hormone was administered directly to the recipient rats. These observations are consistent with the view that under the influence of growth hormone the pancreatic islets liberate their contained hyperglycæmic substance into the portal blood.

We are grateful for the technical assistance we received, particularly from Mr. M. Snowdon, and for financial assistance given by the Medical Research Council to one of us (F. G. Y.) and by Boots Pure Drug Co., Ltd., to another (J. B.).

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LONGEVITY OF *NELUMBO* FRUITS

CONSIDERABLE interest was aroused in Great Britain in 1933 by the flowering at the Royal Botanic Gardens, Kew, of plants of the sacred lotus (*Nelumbo nucifera* Gaertner, syn. *Nelumbium speciosum* Willd.) raised from fruits taken there by a Japanese botanist, Ichiro Ohga, who had found them in the peat of a long-dried-up Manchurian lake (*Bot. Mag. Tokyo*, 37, 87; 1923).

A like interest has been aroused this year in the United States by the germination at Washington in March 1951 of *Nelumbo* fruits having the same origin. These fruits came from a peat layer overlaid by several feet of loess on which trees grew; hence Ohga concluded that they must be at least 300–400 years old. Nelumbo fruits are nut-like and commonly regarded as seeds, the apparent fruit being a large obconical receptacle; they have a very hard coat impervious to air and water, and will not germinate until this coat has been broken or softened, for example, by filing or by the use of concentrated sulphuric acid. Fruits known to be 150 years old were germinated by Robert Brown; others known to be fifty-six years old were germinated by Becquerel (see *Kew Bulletin*, 263; 1933). An interesting paper on "How old are the Manchurian Lotus Seeds?" by Prof. Ralph W. Chaney, Department of Paleontology, University of California, indicates that these Manchurian fruits may have retained their vitality over a period much exceeding four hundred years, possibly for thousands of years.

The sequence of events, as outlined by Chaney in *The Garden Journal of the New York Botanical Garden*, 1, No. 5, 137 (September 1951) and by Ohga, seems to have been as follows. On the floor of a lake, about a mile across, in the Pulantien Basin of southern Manchuria, there accumulated a thick layer of plant fragments, among them the durable fruits of the lotus, a species which grows in shallow water. This process may have taken several centuries. Later the lake drained, and dust from the Gobi desert covered the peat with several feet of loess. The Japanese geologist Endo believes this loess deposit to be of Pleistocene age and the peat layer and its fruits to be 50,000 years old; if so, these fruits may have begun their long sleep at a time when Peking man (*Pithecanthropus pekinensis*) roamed eastern Asia.

To botanists accustomed to the short period during which most seeds and fruits retain their vitality, Ohga's estimate of a longevity of four hundred years was startling; Endo's estimate of 50,000 years accordingly seems fantastic, although a form of packing which protected the embryo and its food-reserves against molecular change so effectively for four hundred years might well protect them indefinitely. There can be no doubt that these Manchurian lotus fruits are very old. The species nowadays does not grow wild within a thousand miles of the Pulantien lake, and these Pulantien fruits differ in size and shape from those of the modern Indian form of the species with which they have been compared. A preliminary investigation by Dr. W. F. Libby, University of Chicago, of the residual carbon-14 isotope of a few fruits available in the United States puts their age at 1,040 years (± 210) according to a note in *Science*, 114, 296 (September 1951). Further investigation is planned.

The retention of viability by *Nelumbo* fruits for a thousand years or so is in its way as great a botanical sensation as the discovery of *Metasequoia glyptostroboides* a few years ago.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Is there an Æther ?

In the last century, the idea of a universal and all-pervading æther was popular as a foundation on which to build the theory of electromagnetic phenomena. The situation was profoundly influenced in 1905 by Einstein's discovery of the principle of relativity, leading to the requirement of a four-dimensional formulation of all natural laws. It was soon found that the existence of an æther could not be fitted in with relativity, and since relativity was well established, the æther was abandoned.

Physical knowledge has advanced very much since 1905, notably by the arrival of quantum mechanics, and the situation has again changed. If one re-examines the question in the light of present-day knowledge, one finds that the æther is no longer ruled out by relativity, and good reasons can now be advanced for postulating an æther.

Let us consider in its simplest form the old argument for showing that the existence of an æther is incompatible with relativity. Take a region of space-time which is a *perfect vacuum*, that is, there is no matter in it and also no fields. According to the principle of relativity, this region must be isotropic in the Lorentz sense—all directions within the light-cone must be equivalent to one another. According to the æther hypothesis, at each point in the region there must be an æther, moving with some velocity, presumably less than the velocity of light. This velocity provides a preferred direction within the light-cone in space-time, which direction should show itself up in suitable experiments. Thus we get a contradiction with the relativistic requirement that all directions within the light-cone are equivalent.

This argument is unassailable from the 1905 point of view, but at the present time it needs modification, because we have to apply quantum mechanics to the æther. The velocity of the æther, like other physical variables, is subject to uncertainty relations. For a particular physical state the velocity of the æther at a certain point of space-time will not usually be a well-defined quantity, but will be distributed over various possible values according to a probability law obtained by taking the square of the modulus of a wave function. We may set up a wave function which makes all values for the velocity of the æther equally probable. Such a wave function may well represent the perfect vacuum state in accordance with the principle of relativity.

One gets an analogous problem by considering the hydrogen atom with neglect of the spins of the electron and proton. From the classical picture it would seem to be impossible for this atom to be in a state of spherical symmetry. We know experimentally that the hydrogen atom can be in a state of spherical symmetry—any spectroscopic S-state is such a state—and the quantum theory provides an explanation by allowing spherically symmetrical wave functions, each of which makes all directions for the line joining electron to proton equally probable.

We thus see that the passage from the classical theory to the quantum theory makes drastic alterations in our ideas of symmetry. A thing which cannot be symmetrical in the classical model may very well be symmetrical after quantization. This provides a means of reconciling the disturbance of Lorentz symmetry in space-time produced by the existence of an æther with the principle of relativity.

There is one respect in which the analogy of the hydrogen atom is imperfect. A state of spherical symmetry of the hydrogen atom is quite a proper state—the wave function representing it can be normalized. This is not so for the state of Lorentz symmetry of the æther.

Let us assume the four components v_μ of the velocity of the æther at any point of space-time commute with one another. Then we can set up a representation with the wave functions involving the v's. The four v's can be pictured as defining a point on a three-dimensional hyperboloid in a four-dimensional space, with the equation:

$$v_0^2 - v_1^2 - v_2^2 - v_3^2 = 1 \qquad v_0 > 0. \quad (1)$$

A wave-function which represents a state for which all æther velocities are equally probable must be independent of the v's, so it is a constant over the hyperboloid (1). If we form the square of the modulus of this wave function and integrate over the three-dimensional surface (1) in a Lorentz-invariant manner, which means attaching equal weights to elements of the surface which can be transformed into one another by a Lorentz transformation, the result will be infinite. Thus this wave function cannot be normalized.

The states corresponding to wave functions that can be normalized are the only states that can be attained in practice. A state corresponding to a wave function which cannot be normalized should be looked upon as a theoretical idealization, which can never be actually realized, although one can approach indefinitely close to it. Such idealized states are very useful in quantum theory, and we could not do without them. For example, any state for which there is a particle with a specified momentum is of this kind—the wave function cannot be normalized because from the uncertainty principle the particle would have to be distributed over the whole universe—and such states are needed in collision problems.

We can now see that we may very well have an æther, subject to quantum mechanics and conforming to relativity, provided we are willing to consider the perfect vacuum as an idealized state, not attainable in practice. From the experimental point of view, there does not seem to be any objection to this. We must make some profound alterations in our theoretical ideas of the vacuum. It is no longer a trivial state, but needs elaborate mathematics for its description.

I have recently[1] put forward a new theory of electrodynamics in which the potentials A_μ are restricted by:

$$A_\mu A_\mu = k^2,$$

where k is a universal constant. From the continuity of A_0 we see that it must always have the same sign and we may take it positive. We can then put

$$k^{-1} A_\mu = v_\mu \quad (2)$$

and get v's satisfying (1). These v's define a velocity. Its physical significance in the theory is that if there is any electric charge it must flow with this velocity, and in regions where there is no charge it is the velocity with which a small charge would have to flow if it were introduced.

We have now the velocity (2) at all points of space-time, playing a fundamental part in electrodynamics. It is natural to regard it as the velocity of some real physical thing. Thus with the new theory of electrodynamics we are rather forced to have an æther.

P. A. M. Dirac

St. John's College,
Cambridge. Oct. 9.

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The Proportional Counter in X-Ray Diffraction Work

Recent work, for example, that by Curran *et al.*[1], has shown how the proportional counter can be made a reliable tool for measuring the energies of soft radiations. Used as a detector for measuring the intensities of diffracted X-rays, it possesses many advantages over the Geiger counter. With the proportional counter, counting losses are entirely negligible for all X-ray intensities likely to be realized with conventional X-ray generators and diffraction techniques. The possibility of discriminating against unwanted radiations of wave-lengths other than that of the characteristic radiation used for diffraction purposes enables diffraction records of greatly improved quality to be obtained, especially when the specimen gives rise to appreciable fluorescent radiation. Particularly valuable is the ability to cut out radiation the wave-length of which is a submultiple of that of the characteristic radiation. The life of the proportional counter is practically infinite, and so it is much more economical than the organic-vapour-quenched Geiger counters commonly employed as X-ray detectors.

A cylindrical brass-bodied proportional counter has been used mounted with its axis at right angles to the diffracted X-ray beam, which enters by a thin beryllium window. The counter was filled to atmospheric pressure with argon plus ethylene. Amplified counter pulses pass through a variable-width single-channel pulse analyser the output of which feeds a scaling unit and/or rate-meter with graphical recorder.

Fig. 1 shows that radiation of wave-length λ = 1·54 A. and energy 8·05 keV. (copper *Kα*) is completely separated from the harmonic wave-length of λ = 0·77 A. and energy 16·1 keV. Curve (*a*) was obtained with characteristic radiation reflected by plane 200 of a lithium fluoride plate set at the appropriate glancing angle, the X-ray tube being run at 30 kV. Curve (*b*) shows radiation of wave-length λ = 0·77 A. obtained by reducing the glancing angle, increasing the X-ray tube voltage to 50 kV., and doubling the X-ray tube current. On curve (*a*) a low peak at 16 keV. is due to the presence of radiation of wave-length λ = 0·77 A. from the second-order reflexion, 400. The harmonic is thus present in noticeable amount even at the low X-ray tube voltage of 30 kV. The small peaks on the low-energy side of both the 8 keV. and 16 keV. peaks are due to a small fraction of energy being lost as argon fluorescent *K* radiation which was not absorbed in the counter gas.

Figs. 2*a* and *b* show counter spectrometer records of part of the diffraction spectrum of powdered chrome alum taken by Geiger counter in Fig. 2*a* and by proportional counter in Fig. 2*b*. Copper *Kα* radiation was used, and in each case a nickel β filter

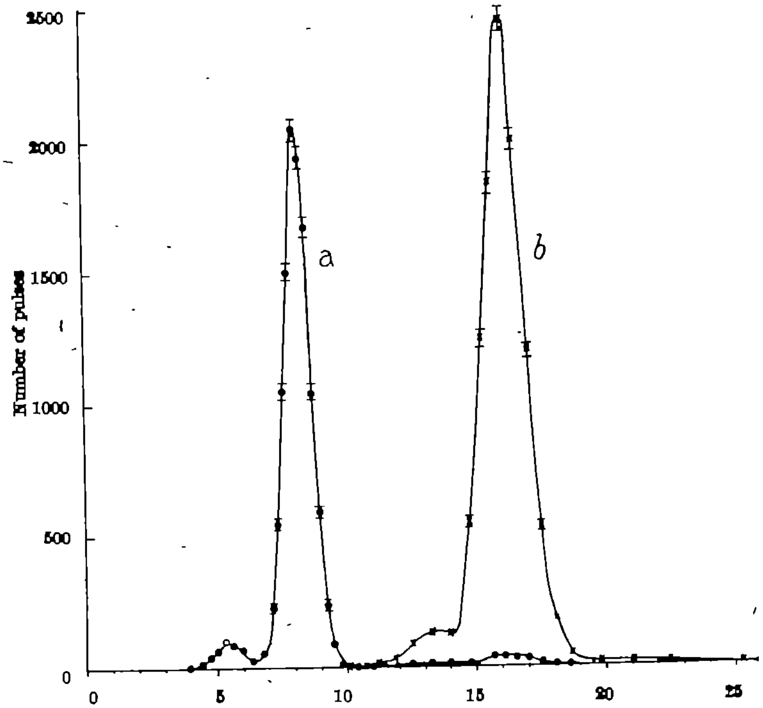

Fig. 1

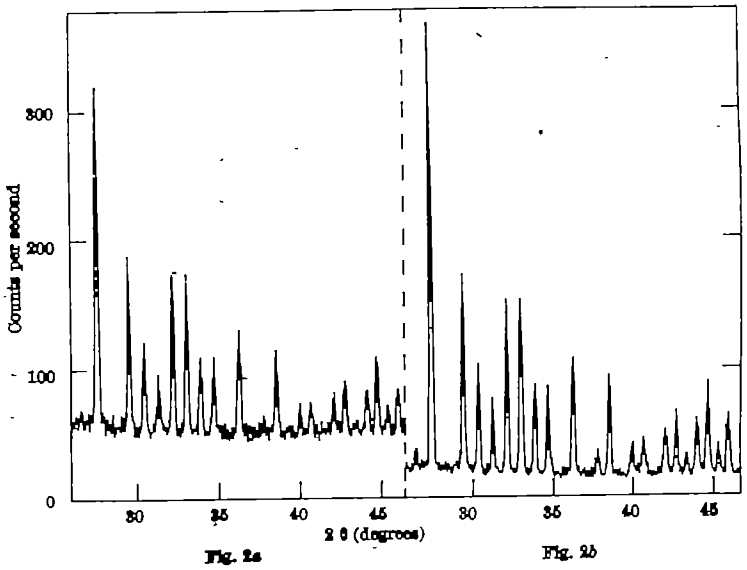

Fig. 2a Fig. 2b

was placed in front of the counter window. The two runs were made under identical conditions, only the counters being changed. It will be seen that the background in the proportional counter record is only about one quarter of that in the Geiger counter record. Several weak lines that can be barely distinguished above the statistical fluctuations of the high background in the Geiger counter record stand out clearly in the proportional counter record and allow reasonable estimates to be made of their intensities. Comparison of peak heights in the two curves shows that the proportional counter has a higher sensitivity for copper *Kα* radiation than the Geiger counter used, which was the best commercially available type. The natural background-rate of the proportional counter falling in the channel used for copper *Kα* radiation measurements was 15 counts per minute, only a quarter of that of the Geiger counter.

This work was supported by a grant from the British Electrical and Allied Industries Research Association.

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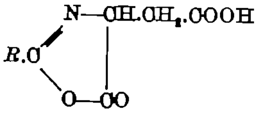
Racemization of N-Acylaspartic Acids

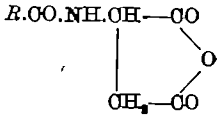
An exception to the general applicability of the method devised by du Vigneaud and Meyer[1] for the racemization of N-acyl-α-amino-acids has been discovered in the course of an attempt to racemize N-acetyl- and N-benzoyl-L-aspartic acids. The method of du Vigneaud and Meyer depends for its success upon the intermediate formation of a readily racemizable oxazolone when an aqueous solution of the sodium salt of such an acid is stirred with acetic anhydride. This treatment, which leads to the complete racemization of the N-acetyl derivatives of optically active methionine, cystine, arginine, tyrosine, phenylalanine, tryptophane and glutamic acid[1,2], achieves, however, only 13 per cent and 24 per cent racemization when applied to N-acetyl- and N-benzoyl-L-aspartic acids respectively.

The N-acylaspartic acids are unique in that they can, theoretically, become dehydrated in three alternative ways to give oxazolones (I), true anhydrides (II), and dihydro-6-keto-1 : 3-oxazines (III) respectively. The latter type of compound has received but little study; Baker and Ollis[3] have prepared 5 : 6-dihydro-6-keto-4 : 4-dimethyl-2-phenyl-1 : 3-oxazine from β-benzamido*iso*valeric acid, and pointed out that this type of compound may play a part in the chemistry of N-acylaspartic acids. Since the preferential formation of the anhydride or the dihydro-1 : 3-oxazine would account for the failure to racemize, the structures of the crystalline products obtained from these acids by the action of acetic anhydride have now been examined.

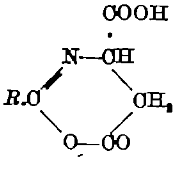
In this connexion it is of interest that Harington and Overhoff[4] obtained two dehydration products, melting points 145° and 175° respectively, from N-acetyl-L-aspartic acid and acetic anhydride. They ascribe to the former the oxazolone structure, on the grounds that it gives 2-methyl-5-oxazolone-4-acetyl chloride when treated with phosphorus pentachloride, while the anhydride structure is ascribed to the isomer of higher melting point without evidence. It has now been established that they both possess the anhydride structure, and that they are the racemic and optically active forms respectively. The isomer of lower melting point is invariably formed from N-acetyl-DL-aspartic acid; but either form may be obtained from the optically active acid. To obtain consistently the optically active anhydride, the N-acetyl-L-aspartic acid, which could not be obtained crystalline, must be quite free from sodium acetate, which is present as a contaminant when an aqueous alkaline acetylation of L-aspartic acid has been carried out.



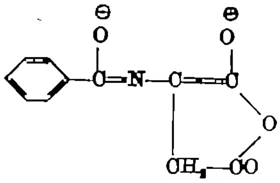
I



II



III



IV

The anhydride structure of these compounds is indicated by their total lack of reactivity towards diazomethane, by the formation of an α-amide with ammonia (thus eliminating structure III), and by the failure of the optically active anhydride to be racemized upon hydrolysis in aqueous sodium acetate (thus eliminating structure I). The structure is confirmed by the formation with aniline of two anilides, melting points 199° and 176–179° (decomp.) respectively. Similar considerations lead to the allocation of the anhydride structure to the anhydro N-benzoyl-L-aspartic acid.

The demonstration of the structures of these crystalline products does not, of course, rule out the presence of other anhydro-products at equilibrium in solution. The partial racemization produced by applying the method of du Vigneaud and Meyer may be due to some oxazolone formation, while the more complete racemization, produced when N-acetyl-L-aspartic acid is heated with acetic anhydride containing a little sodium acetate, may be due to the same cause. It has been established, however, that racemization can occur in such a medium when oxazolone formation is impossible, for example, the racemization of N-acetyl-L-proline[5]. Such racemization probably occurs as a result of the enolization of the anhydride, and new support for this mechanism is found in the observation that the water-insoluble N-benzoyl-L-aspartic anhydride dissolves readily in dilute sodium hydroxide to give a faintly yellow solution, which has an intense blue fluorescence in ultraviolet light. Both colour and fluorescence fade during the course of an hour as hydrolysis to the sodium salt of the acid occurs, and the product is completely racemized. The colour, fluorescence and racemization seem to be best explained by postulating the formation of the ion (IV).

As anticipated, N-benzoyl-L-asparagine is almost completely racemized (95 per cent) when its sodium salt is stirred with aqueous acetic anhydride.

A fuller account of these investigations will be published elsewhere.

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June 28.

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A New View of the Arylhydroxylamine Rearrangement

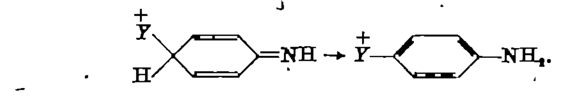
IT is a commonplace that those acid-catalysed aromatic rearrangements, which conform to the general pattern,

$$C_6H_5.NRX \xrightarrow{\text{acid}} (o\text{- or } p\text{-})\ X\cdot C_6H_4.NHR,$$

$$X = Cl, Br, I, NO_2, NO, SO_3H, OH, NHAr, N_2Ar, Alk,$$

notwithstanding that they are formally so similar, do not all proceed by the same mechanism: some involve intermolecular processes and some intramolecular. But they are usually all held to have at least this in common, namely, that X migrates as an electrophilic fragment: whatever adventures it may go through while in transit, it separates from nitrogen without the electrons by which it was bound thereto, and it unites with aromatic carbon by means of electrons which the latter has to supply. Such rearrangements may be called 'electrophilic rearrangements'.

This communication presents the view that there are actually at least two classes of rearrangements among the examples formulated above; that most of them are, indeed, electrophilic rearrangements; but that the arylhydroxylamine rearrangement, in particular, exemplifies the opposite process, a 'nucleophilic rearrangement': the OH group separates from nitrogen with the electrons with which it was bound; and a nucleophilic OH fragment uses its own unshared electrons for the purpose of combining with a carbon kernel. With the customary ellipsis of allowing single valency structures to represent mesomeric systems, the proposed mechanism may be formulated for a *para*-rearrangement as follows:



In the strictly isomeric change, Y: would be a water molecule; but taking closely related non-isomeric substitutions into account, Y: could be any sufficiently accessible and reactive nucleophilic molecule or anion. The mechanism is here formulated in an S_N1' manner, in accordance with the present evidence; but an S_N2' form of it may also exist, in which the first two stages, as written, would become telescoped into a single stage.

This is not the picture hitherto presented of the arylhydroxylamine rearrangement: reference may be made to a recent discussion by Dewar[1]. Because the transference of hydroxyl from an arylhydroxylamine to a foreign amine or phenol has not been achieved[2], and because hydrogen peroxide is not known to be produced during rearrangement in water, Dewar concludes that the rearrangement is electrophilic and intramolecular, adding the rider that it illustrates his π-bond theory (in which X^+, though bound, travels freely over the π-shell until it 'holes out' at an *ortho*- or *para*-position).

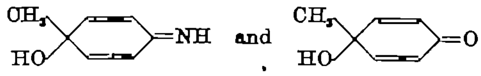
Our case for the view that the rearrangement is, on the contrary, nucleophilic and intermolecular, is based on the study of its kinetics and products. The significant work on products is in the literature already, and is due chiefly to Bamberger[3]. When phenylhydroxylamine was rearranged by means of dilute aqueous sulphuric acid, *p*-aminophenol was the main product. However, when ethyl alcohol was used for diluting the acid, *o*- and *p*-phenetidines, and with methyl alcohol, anisidines, were formed; and when the acid employed was hydrochloric acid, *o*- and *p*-chloroanilines were produced. If phenol was added, the product contained $(p)OH.C_6H_4.C_6H_4.NH_2(p)$ and some $C_6H_5.NH.C_6H_4.OH(p)$, and if aniline was introduced, some $C_6H_4.NH.C_6H_4.NH_2(p)$. Formed *p*-aminophenol was in some cases accompanied by the ether, $(p)NH_2.C_6H_4.O.C_6H_4.NH_2(p)$. The fact that so many fragments can appear in place of OH in the arylhydroxylamine–aminophenol conversion strongly suggests that the latter is not an intramolecular rearrangement. Further, since all the fragments come from nucleophiles:

$$Y = H_2O,\ EtOH,\ MeOH,\ Cl^-,\ PhOH,\ PhNH_2,\ NH_2.C_6H_4.OH,$$

one is led to assume an active electrophilic intermediate.

Bamberger found that the products obtained from an arylhydroxylamine were essentially identical with those produced by nitrogen loss from the corresponding aryl azide in similar conditions. He assumed a common univalent-nitrogen intermediate, ArN, which, when supplied with the extra proton shown by the kinetics to be involved (see below), becomes identical with the carbonium ionic intermediate written above.

By rearranging *p*-tolylhydroxylamine in aqueous acid at low temperatures, Bamberger demonstrated the formation of the iminoquinol and quinol,



along with products derived from them. This is where the previously written sequence of reactions would stop, when the final prototropic change is blocked by methyl substitution.

Bamberger found aniline and azoxybenzene among the products obtained from phenylhydroxylamine. But these substances probably arose from the irrelevant oxidation-reduction of phenylhydroxylamine. Our experiments indicate this to be a chain-reaction, avoidable, but easily started by short exposures to atmospheric oxygen. However, we find that the acid-catalysed rearrangements of phenylhydroxylamine are quite separate from these reactions, and are not dependent on the presence of oxidants.

Our kinetic study shows further that the rearrangements depend on the cation of phenylhydroxylamine, $PhNH_2OH^+$ (to write it in its more stable, rather than its more reactive, form). One consequence of this is that, while at low acidities the rate is proportional to the acidity, it ceases to increase proportionally to the acid when enough acid has been introduced to ionize nearly the whole of the base. No evidence has yet been found that chloride ion becomes involved in the rate-determining process, even when chlorine appears in the product. No sign has been discovered of quadratic dependence on acid, as in the benzidine change.

We think it would be very difficult to accommodate all these facts on any other view of the reaction than that advanced. But the matter is still being tested. As to products, Dr. C. A. Bunton is checking oxygen identities among factor, product and solvent, by the use of heavy-oxygen water; and as to kinetics, evidence of an S_N2' form of the reaction is being sought.

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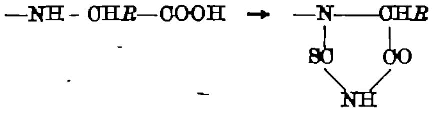
Identification of the Free Carboxyl Groups in Peptides

THE Schlack and Kumpf procedure[1] for identifying the amino-acids which provide terminal carboxyl groups in peptides has been made the basis of a micro method which works well with simple peptides and may be of use in studying the free α-carboxyl groups in proteins. In the case of glycylleucine and glycylvaline, the method has been used successfully, although preliminary experiments with insulin and wool keratin have indicated that some modification of the procedure may be necessary before it can be used with proteins.

Dry ammonium thiocyanate (0·1 gm.) and acetic anhydride containing 10 per cent acetic acid (1·0 ml.) are heated with the benzoylated dipeptide (0·1 gm.) for 30 min. on a boiling water-bath. After cooling the orange solution, 50 ml. of water is added, the mixture left overnight, and the light brown precipitate filtered off. It is then washed well with water and dried; yield 0·1 gm.



The thiohydantoin derivative of the benzoylated dipeptide (20 mgm.) is refluxed with 20 per cent hydrochloric acid (10 ml.) for 8 hr. and the hydrolysate extracted twice with nitromethane. After washing with water, the extract is taken to dryness *in vacuo* and hydrolysed in a sealed tube with 10 ml. of 0·25 *N* barium hydroxide for 48 hr. at 140° C.[2]. The barium hydroxide is removed as carbonate and the hydrolysate evaporated down and examined for amino-acids by paper chromatography. Ninhydrin development of the chromatogram shows a clear spot corresponding to the acid carrying the free carboxyl group. No other spot could be observed.

Thanks are due to the International Wool Secretariat for financial assistance.

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Influence of Salt on the Size and Shape of a Protein – Detergent Complex

STUDIES of the interactions between detergent and protein solutions by a wide variety of techniques have provided useful information on the types of binding involved in these systems[1] and on the denaturation and re-orientation of protein molecules[2]. In particular, the system bovine serum albumin – sodium dodecyl sulphate has been extensively investigated by electrophoresis, sedimentation and viscosity methods by Putnam and co-workers[3], and the heats of interaction for this system have recently been measured in this Laboratory by a direct calorimetric method[4]. The present communication deals with the effect of salt on the turbidity of bovine serum albumin – sodium dodecyl sulphate solutions.

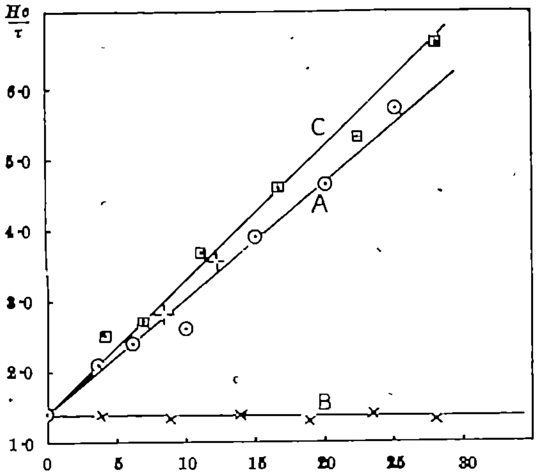
The light-scattering apparatus used was similar in principle to that already described[5], with the improvement that variations in the intensity of the incident light were corrected by reflecting a constant fraction of the latter on to a second photomultiplier tube. Moreover, since intensities of the scattered light were measured at 50° and 130° as well as at 90° to the incident beam, a large circular glass water-bath was placed around the optical cell containing the scattering solution in order to minimize reflexions and water–air refractive index corrections. The apparatus was calibrated by measurement of the turbidity of solutions of bovine serum albumin, a molecular weight of 70,000 being assumed for this protein. Since the protein solutions showed no dissymmetry of scattering, the turbidity (τ) could be calculated from the equation[6]:

$$1/M = \frac{32\pi^3 n_0^2 (dn/dc)^2}{3N_0 \lambda_0^4} \cdot \frac{c}{\tau} + 2\,Bc = \frac{Hc}{\tau} + 2\,Bc\,;$$

where M is the molecular weight of the protein, c its concentration in gm./c.c., dn/dc its refractive increment in solvent of refractive index n_0, N_0 is Avogadro's number, B and H are constants.

The refractive index increments were determined with a Rayleigh–Haber interferometer (Hilger). Solutions were optically clarified by gravity filtration through sintered glass, Grade 4 (clarification was not complete if suction were used), or, in the case of solutions containing sodium hydroxide, by centrifugation.

Curve *A* in the accompanying graph shows the value Hc/τ as a function of the detergent/protein ratio for the system sodium dodecyl sulphate – bovine serum albumin in salt-free solutions. The concentration of protein was maintained constant throughout at 1 per cent (w/v). Since the addition of detergent has little effect on the refractive increment, dn/dc, of the protein, the linear increase in Hc/τ with detergent/protein ratio is due almost entirely to a decrease in turbidity. Curve *B* shows that this



Curves *A* and *B*, detergent/protein ratio (moles); curve *C*, sodium hydroxide/protein ratio (moles)

Hc/τ as a function of detergent (or sodium hydroxide)/protein ratio. □, Sodium hydroxide – 1 per cent bovine serum albumen, + and ○, sodium dodecyl sulphate – bovine serum albumen (two samples), salt-free; ×, sodium dodecyl sulphate – bovine serum albumen in 0·01 *N* sodium chloride

diminution in turbidity is eliminated by the presence of sodium chloride at a concentration of 0·05 molar. Curve *C* shows that a diminution in turbidity comparable with that in curve *A* may be produced by titrating the protein with sodium hydroxide. The protein concentration was maintained at 1 per cent (w/v) during this titration.

The diminution in turbidity shown in curve *A* appears to be due to combination of the serum albumin with detergent anions, resulting in the protein acquiring a net negative charge. On titration with alkali the protein will also acquire a net negative charge. Doty and Steiner[7] have predicted on theoretical grounds that the turbidity of salt-free solutions of large molecules is reduced if the molecules are charged. As expected, the effect disappears in the presence of salt.

In all the solutions for which results are shown in the graph, the dissymmetry ratio of scattering (I_{45}/I_{135}) was approximately equal to unity. If, however, solutions were prepared in which the detergent/protein ratio was 140 moles, dissymmetry ratios of 1·5–1·6 were observed. This suggests an unrolling of the protein molecule at high detergent/protein ratios. The addition of solid sodium chloride to these solutions resulted in an increased turbidity (cf. curve *B*) and in a fall in the dissymmetry ratio to less than 1·10, indicating that the protein-detergent complex takes on a more symmetrical configuration in the presence of salt. Because of this dissymmetry effect at high detergent/protein ratios, it was found that the method of mixing detergent and protein solutions at lower ratios is important. If the protein solution is slowly added to the detergent solution so that initially there is a high detergent/protein ratio, dissymmetry ratios of approximately 1·5 are observed, whereas if the same solutions are mixed in the reverse order, dissymmetry ratios of approximately unity are found.

Neurath and Putnam[8] have measured the intrinsic viscosities of protein–detergent mixtures, and for this system have found evidence for denaturation of the protein, as a complex is formed at a detergent/protein ratio of about 100 moles. However, these experiments were carried out in buffered salt solutions. In solutions containing salt, no dissymmetry of light scattering is found, suggesting that in salt-free solutions an even greater uncoiling of the protein molecules occurs than that found by Neurath and Putnam. It has been observed qualitatively that the viscosities of salt-free solutions containing a high detergent/protein ratio are greater than for those containing salt. Quantitative measurements of the viscosities of salt-free solutions are now in progress.

One of us (B. S. H.) is indebted to the Consolidated Zinc Corporation, Ltd., for the award of a research grant.

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Prediction of Internuclear Distances of Di-atoms

SEVENTEEN years ago[1], on the basis of my proposed modification of the Morse rule connecting fundamental vibration frequency and internuclear distance of di-atoms, I ventured to predict internuclear distances for certain cases which had not then been determined experimentally. The accompanying table compares the values predicted for di-atoms of the *KKpp* sub-period with experimental results given in a new table due to Herzberg[2]. In some cases, the fundamental frequencies on which the calculations depend have been shifted by a few wave-numbers. In spite of these small corrections, it is judged sufficient to make direct comparison between the two sets of numbers without further calculation.

Di-atom	Electronic state	r_e (A.), predicted	r_e (A.), exp.	Error
CO	$a\ {}^3\Pi_r$ $a'\ {}^3\Sigma+$ $X\ {}^1\Sigma+$	1·202 1·367 1·117	1·209 1·359 1·128	− 0·007 + 0·008 − 0·011
NN	$a\ {}^1\Pi_g$ $C\ {}^3\Pi_u$	1·213 1·139	1·213 1·148	0·000 − 0·009
NO	$D\ {}^2\Sigma+$	1·070	(1·065)	+ 0·005
OO	$b\ {}^1\Sigma_g+$ $a\ {}^1\Delta_g$	1·238 1·218	1·227 1·216	+ 0·011 + 0·002
			Mean error	0·007

Results predicted in 1939[3] for singlet and triplet states of HH, HD and DD appear to have about the same errors, and many other cases may be cited. Improved methods have been more recently devised[4] interrelating bond constant and internuclear distance.

My classification[5] of di-atoms into groups, sub-groups, periods and sub-periods, and the introduction of period constants and group numbers into the Morse rule, upon which the above results depend, appears to be vindicated as a working basis. Careful comparison with the errors in calculated numbers derived by formulæ due to other authors seems to weigh in favour of my system. It may be claimed that the original method employed by Mendeljéeff in his atomic periodic table, and successful prediction of physical constants, may be satisfactorily carried over to the spectroscopic data for di-atoms.

A fuller account of this work will appear elsewhere.

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Effect of Phosphates and the *p*H on Sugar Absorption

There has been little discussion on the work of Magee and Reid[1] showing that the addition of phosphates at *p*H 7 to the liquid to be absorbed activates intestinal absorption of glucose but not that of xylose[1–3]. Laszt[3] attributes such an effect to the buffer action of the phosphates, as with other buffers at *p*H 7 he obtained analogous increases; between *p*H 4 and 8 he found an optimum of absorption at *p*H 7. Gellhorn and Moldavsky[4], however, arrived at opposite conclusions; in their opinion absorption would be much greater if instead of maintaining the *p*H at 7, it is somewhat displaced towards the acid or alkaline side. Difficulties in the interpretation of other results have induced us to return to these problems.

Absorption was studied in rats of 100–200 gm. by Sols and Ponz's method[7,8]. Three or four successive absorptions were carried out in the same intestinal loop of each animal. The hexoses remained at 5·4 per cent and the pentoses at 4·5 per cent dissolved in water or in phosphate solutions or other buffers. The time for absorption was 15, 20, 30, 45 or 60 min. The *p*H was tested by electrometric and colorimetric methods.

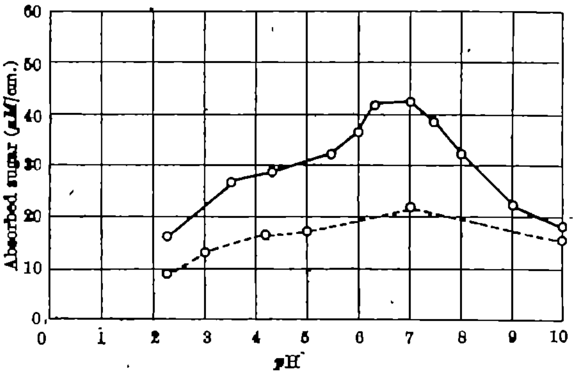

Fig. 1. Influence of *p*H on the absorption of 5·4 per cent D-glucose (———) and 4·5 per cent D-xylose (– – – – – –). Time of absorption, 30 min. for D-glucose and 45 min. for D-xylose. Average values in 41 animals

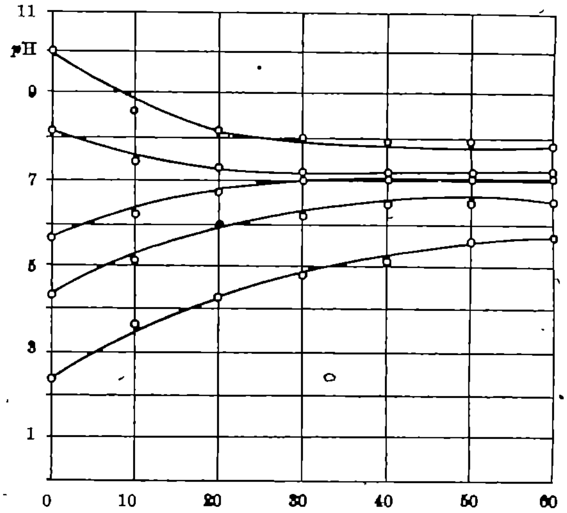

Fig. 2. Neutralization of buffer solutions of different *p*H introduced into the jejunum of rats, as a function of time. Each curve represents the average value obtained in three animals

Experiments on 46 rats showed clearly that the intestinal absorption of glucose was not increased, either by the presence of sodium glycerophosphate (at 2 per cent, neutralized with N/10 hydrochloric acid) or by inorganic phosphates (mixtures of *p*H 7, at 0·2 or 0·02 per cent).

The *p*H (between 2·2 and 10·0) nevertheless influences intestinal absorption. Citric acid–phosphate (McIlvaine, *p*H 2·2–8·0), phosphates (Sörensen, *p*H 5·5–8·0), borax–boric acid (Palitzsch, *p*H 7·0–9·0), and carbonate–bicarbonate (*p*H 10·0) were used. The results were obtained from experiments in thirty rats with D-glucose, eleven with D-xylose, ten with D-arabinose and another ten with L-sorbose. The optimum absorption of D-glucose (selective sugar) and of D-xylose (relatively selective sugar) is found in the interval 6·5–7·5, and it falls remarkably at lower or higher *p*H. Between 6·5 and 7·5, the differences are not statistically significant. At *p*H 3·5 and 9·0, absorption of D-glucose was only 50 per cent. D-Xylose exerts a minor influence (Fig. 1). D-Arabinose and L-sorbose do not seem to be affected by the *p*H. With a strongly acid *p*H, decrease of absorption occurred, and also in a control experiment performed immediately afterwards at *p*H 7; but in all these cases considerable epithelial desquamation presented itself, to which we attributed this effect.

The fact that glucose absorption is not accelerated by the phosphates may be due to the unbuffered D-glucose solutions being conserved in the intestine at *p*H between 6·5 and 7·5 and, therefore, within the optimum zone. The mucosa is, in effect, capable of producing a notable buffer action. We have followed up the *p*H of the intestinal contents during the absorption of D-glucose, starting from buffer solutions at different *p*H. Fig. 2 shows some examples of this buffer action of the jejunum. The more acid or alkaline the solution put into the loop, the greater is the quantity of mucine segregated and found in the intestinal contents. The intestine thus tends to maintain a neutral pH, in which condition the selective absorption of sugars is greatest.

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Gene Function in the Homologous and Heterologous Induction of α-Glucosidases in Yeast by α-Glucosides

A variety of freely segregating genes which specifically control the abilities of yeast to ferment α-glucosides has been discovered[1,2]. The three non-allelic genes determining the abilities of the haploid yeasts of the Carbondale breeding stock to grow with attendant visible gas evolution on maltose, α-methyl glucoside and sucrose, respectively, have been designated *MA*/*ma*, *MG*/*mg* and *SU*/*su*. It has been shown that these genes are concerned in the synthesis by the cell of maltase, an α-heteroglucosidase[3] and β-fructofuranosidase, respectively.

Experiments in which the variation of the fermentative scope of cells of genotype *MG MA su*, *mg MA su*, and *MA mg su* was determined in relation to the carbohydrate component of the growth medium of these cells have now permitted a fuller definition of the functions of *MA* and *MG*. Although the strains of these genotypes lack the gene *SU*, that is, they are incapable of growing with attendant visible gas evolution on medium containing sucrose as the sole carbohydrate nutrient, they all proved capable of sucrase synthesis when grown on a suitable carbohydrate. The sucrase activity which could be induced in these strains was frequently held largely in a covert condition by the freshly harvested cells, but was manifested by the same cells after drying. The strains realized only a small or negligible fraction of their glucosidase synthesizing potential when they were grown on glucose. In the strains containing the gene *MA* without *MG*, growth on maltose elicited a homologous response (maltase synthesis) and a heterologous response (synthesis of a sucrase). The growth of these strains on maltose failed to endow them with ability to ferment methyl glucoside at a significant rate. The strains of this genotype were incapable of responding to α-methyl glucoside with production of either maltase, α-methyl glucosidase or sucrase. In the strains containing the gene *MG* without *MA*, growth on α-methyl glucoside elicited a homologous response (production of α-methyl glucosidase), and a hetero-response (production of a sucrase). The growth on α-methyl glucoside failed to endow these strains with ability to ferment maltose. The strains of this genotype were incapable of responding to maltose with production of maltase, α-methyl glucosidase, or sucrase. Strains containing both *MA* and *MG* responded to both maltose and α-methyl glucoside with sucrase synthesis. In these strains maltose also elicited α-methyl glucosidase as well as maltase activity. When the cells of these strains were grown on α-methyl glucoside, they fermented the latter but not maltose on contact. They proved able, however, to adapt themselves to maltose more rapidly after growth on α-methyl glucoside than after growth on glucose.

The observed effects of the single gene changes in genotype *MG MA su* on the response pattern of the strains to α-glucosides are summarized in the accompanying table.

Influence of Single Substitutions of *MG* and *MA* in the Genotype *MG MA su* by the Recessive Alleles *mg* and *ma*

Gene alteration	Responses elicited by α-glucosides: Maltose			α-Methyl glucoside	
	Maltase	Sucrase	α-Methyl glucosidase	Sucrase	α-Methyl glucosidase
MG replaced by *mg*	+	+	−	−	−
MA replaced by *ma*	−	−	−	+	+

+, signifies that the production of the enzyme in response to the inducer was not markedly altered by the noted genic change.

−, signifies that the genic change noted was associated with a large or complete loss of the ability to produce enzyme in response to the inducer.

Thus it may be inferred that *MA* controls the ability of the cells to respond heterologously as well as homologously to maltose, while *MG* controls their ability to respond heterologously as well as homologously to α-methyl glucoside. It has been attractive to consider that yeast α-glucosido-hydrolases (maltase, α-methyl glucosidase, and gluco-sucrase) derive from a common precursor[3]. On the view that there exists a one-to-one relation[4] between a gene and an enzyme, we might assume that gene *MA* with maltose directs the conversion of the precursor into maltase, and that gene *MG* with α-methyl glucoside directs the conversion of the precursor into α-methyl glucosidase. An economical account of the control of heterologous inductions by genes *MA* and *MG* would be afforded by the assumption that primary enzyme products of these genes (maltase and α-methyl glucosidase respectively) may be further converted by the cell into other glucosidases.

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Reversible Oxidation of Glucose by Glucose Dehydrogenase

Ox liver has been shown to contain an enzyme, glucose dehydrogenase, which catalyses the reaction[1,2]:

$$\text{Glucose} + \text{diphosphopyridine nucleotide} \rightleftharpoons \text{gluconate} + \text{reduced diphosphopyridine nucleotide.} \qquad (1)$$

This enzyme has now been purified approximately 125-fold, starting from an aqueous extract of ox-liver acetone powder. The purification procedure consists of ammonium sulphate fractionation, precipitation of inactive protein by lead acetate and acidification, and adsorption on and elution from calcium phosphate gel. The purified enzyme has been found to be active with both diphosphopyridine nucleotide and triphosphopyridine nucleotide; but the reaction-rate with the latter is approximately one-half of that obtained with the former.

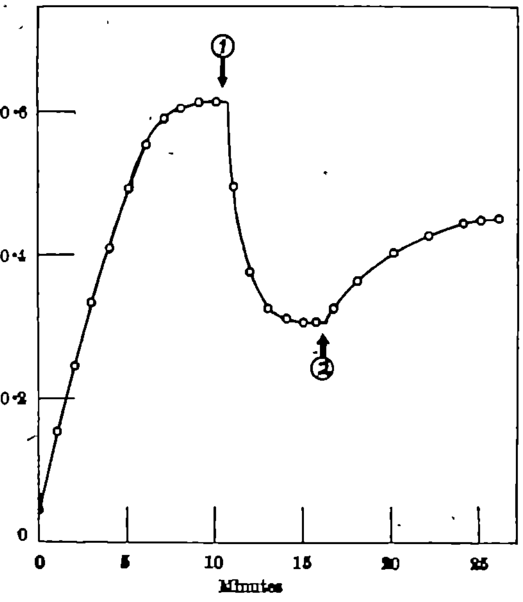
The enzyme has been used for studying the mechanism of oxidation of glucose to gluconate. This oxidation has been shown in other systems to proceed via the gluconolactone both chemically[3] and biologically[4]. Assuming that at *p*H 7·0 $E_0{}^1$ is − 0·43 V.[5,6], reaction (1) can be calculated to have an equilibrium constant of approximately 10^5. Thus, starting with unit concentrations of gluconate and reduced pyridine nucleotide, the reaction could proceed only to the extent of converting 0·3 per cent of the gluconate to glucose. However, if gluconolactone is an intermediate in the oxidation, then reaction (1) may represent the sum of the following reactions:

Glucose + diphosphopyridine nucleotide ⇌ gluconolactone + reduced diphosphopyridine nucleotide. (2)

Gluconolactone + H_2O ⇌ gluconic acid. (3)

Gluconic acid ⇌ gluconate + H^+. (4)

Since at neutral *p*H the major free-energy change in the above series of reactions occurs in reaction (4), it is probable that reaction (2) results in a comparatively small free-energy change and may therefore be reversible. A similar suggestion for the oxidation of glucose phosphate to phosphogluconic acid has been made by Lipmann[7]. The validity of this hypothesis was shown by the oxidation of reduced diphosphopyridine nucleotide and the formation of an equivalent amount of reducing sugar on incubation of glucose dehydrogenase, δ-gluconolactone, and reduced diphosphopyridine nucleotide. Reaction (2) has been followed in both directions by determination of the change in absorption at 340 mμ, as is shown in the accompanying graph. From a series of such experiments, the equilibrium constant for reaction (2) has been calculated to be approximately 15 at *p*H 6·7.



Reversibility of the reaction catalysed by glucose dehydrogenase (reaction 2). Reduction of diphosphopyridine nucleotide and oxidation of reduced diphosphopyridine nucleotide determined spectrophotometrically at wave-length 340 mμ. Quartz cells, *d* = 1 cm. Reaction mixture contained 2·2 millimoles of phosphate buffer, 0·965 micromoles of diphosphopyridine nucleotide, 0·1 c.c. of glucose dehydrogenase (10 mgm. protein per c.c.), and 20 micromoles of glucose in a total volume of 2·9 c.c. At arrow 1, 315 micromoles of δ-gluconolactone added. At arrow 2, 20 micromoles of glucose added. *p*H just prior to the addition at arrow 2, 6·7

It should be noted that, since reaction (3) has also been shown to be reversible[8,9], reduction of gluconate to glucose at high hydrogen ion concentrations is also theoretically possible. In this connexion it has been observed that incubation of gluconic acid with the enzyme and reduced diphosphopyridine nucleotide at *p*H 3·5 results in a slow but significant oxidation of reduced diphosphopyridine nucleotide, this oxidation being reversed by the addition of glucose.

From the equilibrium constant determined for reaction (2), from the equilibrium constant calculated from the data of Levene and Simms[9] for hexonic acids and their corresponding lactones for reaction (3), and from the dissociation constant of gluconic acid (*p*K, 3·78[10]), the potential ($E_0{}^1$) at *p*H 7·0 for the system glucose ⇌ gluconate can be estimated to be about − 0·43 V. This is in agreement with the value cited in the literature[5,6]. Further details of the purification and properties of ox liver glucose dehydrogenase will be published at a later date.

We wish to thank Dr. Severo Ochoa for his interest in and encouragement of this work.

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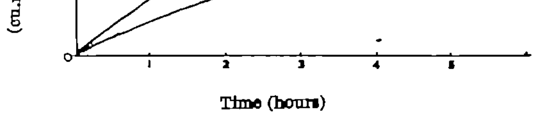
Glucose, Glutamate and Succinate Oxidation in Brain

THERE have, for some time, been difficulties in interpreting the role of glutamate in brain metabolism and its relation to glucose oxidation[1–4]. Weil-Malherbe[2] has adduced evidence to show that, in brain, summation of oxidations occurs if glucose and glutamate are used together as substrate. Krebs and Eggleston[5] have shown that the diffusion of potassium from brain cells *in vitro* is only fully prevented if both glucose and glutamate are present in the medium. On the other hand, Furchgott and Shorr[6] have found that at low oxygen tensions the addition of succinate to brain depresses the normal metabolic activities of the tissue, despite the fact that an increase in oxygen uptake occurs. Our investigations have given rise to certain considerations which seem relevant to this problem.

The early addition of glucose to a preparation of minced guinea pig brain in Krebs–phosphate–Ringer solution produced a substantial increase in oxygen uptake. Later addition, however, produced a very much smaller increase, and addition after three hours none whatever. The addition in the same way of glutamate or succinate produced a much greater increase in oxygen uptake than did glucose, and an almost constant rate of oxidation was maintained for several hours. This effect was obtained even if the glutamate was added after five hours. If glucose was added at any time to a preparation already respiring in succinate or glutamate, no increase in the oxygen uptake of the system was produced. This finding is incompatible with the observations of Weil-Malherbe[2], which show summation of oxidations under these conditions. On the other hand, the addition of glutamate to a preparation already respiring in glucose did produce an increase, but the new rate of oxidation was only equal to that occurring in glutamate alone. The same results were obtained with succinate. The addition of glutamate to a preparation already respiring in succinate produced an increase in oxygen uptake, even though previous addition of glucose to this preparation produced no increase. If succinate was added in the same way to a preparation respiring in glutamate, an increase in the oxygen uptake was also produced. These results are summarized in the accompanying graph.

Those observations suggest that the mechanisms involved in the oxidation of glutamate or succinate are considerably more stable than those involved in the oxidation of glucose. The stability of the latter mechanisms appears to be directly dependent upon the availability of substrate, for if the tissue is permitted to respire in Krebs–phosphate–Ringer solution alone, it rapidly loses its capacity to oxidize added glucose. However, even after several hours respiration in Krebs–phosphate–Ringer solution alone, the capacity of the tissue to oxidize succinate or glutamate is only slightly impaired. The increase in oxygen uptake following the addition of glucose appears, moreover, to bear some relationship to the rate of respiration prevailing at the time of addition, while the increase following the addition of glutamate or succinate seems to be independent of the prevailing rate of respiration.



(1) Guinea pig brain respiring in Krebs–phosphate–Ringer solution containing glucose. (2) Effect of adding glutamate to brain respiring in glucose. (3) Brain respiring in Krebs–phosphate–Ringer solution containing glutamate, but no glucose. (4) Effect of adding glucose (marked by arrow) to brain respiring in glutamate. (5) Effect of adding succinate to brain respiring in glutamate.

All experiments were carried out in Warburg flasks, at 37·5° C., in air, at 100 shakings per minute. The brain mince was produced by pressing the brain once through a 60-mesh sieve. 50–150 mgm. of tissue in Krebs–phosphate–Ringer solution was used in each flask, the final fluid volume being 5 ml., and the gas volume about 25 ml. The carbon dioxide was absorbed with potassium hydroxide paper. The final concentration of added glucose in each case was 0·2 per cent, that of glutamate or succinate 0·02 molar. The time between the death of the animal and the first reading was 20–30 min. Oxygen uptakes are uniformly calculated for 100 mgm. of tissue

The fact that the addition of glutamate to a preparation already respiring in succinate produces a further increase in oxygen uptake indicates that the mechanisms involved in the oxidation of glutamate to α-keto-glutarate and succinate are not inhibited by the concentration of succinate used.

The addition of glucose to a preparation containing the same concentration of succinate might similarly be expected to produce an increase in oxygen uptake. That no such increase occurred, no matter when the glucose was added, suggests that, under these conditions, glucose oxidation does not take place. Direct estimations of the amount of glucose consumed in the course of each experiment confirm this view. Further corroborative evidence is seen in an observation reported by Lipsett and Crescitelli[7]. These workers found that the addition of potassium chloride increased the oxygen uptake of rat brain slices respiring in glucose, but that this potassium effect was abolished in the presence of glutamate, succinate and certain other members of the tricarboxylic acid cycle. If, as our findings suggest, glucose is not oxidized in the presence of glutamate or succinate, then a potassium effect can scarcely be expected. It is difficult to see in what way an increase in the concentration of members of the tricarboxylic acid cycle can inhibit glucose oxidation; but it is possible that this phenomenon represents a mechanism by which the rate of glucose oxidation in brain is regulated.

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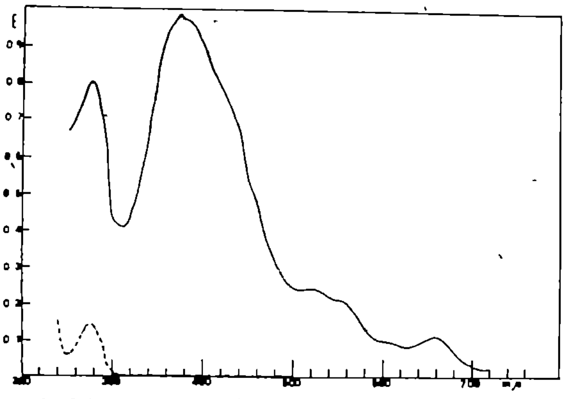
Spectrophotometric Determination of Hæmoglobin in Blood

A VARIETY of methods has been used for the determination of hæmoglobin in blood. They are based on (i) oxygen absorption[1], (ii) the iron content[2], or (iii) the transformation of the hæmoglobin to carboxyhæmoglobin[3], cyanhæmatin or acid hæmatin, which are then estimated colorimetrically[4] or spectroscopically[5,6].

The method described here is a development of the acid hæmatin procedure and involves the determination of the intensity of light absorption by the pigment using a Unicam spectrophotometer. The full absorption spectrum of the acid hæmatin (0·02 ml. blood in 0·1 *N* hydrochloric acid) has been determined in the ultra-violet and visible regions.



0·02 ml. blood in 10 ml. N/10 hydrochloric acid : ———, blood ; —·—·, serum

The absorption curve (see graph) shows maxima at 280 mμ, 372·5 mμ, 510 mμ and 660 mμ, and minima at 310 mμ, 500 mμ and 630 mμ. (Other characteristics of this spectrum are that $E(372\cdot5)/E(310) = 2\cdot50$ and that the intensities of absorption at 350 mμ and 408 mμ are the same.) The maximum at 372·5 mμ is used for the assay; and by calculation based on the iron content of the pigment, the E(1%,1 cm.) value was found to be 32·3. The conversion factor 15·5 was then derived to give the percentage of hæmoglobin in blood.

The plasma proteins and other blood constituents do not absorb in this region. Again, oxalate does not interfere, though citrated blood gives a slightly higher result. The acid hæmatin appears to be stable for at least six days, thus permitting the collection of a large number of samples prior to assay.

The procedure is as follows. 0·02 ml. of blood collected in a micro-pipette from a finger prick is added to 10 ml. of 0·1 N hydrochloric acid in a test-tube and shaken. After at least 10 min., the intensity of absorption of the acid hæmatin solution is measured in the spectrophotometer at 372·5 mμ, using a 1-cm. cell and decinormal hydrochloric acid as compensator. The percentage hæmoglobin in the blood is given by $E(372\cdot5) \times 15\cdot5$.

COMPARISON BETWEEN THE SPECTROPHOTOMETRIC AND WONG'S IRON METHODS

No.	E(372·5)	E(372·5) × 15·5	Wong's method
1	0·990	15·38	15·40
2	0·955	14·80	14·80
3	0·885	13·70	13·90
4	1·025	15·90	15·95
5	0·925	14·38	14·40
6	0·980	15·20	15·10
7	0·900	13·95	14·00

The results obtained by this procedure are reliable and in close agreement with values from the iron determinations; further, the assay requires much less time and manipulation.

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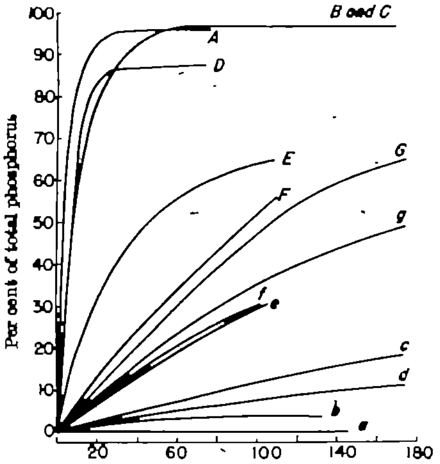
Specific Requirements for the Action of Deoxyribonuclease

THE mechanism of action of pancreatic deoxyribonuclease, now available in the crystalline state[1,2] on highly polymerized deoxypentose nucleic acids is still obscure. The enzymatic attack is known to result in the formation of dialysable oligonucleotides and of a non-dialysable 'core' which, in the case of the nucleic acids from calf thymus[3,4] and wheat germ[5], is characterized by proportions of adenine, and to a lesser degree of thymine, greatly in excess of those encountered in the original substrate. Mononucleotides and inorganic phosphate are not found among the degradation products[3,4], and this precludes the attribution to deoxyribonuclease of functions similar to those of phosphomonoesterases. It could be regarded as a phosphodiesterase of a closely circumscribed, as yet undefinable, specificity. A small number of acidic groups is, in fact, liberated during the digestion[6]. That the attack of an enzyme the action of which consists in the depolymerization of a substance of high molecular weight, exhibiting no easily recognizable periodicity of constituent sequence, must follow an intricate pattern is clear: every break of the original molecule produces substrates that are new and different; the enzyme must deal with kaleidoscopic substrate changes.

It appeared of interest to correlate substrate structure and susceptibility to enzymatic attack by studying the rate of disintegration to dialysable fragments, under the influence of crystalline pancreatic deoxyribonuclease, of deoxypentose nucleic acid preparations of different states of integrity. All preparations were derived from the highly polymerized deoxyribonucleic acid of calf thymus. Approximately 0·2 per cent solutions of the substrates in distilled water were, in some cases after the addition of 0·01 per cent of crystalline deoxyribonuclease, placed in small 'Cellophane' bags and incubated at 37°, with simultaneous dialysis against the ten- to twenty-fold volume of 0·02 M borate buffer of pH 7·3, which was 0·02 M with respect to magnesium sulphate and contained 0·001 per cent of ethylmercurithiosalicylate. Control experiments, in which both enzyme and magnesium were omitted, also were carried out; they are not included here, since no dialysable fragments occurred under these conditions. The rate of appearance of dialysis products was followed spectroscopically and, more conveniently, by determination of the total phosphorus in the dialysates.

For the presentation of the results in the accompanying diagram, the amounts of dialysable nucleotide phosphorus (as percentage of total substrate phosphorus) are plotted against time. The curves marked with capital letters indicate experiments carried out in the presence of both deoxyribonuclease and magnesium ions; small letters refer to the corresponding experiments performed without enzyme, but with magnesium ions present. The following substrates were employed: A, intact[7] deoxyribonucleic acid; B, preparation A kept at pH 11·8 (1 hr., 25°) and readjusted to pH 7·5; C, preparation A kept at pH 2·95 (1 hr., 25°) and readjusted to pH 7·5 (it should be noted that preparations B and C are capable of re-polymerization, regaining considerable, though highly thixotropic, viscosity[7]); D, preparation A kept in glycine buffer of pH 2·86 (24 hr., 37°), neutralized by dialysis against borate buffer of pH 7·3 and recovered by the evaporation in a vacuum of its frozen solution, fter thorough dialysis against water (this substance till contained all nitrogenous constituents in unhanged proportions and ratios[4]); *E*, preparation *A* cept in glycine buffer of *p*H 2·3 (24 hr., 37°) and lialysed and recovered as described for *D* (this substance retained 48 per cent of the purines originally resent; the pyrimidine composition was unhanged); *F*, preparation *A* suspended in dilute ydrochloric acid of *p*H 1·7 (26 hr., 36°) and dialysed nd recovered as described for *D* (this substance ontained about 13 per cent of the purines originally resent—8 per cent of the adenine, 24 per cent of he guanine; the pyrimidine composition was unhanged); *G*, this is the non-dialysable degradation roduct described recently as "apurinic acid"[8], in vhich a deoxypentose nucleic acid has been completely deprived of its purine constituents without mpairment of its original inter-pyrimidine ratios. t will be understood that in preparations *E*, *F* and *G* he position in the nucleic-acid chain of the missing urine nucleotides is marked by reactive aldehydo groups.



Action of crystalline pancreatic deoxyribonuclease + magnesium ions (curves marked with capitals) and of magnesium ions alone (curves marked with small letters) on intact calf thymus deoxyribonucleic acid (curves *A* and *a*) and on products of its denaturation (curves *B*, *C*, *D* and *b*, *c*, *d*), or partial degradation (curves *E*, *F*, *G* and *e*, *f*, *g*). See the text for the experimental arrangement and the composition of the substrates

The denaturation of the nucleic acid, that is, the nterference with its physical qualities, as must have occurred in preparations *B*, *C* and particularly *D*, loes not, by itself, materially impede the enzymatic reakdown. (Compare curves *A*, *B*, *C*, *D*.) The letachment of even a portion of the purines (curves *E* and *F*) or their complete removal (curve *G*) acts, owever, as a block. It is apparent that the enzyme equires the full complement of purines to be present, lthough it cannot yet be decided whether the latter re necessary as the points of attachment or because f specificity characteristics of deoxyribonuclease imilar to those discussed recently with respect to ibonuclease[9]. In addition, the interference with the mphoteric properties of the nucleic acid and the reation of aldehydo groups, both consequences f the removal of purines, may also be held esponsible.

The peculiar effects of magnesium ions in the bsence of enzyme (curves marked with small letters) re not without interest. The ability of this divalent cation to bring about a non-enzymatic disintegration appears to be in an inverse relationship to the susceptibility of the particular substrate to enzymatic attack. The intact nucleic acid is broken rapidly by the enzyme in the presence of magnesium (curve *A*); the cation alone has no effect (curve *a*). On the other hand, in apurinic acid, practically all the work seems to be done by magnesium ions alone (compare curves *G* and *g*). It is not possible to offer an adequate explanation of these findings. The role of magnesium ions in the activation of deoxyribonuclease has been considered repeatedly[1,2,10–13]. The experiments presented here could lead to the surmise that two different types of mutually supporting bonds are opened in the nucleic acid by the complete enzyme system: one broken by the deoxyribonuclease, the other affected by magnesium ions. However, attempts to demonstrate two phases of degradation by separating them in time were not successful. When a solution of intact deoxypentose nucleic acid in physiological saline (0·05 *M* with respect to sodium citrate) was treated with deoxyribonuclease at 37° for 18 hr., a considerable drop in viscosity was observed; but the addition of magnesium ions to the solution, after it had been freed of enzyme and citrate, failed to produce dialysable fragments.

These experiments and related studies will later be presented in detail. This work has been supported by research grants from the National Institutes of Health, United States Public Health Service, and from the Rockefeller Foundation.

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ERWIN CHARGAFF

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July 16.

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Mould Lipase: Effect of Addition of Vitamins and Sterol to the Cake Medium on the Growth and the Activity of the Lipolytic Mould

WE have isolated a strain of *Aspergillus niger* from the castor bean which shows high lipolytic activity. We have found that this lipolytic strain grows well in a cake medium containing 15 per cent oil-free groundnut cake, 10 per cent fresh groundnut oil and 200 c.c. water, adjusted to *p*H 4·2 and incubated at 35° C. for four days. The effect of addition of substances like vitamin B_1, vitamin B_2, ascorbic acid, α-tocopherol, digitonin and cholesterol to the cake medium on the activity of the lipolytic mould has been studied.

The strain of *A. niger* was inoculated on the cake medium in different conical flasks; the medium was autoclaved for 15 min. under 10-lb. pressure. The mats were removed after four days incubation and the lipase prepared according to Ramakrishnan and Nevgi's method[1]. The hydrolysis of fresh groundnut oil was carried out using the lipase and disodium hydrogen phosphate – citric acid buffer of *p*H 6·2. Each set of the experiments consisted of 1 c.c. groundnut oil, 5 c.c. water, 2 c.c. phosphate buffer, 0·1 gm. mould lipase and a few drops of toluene in a conical flask incubated for 24 hr. at 37° C. Blanks always accompanied the samples. After the period of incubation, the contents were taken out and titrated against *N*/10 sodium hydroxide after the addition of 25 c.c. of neutral alcohol and warming for some time. All readings were taken under sterile conditions. The difference between the sample and the blank will give the activity of lipase in terms of c.c. of *N*/10 sodium hydroxide. The results are given in Table 1.

Table 1

Amount of the substance added (mgm.)	Difference in c.c. of *N*/10 sodium hydroxide between the sample and blank in case of lipase obtained from the mould grown in the medium containing: Cake only	Cake + vit. C.	Cake + vit. B_1	Cake + vit. B_2	Cake + α-tocopherol	Cake + digitonin	Cake + cholesterol
0·0	22·6	—	—	—	—	—	—
1·0	—	22·8	22·9	24·3	23·6	No growth	27·8
5·0	—	25·7	25·8	28·8	27·9	,,	35·3
10·0	—	23·1	23·5	25·1	24·2	,,	26·1
20·0	—	18·5	19·2	21·9	22·1	,,	24·2

From Table 1, it can be seen that the lipolytic mould does not grow in the medium containing digitonin. It grows very well in the medium containing cholesterol, vitamin B_2 or α-tocopherol. The lipolytic activity is very high in the case of the mould grown in the medium containing 5·0 mgm. of cholesterol. Vitamin B_2, α-tocopherol and cholesterol increase the activity of the lipolytic mould when added to the medium at a concentration of 5 mgm. per 200 c.c.

Table 2

*p*H	Difference in c.c. of *N*/10 sodium hydroxide between the sample and the blank in case of lipase from mould grown in the medium containing: Cholesterol	Vitamin B_2	α-Tocopherol
3·6	12·3	10·5	7·2
4·8	19·2	16·2	9·8
5·2	30·6	22·6	15·2
5·7	36·9	29·3	19·1
6·2	35·3	25·8	27·9
6·8	29·6	18·5	15·2
7·2	22·5	10·2	8·3

In order to see whether the optimum *p*H for the activity of the mould lipase is affected by adding these substances, the hydrolysis of groundnut oil was carried out using these lipases and disodium hydrogen phosphate – citric acid buffer of different *p*H. The results are shown in Table 2. It was found that the optimum *p*H slightly changes (5·7–6·2), depending upon the nature of the substance added to the medium.

From these observations, it can be seen that addition of cholesterol, vitamin B_2 and α-tocopherol to the medium enhances the activity of the lipolytic mould, and the optimum *p*H for its activity changes with the nature of the substance added to the medium.

Details of this investigation have been submitted to *Enzymologia*.

Our thanks are due to the Indian Council of Medica Research for having awarded a research fellowship t one of us (C. V. R.) to carry out this investigation.

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[1] Ramakrishnan, C. V., and Nevgi, G. V., *Ann. Biochem. and Exp Med.*, 10, No. 1–2, 20 (1950).

Thermal Conductivity of Human Fat and Muscle

UNTIL recently, it was generally believed tha human subcutaneous fat serves as an effectiv insulator. Nevertheless, we have been unable t trace any record of actual measurements of th thermal conductivity of human tissue. Bordier[1], i 1898, made experiments on beef tissue by a satisfactory method. He found the muscle to conduc 1·8 times as well as the fat. A few other less satisfactory measurements were made about the sam time with similar results. The human case wa assumed to be similar.

No further experimental work seems to have bee published until 1938, when Hardy and Soderstrom[2] in a paper dealing with human calorimetry, state that they had measured the conductivity of bee tissue, and found for fat 0·00049 cal.cm./cm.^{2}sec. °C and for muscle 0·00047. They base on this result denial that a fat person has more insulation agains cold by reason of this fat than a thin person.

Clearly, measurements were called for on huma tissue, and these we have undertaken, using a instrument devised by one of us[3], a thermo electr heat-flow disk. Pieces of fat and muscle, abou 1 cm. thick and 5 cm. × 5 cm. or more in area, ar placed between two thin glass plates. In the centr of one side of the specimen is a heat-flow disk an a thermo-junction connected in opposition to a simila junction on the other side of the specimen. Two suc assemblies, one with fat, the other with muscle, wer placed in an incubator with a woven-wire resistanc heating-mat sandwiched between them. A curren of heat (about 40–50 kcal./m.^{2}hr.) could thus b caused to flow through the two specimens. Th flow is at right angles to their planes in the centr where it is measured by the disk, while the differenc of temperature between the two sides of the specime is measured by the couples. The thermal conductivit is given by $\frac{\text{heat-flow} \times \text{thickness}}{\text{temperature-difference}}$, and is expresse in cal.cm./cm.^{2}sec. °C.

Specimens of human tissue were obtained fron hospital post-mortems, and fresh-killed beef from th Caledonian Market. The last five samples of huma tissue tested gave the following results:

Date	Fat	Muscle	Ratio
11.6.1951	0·000445	0·00104	2·33
	0·000415	0·00045	1·08
14.6.1951	0·00047	0·00122	2·6
20.6.1951	0·00047	0·00095	2·02
22.6.1951	0·000385	0·000775	2·0
	0·000445	0·00108	2·42
Mean	0·000438	0·00092	

The figures for 11.6.1951 refer to two separate tissu pairs from different bodies, those for 22.6.1951 ar for a pair from the same body, each piece being measured at two points.

The values for beef were:

Date	Fat	Muscle	Ratio
22.5.1951	0·000484	0·00057	1 18
28.5.1951	0·000495	0 00046	0·93
18.6.1951	0·000487	0 00097	2·0
Mean	0·000489	0 00067	

It seems legitimate to conclude from the above figures that fat is a better thermal insulator than muscle. The latter, however, is very variable when measured dead; the near-constancy of the figures for fat shows that the variations in those for muscle are due to the material and not the method. Preparations kept for a day or two at room temperature showed very slight change in the fat, but large changes in the muscle, usually an increase. The discrepancy between the results of Bordier and Hardy and Soderstrom with beef tissue is thus easily explained. The agreement with the latter's figures for fat is very close.

H. STAFFORD HATFIELD
L. G. C. PUGH

Division of Human Physiology,
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Holly Hill, London, N.W.3. June 28.

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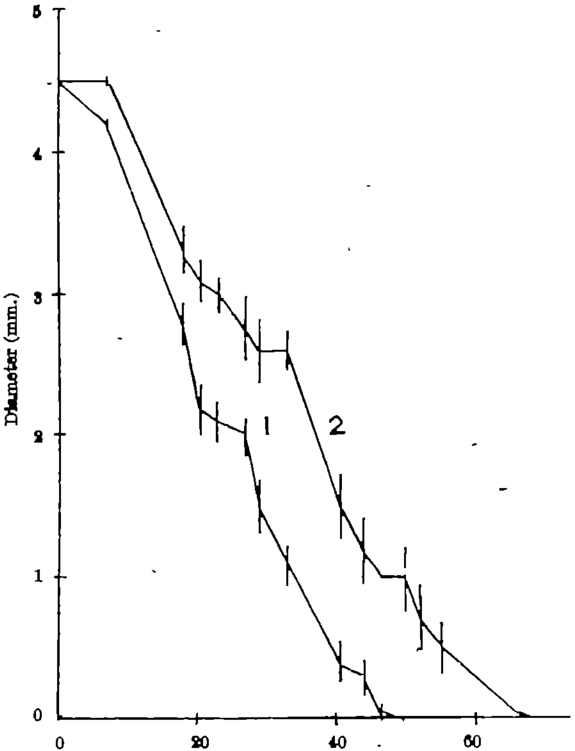
Electric Shock and the Regeneration of the Corneal Epithelium of Rabbits

IT was considered of interest to discover the effect of electric shock on epithelial regeneration, since there are indications that mitotic activity is profoundly affected in shock conditions[1]. In order to obtain quantitative information, artificially produced lesions of the corneal epithelium of rabbits were regarded as a suitable object. With the aid of Nižetić's corneal trepan and a small lancet, practically identical lesions were made in each cornea. Each of them had a diameter of 4·5 mm. and for convenience was dyed with uranin (1 per cent); thus it was easy to measure two diameters at right angles to each other. There were two groups, each consisting of four animals, and both eyes of each animal were operated on. One group of animals was stressed by electrical injury three times a day during observation, by applying alternating current of 50 c./s. and 45 V. for one second. Convulsions lasted for nearly 60 sec., unconsciousness up to 180 sec. Except during the convulsions, the sensitiveness of the cornea was normal. The other group served as a control. To obtain information as to the speed of regeneration, the extent of the two diameters of each lesion was measured with a circle every three hours during the day-time.

Beginning from the eighteenth hour after the operation, the difference between the two groups of animals became significant. The accompanying graph constructed from the average means, including standard errors, against time, shows the diminution of the diameters of the lesions in the two groups of rabbits. It is evident that the regeneration of the epithelium of the shocked animals is inhibited in comparison with the regeneration of controls. The complete regeneration of the shocked animals was retarded by more than half a day, that is to say, by about 25 per cent of the normal period. Comparing both curves of the graph, a linear function may be possible in either case, especially when we take into account the existence of an initial lag due to the cocainization of the eye.



Diameters of the corneal lesions. (1) Control group; (2) shocked group

As to the cause of inhibition of regeneration, there are indications that sugar metabolism is affected; but other disturbances may also be involved.

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May 24.

[1] Bullough, W. S., and Green, H. N., *Nature*, 164, 795 (1949).

Vegetative Propagation from the Broccoli Curd after Suppression of Flowering

IN the course of an inspection of early varieties of autumn cauliflower and broccoli grown for seed production in Cyprus during 1946, it was observed in certain crops that after the inflorescence had formed very few flower buds developed. Suppression of flower development also occurred in a seed crop in the Scilly Isles later that year, and in a glasshouse in Devon, where selected broccoli plants were being seeded.

Further observations were continued in the case of the glasshouse crop. These plants had been transplanted from the field when the curds were visible. The curds were broken up by the elongation of the inflorescence stalks, and flowers developed. On certain plants a few early flowers which had been pollinated continued to develop and formed seed pods; but later buds turned yellow in colour, shrivelled and dropped before opening. At the same time the bracts on the inflorescence stalks started rapid growth, eventually forming a dense mass, and finally, after a few weeks, leafy shoots were observed to develop.

It was found that these vegetative shoots could be rooted[1] in sand and produced plants which did not appear to differ in any respect from those raised from seed, and which formed curds at the normal season for the variety.

The following year a series of curd cuttings were rooted and grown on until the first flower buds were opening, when some of the plants were transferred to a glasshouse where the temperature ranged from 60° to 80° F. The remainder of the plants were kept in the unheated glasshouse where the temperature at the time of the year ranged from 40° to 70° F. After four days the flower buds on the plants at the higher temperature were observed to be aborting, with rapid development of bracts. The buds on the plants at the lower temperature opened normally, were pollinated and produced seed.

The results appear to follow closely those obtained with Danish Ball Head cabbage, in which flowering is suppressed at an average temperature of 60° F.[2].

When breeding cross-pollinated species it is often desirable to be able to return to the original parent material. It is also of considerable value to be able to establish clones. This has not previously been achieved with cauliflower and broccoli. By removal to a temperature of 70°–80° F. for a relatively short period, plants which have already formed curds can be returned to a vegetative state. Large numbers of plants can then be obtained from a single curd by rooting the leafy shoots which develop after flower suppression at the high temperature.

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[1] Graham, R. D., and Stewart, L. B., *Trans. and Proc. Bot. Soc. Edin.* 30, Pt. 3 (1930).

[2] Miller, J. C., *Bull. Cornell Univ. Exp. Stat.* (1929).

Could an Arms-Race end Without Fighting?

Dr. L. F. Richardson has attempted (*Nature*, Sept. 29, p. 567) to foretell the result of the arms-race by means of differential equations. While his conclusions are most interesting, has he investigated the effect of assuming slightly different initial equations which would appear at least as reasonable as those he adopts? The following argument suggests a somewhat altered form for his equations (1) and (2).

There would not appear to be anything particularly absolute in reactions to any given arms expenditure; what one generation considers heavy, a succeeding generation considers but slight. Hence all terms in the equations should imply influences relative to the general rate of expenditure, not to the absolute rate. This implies that the equations should be homogeneous in x and y—thus throwing doubt, in the case of equation (1), on the terms $ky\{1 - \sigma(y - x)\}$ and g. Since Dr. Richardson assumes $g = 0$, this term need not be discussed further; but consider the effect on the former term of a general increase of arms expenditure when, initially, $\{1 - \sigma(y - x)\} = 0{\cdot}5$. A doubling of expenditure by both sides would then reduce the 'defence' reaction of the first side to zero—a result which seems scarcely likely.

A more reasonable form of equation (1) would seem to be:

$$\frac{dx}{dt} = ky - \sigma(y - x) - \alpha x. \qquad (a)$$

Assuming that a similar equation, with identical coefficients, governs the rate of increase of expenditure of the second side, the two simultaneous equations lead simply to:

$$x + y = (x_0 + y_0) \exp\left[\,(k - \alpha)(t - t_0)\,\right] \qquad (b)$$

$$\frac{x - y}{x + y} = \frac{(x_0 - y_0)}{(x_0 + y_0)} \exp\ \left[2(\sigma - k)(t - t_0)\right], \qquad (c)$$

where x_0 and y_0 are the values of x and y at time t_0. If at any time (say, when $t = t_0$), $(x + y)$ is increasing, then $k > \alpha$, and $(x + y)$ continues to increase exponentially. If $\sigma > k$, that is, if the 'submissiveness' coefficient σ overrides the 'defence' coefficient k, the relative difference in arms would increase, again exponentially (equation c), and one might perhaps presume that there would be no war. If the reverse were true, the armed strengths of the two sides would become relatively almost equal, and one would probably regard war as increasingly inevitable.

On this analysis, therefore, an arms-race would lead to war unless there were an appreciable degree of 'submissiveness'—a result which is perhaps scarcely surprising.

M. R. Horne

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Mr. M. R. Horne's letter should be welcomed as raising questions that will not be understood until they have been argued. The question at issue may be stated thus.

Let us name $\dfrac{\partial}{\partial y}\left(\dfrac{dx}{dt}\right)$ the 'effective' defence-coefficient. Now, on Mr. Horne's hypothesis,

$$\frac{\partial}{\partial y}\left(\frac{dx}{dt}\right) = k - \sigma,$$

which can have either sign, but cannot change sign. But on Richardson's (1939) hypothesis,

$$\frac{\partial}{\partial y}\left(\frac{dx}{dt}\right) = k\,\{1 + \sigma\,(x - 2y)\},$$

which can change sign according as $2y - x \gtrless 1/\sigma$. The common saying that 'all bullies are cowards' suggests that a change of sign occurs somewhere. However, the present equations are intended to represent the behaviour, not of individuals, but of nations. The effective defence-coefficient of Germany has been estimated from statistics of warlike expenditure, and was found to be positive during 1908–14, negative during 1920–30, and positive again during 1930–39. The discussion of the submissive interval is at present published only in microfilm[1].

Lewis F. Richardson

Hillside House,
Kilmun, Argyll.
October 15.

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[1] Richardson, L. F., "Arms and Insecurity", published by the author (1949).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 26

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. W. S. Feldberg, F.R.S.: "Anticholinesterases".*

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Mr. F. G. Skinner: "The English Yard and Pound".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Should Broadcasting be Superseded by Wire Distribution?" (to be opened by Mr. P. P. Eckersley).

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the LONDON AND SOUTH-EASTERN COUNTIES SECTION of the ROYAL INSTITUTE OF CHEMISTRY and the WOOLWICH POLYTECHNIC SCIENTIFIC SOCIETY, at the Woolwich Polytechnic, Woolwich, London, S.E.18), at 7.30 p.m.—Dr. F. Wormwell: "Corrosion Processes—their Cause and Prevention".

Tuesday, November 27

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Prof. Frank Debenham: "The Water Problems of Africa".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Dr. Elizabeth Colson: "Social Control and Vengeance in Plateau Tonga Society".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Seventh Annual General Meeting; Mr. B. S. Cooper: "Light Sources in Chemical Analysis and Testing".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, Portland Place, London, W.1), at 6.30 p.m.—Mr. K. F. H. Murrell: "The Visual Presentation of Instrument Data".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. T. R. Boys: "The Use of Working Scale Models in the Development of Broadcasting Aerials".

ROYAL METEOROLOGICAL SOCIETY, MIDLAND CENTRE (at the Midland Institute, Paradise Street, Birmingham), at 7.15 p.m.—Sir Robert Watson-Watt, F.R.S.: "The Uses of Radar in Meteorology".

Tuesday, November 27—Wednesday, November 28

INSTITUTION OF GAS ENGINEERS (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 10 a.m. each day.—17th Autumn Research Meeting.

Wednesday, November 28

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. Edward Hindle, F.R.S.: "The Whaling Industry" (Trueman Wood Lecture).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. H. S. Houthakker: "The Econometrics of Family Budgets".

INSTITUTION OF ELECTRICAL ENGINEERS, SUPPLY SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. B. Rowson: "A Statistical Approach to some Problems in Electricity Supply".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, CHEMICAL SECTION (at the Portico Library, Mosley Street, Manchester), at 5.45 p.m.—Mr. A. N. Leather: "Good Food, Clean Water and Pure Air".

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Report and Discussion on the 1951 Meeting of the C.I.E.

Thursday, November 29

BIOMETRIC SOCIETY, BRITISH REGION (at the Wellcome Research Institute, 183 Euston Road, London, N.W.1), at 2.15 p.m.—Annual Meeting; Scientific Papers.

BRITISH GLACIOLOGICAL SOCIETY (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 4.30 p.m.—Mr. W. H. Ward: "The Barnes Ice-Cap in Central Baffin Island"; Annual General Meeting.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Harold Spencer Jones, F.R.S.: 'Distance Measurements in Astronomy". (Further Lectures on December 6 and 13.)

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. E. T. Blott and Mr. C. G. Verver: "Methods for Expressing the Viscosity-Temperature Relationships of Lubricating Oils".*

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Mr. F. C. Bawden, F.R.S.: "The Scientific Basis of Medicine, 16, Current Knowledge on Nature of Viruses".* (Further Lectures on December 4, 6 and 11.)

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. H. H. Gardner: "Structural Problems in Advanced Aircraft".

Friday, November 30

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Anniversary Meeting.

COUNCIL FOR THE PROMOTION OF FIELD STUDIES (at Goldsmiths' Hall, Foster Lane, Cheapside, London, E.C.2), at 5 p.m.—Annual General Meeting; Dr. Arthur Raistrick: "The Bone Recorder and other Archæological Remains on Malham Moor".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. S. Y. Chung and Prof. H. W. Swift: "Cup-Drawing from a Flat Blank—Experimental and Analytical Investigations".

INSTITUTION OF ELECTRONICS, NORTH-WESTERN BRANCH (at the College of Technology, Manchester), at 7 p.m.—Dr. T. Kilburn: "The Use of Cathode Ray Tubes in Digital Computing Machines".

Saturday, December 1

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. A. D. Lacaille: "Stone Age Tools".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PRINCIPAL (graduate of a university in the United Kingdom, with first- or second-class honours, or higher degree, in science or engineering) OF THE NEATH TECHNICAL COLLEGE—The Director of Education, County Hall, Cardiff (November 30).

ASSISTANT, Grade B, IN PHYSICS—The Principal, Royal Technical College, Salford (December 1).

ASSISTANT MASTER (in the Secondary Technical School for Boys) to teach CHEMISTRY throughout the school—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (December 1).

ASSISTANT LECTURER IN APPLIED OPTICS—The Registrar, College of Technology, Manchester 1 (December 3).

SENIOR ASSISTANT ENGINEER in the Generation (Operation) Department at Divisional headquarters—The Divisional Secretary (Establishments), British Electricity Authority, North-Eastern Division, Carliol House, Newcastle-upon-Tyne 1 (December 3).

WATER SUPPLY ENGINEER in the Water Works Sub-Department of the Public Works Department, Ceylon—The High Commissioner for Ceylon in the United Kingdom, 13 Hyde Park Gardens, London, W.2 (December 5).

ADVISORY OFFICERS (with a recognized degree in botany or agriculture and a leaning towards grassland work) at the Sports Turf Research Institute—The Secretary, St. Ives Research Station, Bingley, Yorks. (December 8.)

AERODYNAMICISTS, PHYSICISTS and ENGINEERS (Scientific Officer (Ref. C.678/51A) and Experimental Officer (Ref. C.679/51A) grades), at a Ministry of Supply research establishment in Hampshire, for work concerned with problems of heat transfer, aerodynamics, projects and performance in the increasingly important field of gas turbine research—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No. (December 8).

LECTURER IN PHYSICS—The Registrar, The University, Sheffield (December 8).

ASSISTANT CIVIL ENGINEER in connexion with the design, maintenance and construction of dock and harbour works—The Secretary, Tyne Improvement Commission, Bewick Street, Newcastle-upon-Tyne 1 (December 14).

EXPERIMENTAL OFFICER in the Mechanical Engineering Research Organization (Department of Scientific and Industrial Research), for research work on the plastic deformation of metals occurring in commercial processes such as rolling, deep drawing, forging, pressing, wire drawing, tube drawing, extrusion, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.680/51A (December 15).

LECTURER OR ASSISTANT LECTURER (with a University degree in agriculture, preferably with honours, or postgraduate work in Crop Husbandry and/or Horticulture) IN AGRICULTURE (Crop Husbandry), and a LECTURER OR ASSISTANT LECTURER (with a University degree in either Chemistry, Geology or Agriculture with postgraduate experience in Pedology) IN PEDOLOGY, in the Faculty of Agriculture, University College of Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 15).

LECTURERS IN ELECTRICAL ENGINEERING, CIVIL ENGINEERING, MECHANICAL ENGINEERING, NAVAL ARCHITECTURE, PRODUCTION ENGINEERING, GEOLOGY, APPLIED CHEMISTRY, METALLURGY, MATHEMATICS, OPTOMETRY, APPLIED PHYSICS, PHILOSOPHY (special reference to scientific method), ECONOMICS, ECONOMIC HISTORY, ARCHITECTURE, and ENGLISH, at the New South Wales University of Technology—The Agent-General for New South Wales, 56–57 Strand, London, W.C.2 (December 15).

RESEARCH OFFICER (Physical Chemist, Infra-Red Spectroscopy) IN THE BIOCHEMISTRY UNIT, Wool Textile Research Laboratory, Melbourne—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3626 (December 15).

SCIENTIST, Grade I, at the Central Research Establishment, Stoke Orchard, Cheltenham, to assist in the supervision of chemical and physical research, fundamental to the carbonization of coal—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/397 (December 15).

SCIENTISTS, Grade II (with a good honours degree in chemistry) at the Laboratories in Leeds and Sheffield—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/398 (December 15).

Senior Scientific Officers and Scientific Officers at Admiralty experimental establishments in the vicinity of London, Greenock, Haslemere, Portsmouth, Rosyth and Weymouth: Physicists (Ref. A.336/50A) capable of undertaking research or development in general physical problems, electronics, acoustics or thermodynamics, Electrical Engineers (Ref. D.367/50A) qualified to undertake research, development or design in telecommunications, radar, electronics, instrumentation or light electrical mechanisms, and Mechanical Engineers (Ref. C.631/50A) capable of design, development or research work in light mechanisms, structures or hydrodynamics—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No. (December 15).

Senior Scientific Officers at a Ministry of Supply experimental establishment in Southern England for (*a*) research work in connexion with aircraft flight testing, and (*b*) to lead a team in aeronautical research work connected with the development of flight testing and operating technique for helicopters—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4104/51 (December 20).

Lecturer in Animal Husbandry—The Registrar, The University, Liverpool (December 31).

I.C.I. Research Fellowships in Biochemistry, Chemistry, Engineering, Pharmacology or Physics—The Secretary, The University, Edinburgh (March 1).

Aeronautical and Mechanical Engineers (Scientific Officer grade) mainly in the Aerodynamics and Structures Departments of the Royal Aircraft Establishment, South Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.596/51A.

Assistant, Grade B (with honours chemistry degree, and preferably teaching experience to B.Sc. (general) and A.R.I.C. standard), for Chemistry—The Clerk to the Governors, Mid-Essex Technical College and School of Art, Market Road, Chelmsford.

Assistant Drilling Engineer (with a degree in mechanical or mining engineering, or equivalent institute qualifications, with practical experience) in the Public Works Department (Geological Survey), Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Assistant Drilling Engineer 4/161'.

Assistant Lecturer (University graduate in engineering, or equivalent qualification) in Mechanical Engineering—The Principal, College of Technology and Arts, Rugby.

Assistant Physicist at the Hogarth Radiotherapeutic Centre—The Secretary, General Hospital, Nottingham.

Design Engineers to undertake the duties of project engineers, including the design of special plant and equipment and the layout required for efficient manufacturing processes—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

Electrical Engineer (Electronic) on the headquarters staff at the London office—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.28544.B.

Electronic Physicists and Engineers (Experimental Officer grade) at a Ministry of Supply research establishment in the South-East of London: Electrical Engineer (Ref. D.491/51A) with experience of aircraft radar installation and maintenance, and a Physicist (Ref. A.336/51A) with experience in the generation and reception of signals in the V.H.F./U.H.F. region, or in the production and handling of short duration pulses—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

Engineer at a Ministry of Supply establishment in Bickley, Kent, to direct the inspection of the preservation, identification and packaging of electrical, mechanical and telecommunications equipments and stores, and to be responsible for general policy and design in this sphere—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.362/51A.

Industrial Chemist to interpret basic chemical research to engineers engaged in the design of chemical plants and to advise on the design of these plants—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

Officer-in-Charge (graduate in agriculture, preferably with Ph.D. and with at least five years postgraduate experience in experimental work), Tobacco Research Station, Trelawney, Southern Rhodesia—The Secretary, Tobacco Research Board of Southern Rhodesia, P.O. Box 1909, Salisbury, Southern Rhodesia (apply by air mail).

Pharmaceutical Chemist (with at least ten years practical research and teaching experience) at Lady Hardinge Medical College, New Delhi—The Secretary (Division 5A), Ministry of Health, Savile Row, London, W.1.

Physicists and Engineers (Principal Scientific Officer grade) at Royal Naval Scientific Service research and development establishments in the South of England: Physicists and Electrical Engineers (Ref. A.340/51A) who have specialized in electronic devices and circuitry, and Mechanical Engineers (Ref. C.667/51A) who have specialized in electro-mechanical devices and servo mechanisms—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

Research and Development Engineers and Technical Assistants at the Ministry of Supply Factory, Capenhurst, Chester, to participate in the work of a team engaged in the pilot plant stage of translating physical and chemical research to the plant stage—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs., stating post applied for.

Scientific Officers at the Ministry of Supply Factory at Capenhurst, Chester, to undertake original research of a physical nature directed toward the design and development of an atomic energy factory and to collaborate with the engineering organizations responsible for the building and operation of the factory—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

Senior Scientific Officer (Ref. C.669/51A) to lead a section in special investigations chiefly concerning Naval Aviation and related mechanical problems, a Scientific Officer (Ref. A.341/51A) for work connected with out-of-door instrumentation, Experimental Officers (Mechanical Engineers) (Ref. C.668/51A) to assist with the development of special flight-deck equipment for naval aircraft, and an Assistant Experimental Officer (Physicist) (Ref. A.342/51A) to carry out electronic methods of measurements, in which work initial training will be given, in the Naval Aircraft Department of the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Productivity Team Report. The Hop Industry: Report of a Visit to the U.S.A. and Canada in 1950 of a Productivity Team representing the Hop Industry. Pp. ix+113+35 plates. (London and New York: Anglo-American Council on Productivity, 1951.) 9s. 6d. [109

Fair Isle Bird Observatory. Annual Report 1950. Pp. 48. (Lerwick: Fair Isle Bird Observatory, 1951.) 2s. 6d. [109

British Standard 1755: 1951, Glossary of Terms used in the Plastics Industry. Pp. 59. (London: British Standards Institution, 1951.) 6s. net. [109

The Extent of Centralization: a Discussion based on a Case Study in the Coal Industry. (National Industry Series 6 and 7.) Part 1. Pp. iii+20. Part 2. Pp. iii+21–44. (Claygate: Acton Society Trust, 1951.) 2s. each Part. [109

Department of Scientific and Industrial Research. Report of the Mechanical Engineering Research Board, with the Report of the Director of Mechanical Engineering Research for the Period May 1947 to December 1950. Pp. iii+39+8 plates. (London: H.M. Stationery Office, 1951.) 2s. 6d. net. [109

Royal Institute of Chemistry. Lectures, Monographs and Reports 1951, No. 2: Organization for Development in a Chemical Company. By Edward A. O'Neal. (Twelfth Gluckstein Memorial Lecture.) Pp. 21. (London: Royal Institute of Chemistry, 1951.) 3s. 6d. net. [109

Scientific Proceedings of the Royal Dublin Society. Vol. 25 (N.S.), No. 18: Periodic Classifications of the Biological Elements. By W. R. Fearon. Pp. 235–238. (Dublin: Royal Dublin Society, 1951.) 1s. [139

Other Countries

Union of South Africa: Department of Mines. Geological Series Bulletin No. 19: Fluvial Andalusite Deposits in the Marico District. By D. P. Van Rooyen. Pp. ii+18. 1s. Geological Series Bulletin No. 20: Earthquakes in South Africa. By Dr. L. J. Krige and B. D. Maree. Pp. ii+14. 1s. (Pretoria: Government Printer, 1951.) [109

United States Department of Agriculture. Circular No. 869: Control of Insects in Stored and Manufactured Tobacco. By Joseph N. Tenhet and C. O. Bare. Pp. 32. 15 cents. Circular No. 876: Use of Honey Bees in Alfalfa Seed Production. By George H. Vansell. Pp. 11. 5 cents. (Washington, D.C.: Government Printing Office, 1951.) [109

Institut des Parcs Nationaux du Congo Belge. Contribution à l'étude éthologique des mammifères du Parc National de l'Upemba. Par R. Verheyen. Pp. 162+20 plates. (Bruxelles: Institut des Parcs Nationaux du Congo Belge, 1951.) [109

Comité International de Thermodynamique et de Chimie électrochimiques (International Committee of Electrochemical Thermodynamics and Kinetics). Comptes rendus de la II^{e} Réunion (Proceedings of the II^{d} Meeting), 1950. Pp. xvi+408+6 plates. (Milano: Cesare Tamburini, 1951.) 3800 lire. [119

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List of Scientific and Technical Journals published in South-East Asia (Philippines, Indonesia, Malaya, Thailand, Indo-China, Hong Kong). Revised edition. Pp. xiii+32. (Manila: Unesco East Asia Science Co-operation Office, 1951.) [129

Meddelelser fra Kommissionen for Danmarks Fiskeri- og Havundersøgelser. Serie Fiskeri, Bind 11, Nr. 6: Animal Production in the Danish Waddensea. By Erik L. M. Smidt. Pp. 151. (København: C. A. Reitzels Forlag, 1951.) 24 kr. [139

University of Illinois: Engineering Experiment Station. Bulletin No. 388: Cleavage Fractures of Ship Plates. By Prof. Wilbur M. Wilson, Robert A. Hechtman and Prof. Walter H. Bruckner. Pp. 95. 1 dollar. Bulletin No. 389: An Evaluation of the Hardening Power of Quenching Media for Steel. By Earl J. Eckel, Ross M. Mayfield, Glen W. Wensch and Frank A. Rough. Pp. 131. 1.50 dollars. Bulletin No. 391: Radiant Baseboard Heating and Effects of Reduced Thermostat Setting and Open Bedroom Windows at Night. By Prof. Warren S. Harris and Robert H. Weigel. Pp. 67. 75 cents. Bulletin No. 395: Almost Sinusoidal Oscillations in Nonlinear Systems, Part 1, Introduction; Simultaneous Oscillations. By Prof. Johannes G. Schaffner. Pp. 64. 60 cents. Circular No. 62: Preparing Technical Material for Publication; a Manual for Authors of College and Station Publications. By Lisle A. Rose, Prof. Elmer F. Heater and George R. Foster. Pp. 39. 60 cents. (Urbana, Ill.: University of Illinois, 1951.) [139

Catalogues

Wormal: New Flock Treatment for Control of Tapeworms, Large Roundworms and Cecal Worms. Pp. 6. (Charles City, Iowa: Dr. Salsbury's Laboratories, 1951.)

Service to Science. No. 18. Pp. 4. No. 20. Pp. 4. (Croydon: Townson and Mercer, Ltd., 1951.)

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FURTHER EDUCATION IN THE WELFARE STATE

IN his recent book, "The English Universities and Adult Education" (see *Nature*, November 17, p. 887), Mr. S. G. Raybould takes up first the challenge that the work of the extra-mural departments of the universities of Great Britain should justify its support primarily in terms of the nature of university work, and not on grounds of the value of adult education in general. Accordingly, his first chapter examines the question of university standards. Indeed, he regrets that the challenge has not been presented earlier in a form compelling a reply; but his challenge should certainly stimulate that fresh thought about the nature and purpose of adult education, in relation both to the development of the individual and to social change, which is an urgent need. If at the same time there is further fundamental thinking about the purposes and functions of a university, there should be little danger that any attempt to instil the spirit and method of university teaching into all adult education will fail to meet the essential test which should be applied to any increase in university commitments. This, as Mr. Raybould rightly insists, is not whether educational needs exist which are not being met, but whether they are of a character proper for universities to meet.

In his examination of this question of standards and of the possibility of adult part-time students attaining a university standard, Mr. Raybould emphasizes one argument for university participation in adult education which has gained much force since it was considered by the Oxford report of 1909 entitled "Oxford and Working-class Education", and that of the Ministry of Reconstruction in 1919. Both reports recognized adult education as a means by which the universities can play a part in equipping men and women in all walks of life for discharging effectively their responsibilities as members of a democratic community. Subsequent political developments have strengthened this argument. As Mr. Sydney Ball remarked in a paper at the Workers' Educational Association Conference at Oxford last year: "Changes in the structure of English Society are throwing more and more responsibility on the shoulders of men who have had no opportunity of obtaining the synoptic mind which, as Plato says, is desirable in governors".

Nor is this all. Mr. Raybould himself adds that the increasing complexity of industrial organization, and the growing tendency of different classes to live in different quarters of the same town, or even in different towns, make it increasingly difficult for the various sections of the community to appreciate each others' circumstances and aspirations. That reason alone would make it important for leaders of every class to have an opportunity of obtaining a wide outlook on the historical development and economic condition of the whole English community, such as can be given by a university education. This point of view was strongly endorsed in the paper on "Some Aspects of Technical Education in the United States and Great Britain" which Dr. P. F. R. Venables delivered at the British Association meeting last August. Noting that the emphasis placed in the United States on general education and social studies in the curricula for courses for technological degrees is primarily on professional grounds, he suggested that this aspect of technological education deserves more attention in Great Britain than it has received. Even for part-time degrees and 'higher national certificates', he suggested that experiment is required in the provision of such post-advanced courses, especially by university extra-mural departments, and that such part-time postgraduate courses would have the advantage of being given to older students with industrial experience of potential significance.

The value of that argument is fully admitted by Mr. Raybould in discussing the question of standards; but Dr. Venables advances a further reason which, particularly at the present time, should ensure that the claims of adult education on the universities receive careful evaluation. Dr. Venables expresses the view that the courses in engineering and business administration described in the United States as 'social technology' have completely justified themselves, both as regards the students and also as regards industry, which because of its increasing complexity and its social problems needs men who are trained to handle people as well as to initiate and develop processes. He suggests that we would do well to examine the possibility of making similar provision in Great Britain, and not least in relation to productivity problems.

Any such examination must at present take account of what is being done both in the universities and in the technical colleges, and emphasizes the undesirability of dealing with technological education and university education in isolation, either from one another or from adult education in general. Mr. Raybould urges almost as strongly as Dr. Venables that not only are industrial relations an important subject of study in universities as well as elsewhere, but also that, because of the concern of such study with ends as well as means, it is particularly appropriate for association with adult education, when theory can illuminate—and itself be illuminated by—practice. Such subjects as international relations and industrial relations are, he suggests, more effectively developed as adult than as undergraduate studies, and in no other subject is there greater need for the characteristic methods and virtues of the university—thoroughness, candour and tolerance.

Persuasively though Mr. Raybould presents these important arguments for university participation in adult education, he does not disguise the test of such participation which he himself suggests. He contends that whatever the subjects studied, the attainment of a 'university standard' of work in extra-mural classes normally demands a long and systematic course of study. Given this and the conditions implied, but not otherwise, Mr. Raybould maintains that adults may, in part-time courses, undertake work and achieve results which justify universities in providing the teaching, particularly in the humanities and in those studies needed for the effective discharge of the responsibilities of citizenship. Since 1945, however, university extra mural agencies have provided a much larger number and proportion of short courses not involving "serious student effort" than at any time before that date. The expectation that the short courses would lead to longer and more systematic courses has not in general been realized. Accordingly, Mr. Raybould suggests that a radical change of policy in extra-mural work is required, with a shifting of emphasis from quantity to quality. First, he would omit most of the short courses which do not involve, in addition to attendance at lectures and discussions, directed study on the part of the students, apart from such courses, such as refresher courses designed to keep graduates engaged in teaching, industry or professional work in touch with current research in their special subjects. In most universities this policy would involve a scaling-down of programmes of work and the transfer of responsibility for elementary courses to other bodies such as the Workers' Educational Association.

Mr. Raybould recognizes clearly what is implied by such a policy, and the modifications in organization, the staffing of extra-mural work and financial arrangements which are involved. These are discussed in successive chapters in which criticisms already advanced of university participation in this work are considered in relation to particular points. All his experience does not make Mr. Raybould dogmatic; but he is confident that the difficulties can be overcome and is convinced that here is work which the universities should undertake, but with deeper insight and a fuller sense of responsibility, and with something of the spiritual impulse which inspired the whole movement thirty or forty years ago. Only then are the universities likely to avoid the danger of dissipation of their resources.

There can be no question that constructive and imaginative thinking is required, no less on the part of the universities than of the Workers' Educational Association itself. To the future policy of that Association Mr. Raybould directed attention in his booklet "The W.E.A.—the Next Phase", published two years ago. The questions there discussed are raised again in his book, and in a wider context, which makes it clear that the right answers can only be found when the functions of the universities and the broad educational situation of Great Britain are taken into account. The vital need is for fresh thought about the nature and purpose of adult education.

'OPOSSUM SHRIMPS'

The British Mysidacea

By the late Prof. W. M. Tattersall and Olive S. Tattersall. (Ray Society, Vol. 136, for the Year 1950.) Pp. viii+460. (London: Bernard Quaritch, Ltd., 1951.) 42s.

WHEN Prof. W. M. Tattersall died in 1943, he had been collecting materials for a monograph on the British Mysidacean Crustacea which was to be published by the Ray Society. In this work he had been assisted by Mrs. Tattersall, herself a competent zoologist, who had prepared a considerable number of the illustrations. Most of the voluminous material, however, was in the form of notes, lists of localities and so forth, and only a few pages were actually ready for the printer. Mrs. Tattersall resolved to undertake the heavy labour of completing the monograph, incorporating her husband's notes and preparing the rest of the drawings. It may be said at once that she has accomplished admirably her self-imposed task, and that the many friends of her late husband will be grateful to her for having provided this worthy memorial to him.

The book opens with a historical summary of the literature on the group, followed by chapters on the general morphology and bionomics. These chapters are quite competently done, although Prof. Tattersall's great experience would, no doubt, have enabled him to supplement them on many points. It would have been interesting, for example, to have had a fuller discussion of the so-called 'luminous organ', from which the genus *Gnathophausia* derives its name. In the systematic part which follows, the keys to families, genera and species seem to be well constructed, although their adequacy could only be tested by using them in the actual determination of specimens. The generic and specific diagnoses are clearly phrased and so arranged that comparison is easy. The figures are admirably clear and, from an artistic point of view, are not unworthy to be placed alongside the work of such masters of crustacean iconography as G. O. Sars and H. J. Hansen.

A valuable feature of the book is the list of localities in British seas given for each species. These lists are taken from Prof. Tattersall's notes, and, in very many cases, were authenticated by his own examination of specimens. Where this could not be done, the names of the authors responsible for the records are given. As in the case of many other groups of marine invertebrates, these lists show how patchy is our knowledge of the distribution of the littoral fauna around British shores. Very few marine laboratories have published lists of the local fauna like that available for Plymouth, and over great stretches of coastline where there are no laboratories the composition of the littoral fauna is a subject for guesswork. For example, there is some reason for believing that the fauna of the shores of the Moray Firth differs considerably from that of the rest of East Scotland; but there are very few Mysidacea recorded from it in this work.

A good deal of importance is attached to Geoffrey Smith's supposed discovery of a vestigial exopod on the mandible of *Paranaspides* (which is not, of course, a Mysidacean, as the unwary reader of p. 10 might be led to suppose). It is necessary, therefore, to say that no one has been able to confirm Smith's statements on this point and that the 'exopod' was certainly absent in the single specimen dissected by the present writer in order to search for it.

Misprints and similar errors, although not numerous, are sufficiently conspicuous to suggest inadequate proof-reading, for which, of course, the author may not be to blame: "neutral" for "neural" makes nonsense on p. 360; Davis Straits is not in Scotland (p. 119), nor St. Andrews in the "north" of that country (p. 372); the maxilla is not a "thoracic" appendage (p. 300); and a very distinguished British zoologist of the last generation (or the one before that, perhaps) did not spell his name "Lancaster" (p. 433). Finally, several references in the text are not explained in the bibliography at the end of the volume.

W. T. Calman

NATURAL HISTORY OF GUANOS

Survey of Existing Knowledge of Biogeochemistry, 3
The Biogeochemistry of Vertebrate Excretion. By George Evelyn Hutchinson. (Bulletin of the American Museum of Natural History, Vol. 96.) Pp. xviii+554+16 plates. (New York: American Museum of Natural History, 1950.) 10 dollars.

GUANO has played a considerable part in agricultural history. The original Peruvian material began to be imported into Great Britain, in substantial amount, during the 'hungry forties' of the nineteenth century, and for more than a generation it constituted a substantial part of the total fertilizer supply. In the southern part of the United States, also, it restored the productivity of the worn-out soils of the old tobacco and cotton plantations. We now know that its effects are to be explained simply enough—it provided both phosphate and nitrogen in concentrated and readily available forms. But farmers often thought of it as something with quite miraculous properties.

Mr. G. E. Hutchinson's monograph is by far the most complete treatise on the subject, and the standard of his scientific scholarship is of the highest. He enumerates and describes the known deposits, analyses the climatological and biological conditions under which they have been formed, critically examines the great mass of literature and points to the lack of proof for some of the earlier theories and to the remaining gaps in our knowledge.

Many of the broad generalizations about guano formation are easily to be understood. Large volumes of excrement and egesta will be deposited wherever large numbers of sizable animals congregate to rest or to rear their young. Marine birds and seals yield the largest quantities of possible raw material; and in both cases a fish diet results in material with high initial contents of phosphates and of nitrogen compounds. But, other things being equal, the product from birds will have the higher value, because the excreted nitrogen is mostly in the relatively stable form of uric acid and, moreover, is in a semi-solid form that is rapidly desiccated. Preservation is tolerably complete only on rainless sites, because even moderate and occasional moistening leads to a breakdown of nitrogen compounds into volatile products. Again, the eggs and young of sea-birds are liable to wholesale destruction by land predators, so that island sites are the only ones that can support large permanent bird-colonies; certain rainless islands, however, are uncolonized because soil or rock surfaces reach day temperatures that are lethal to developing embryos.

In many cases the population of guano birds shows marked cyclical changes—usually a gradual build-up followed by holocaust. The latter does not seem to result from a build-up either of birds of prey or of parasites, and famine rather than epidemic disease seems to be the common cause. The catastrophic falls are more marked among surface-feeders than among deep-diving species, and may thus probably be related to changes in the size and frequency of shoals of shallow-swimming fish. Where the chief food of a particular surface-feeding bird is a species of fish that swims at depths which vary according to the relative temperatures of the upper and lower waters, the immediate cause of catastrophe might be, for example, a persistent high temperature of the uppermost layer of the sea. It is thus tempting to believe that the ultimate cause of the bird's population cycle is to be sought in a regular cyclical change in ocean currents. But catastrophes do not seem to occur with the degree of regularity that would be expected on such a hypothesis.

Mr. Hutchinson's study will be of great interest to students of animal population.

J. A. Scott Watson

THE GORILLA

The Anatomy of the Gorilla

The Studies of Henry Cushier Raven, and Contributions by William B. Atkinson, Herbert Elftman, John Eric Hill, Adolph H. Schultz, William L. Straus, Jr., and S. L. Washburn. Arranged and edited by William King Gregory. (The Henry Cushier Raven Memorial Volume: a Collaborative Work of the American Museum of Natural History and Columbia University.) Pp. viii+259 (116 plates). (New York: Columbia University Press; London: Oxford University Press, 1950.) 97*s.* 6*d.* net.

At the time of his death in 1944, Henry Raven was curator of the Department of Comparative Anatomy of the American Museum of Natural History. He had been a naturalist from boyhood and had visited many parts of the world in search of birds and mammals for the American Museum. In 1929 he returned from an expedition to Africa with a collection of 'pickled' gorillas and also a young live chimpanzee, which soon became a celebrated character in New York. She lived in the Raven house, and took part in a number of Raven's public lectures on anthropoid life. From this time on, his interests became increasingly fixed on the primates, and during the ensuing years he devoted much time to the anatomical study of the gorillas which he had brought back from the jungles of the Belgian Congo and the Cameroons. His death occurred before the completion of his task, and the present volume is a record of his own descriptions of the muscles, blood vessels, peripheral nerves and reproductive organs, supplemented by notes provided by the late J. E. Hill. Raven was primarily interested in regional anatomy, and his descriptions do not attempt to correlate form with function, nor to compare the anatomy of the gorilla with that of man and other primate types. The volume has been rounded-off with short contributions on the thoracic viscera, by S. L. Washburn; on the abdominal viscera and female reproductive system, by H. Elftman and W. B. Atkinson; on the skin, by W. L. Straus; and on the skull, teeth, palatine ridges and growth, by A. H. Schultz.

Raven's detailed descriptions of the musculature of the gorilla are accompanied by a magnificent series of plates and line drawings, many of which were prepared under his personal supervision. Partly, however, because of his premature death, the balance of his section of the volume is uneven. Thus, in contrast to the detail with which he treats the muscles, he devotes only a few pages to the vascular and reproductive systems. The osteology of the gorilla—a subject of great importance in the study of primate fossils—is dealt with scarcely at all. This lack of balance is unfortunately not corrected by the supplementary chapters in the book which, while they also provide excellent and much-needed information, again deal only with limited aspects of the subject.

Dr. W. K. Gregory points out in a foreword that Raven began his dissections of the gorilla with the object of providing a "comprehensive anatomy of this great near relative of man". There can be no doubt that, while he was prevented from doing this, he has nevertheless left what the fly-leaf calls a "permanent definitive work in this field". In the chapter which he has provided, Prof. Schultz remarks that "the literature on gorillas contains many premature generalisations supported by far too few observations". In as highly variable an animal as the gorilla, he goes on to say, "large series of specimens must be investigated in order to establish really representative averages and to find the full ranges of individual variations". The anatomy of the great apes has never been studied, as he indicates, on a scale commensurate with the prominent position these animals occupy in discussions on human evolution. The Raven Memorial Volume helps to show how small is the area of anatomical fact on which these evolutionary discussions are based, and how much needs to be done to strengthen the factual foundation on which has been built so large and detailed a superstructure of phylogenetic speculation.

NEO-VITALISM AND FARMING

Food, Farming and the Future

By Friend Sykes. Pp. 294. (London: Faber and Faber, Ltd., 1951.) 21*s.* net.

Of late years there has been a revival in certain agricultural circles of the old vitalistic ideas formerly widely held until Wöhler's synthesis of urea broke down the distinction between substances which could be prepared in the laboratory and those which could not, but required the intervention of a living organism. Broadly speaking, the position of their successors to-day is that the nutrient salts considered by modern plant physiologists as necessary and sufficient for the full growth of plants are in reality not so, but they need in addition some vital principle which has hitherto eluded chemists and physiologists. In addition to the well-recognized continuity of life through the seed, there is another continuity through the nutrients, and unless these have recently formed part of some living organism the plant, though morphologically complete, lacks some essential quality; in particular, it becomes susceptible to disease, and if fed to animals or human beings induces a like susceptibility in them.

The idea was put forward by the late Sir Albert Howard, and its element of mysticism and supposed naturalness at once made an appeal; it was taken up by a group of able and persuasive advocates of whom Mr. Friend Sykes, the author of the present volume, is one of the best known. He has already written "Humus and the Farmer" and had not intended producing another book on the subject; but his correspondence showed that further clarification was necessary, and this he has set out to effect.

Mr. Sykes's farming system consists in growing a four-year ley which, as in the Clifton Park system, includes some deep-rooting plants, and then ploughing up and growing cereals for four years. The straw is converted into farmyard manure in the old-fashioned way by wintering cattle in stock yards, and the manure thus produced is given to the potatoes, kale and other crops. There are no special features here; similar systems can be found elsewhere.

The difference from ordinary farming is that Mr. Sykes uses no fertilizers and no chemical agents for plant or animal protection. By withholding fertilizers he claims that his crops are entirely free from disease and produce seed free from adherent fungus spores, so that no seed dressing is ever required; that his animals likewise suffer neither disease nor sterility; and further, that his cereals have a health-giving quality lacking in ordinary farm produce. He recognizes that the basis of his crop production is the nitrogen of the air as in ordinary farming, but he maintains that the plant nutrient produced by microbiological fixation has far greater value than that produced by catalytic fixation; the end-product is nitrate, but in one case the nitrate is natural and associated with the vital principle, and in the other it is artificial and devitalized.

Unfortunately, the evidence for the claim is entirely subjective. Mr. Sykes claims to be able to detect by taste the difference between humus-grown crops and those produced in the usual way. An experiment on the farm scale has been set up; it will be convincing only if both design and execution conform to modern standards. In these days of hormones, trace elements and isotopes, no responsible scientific worker would pretend that the full story of plant nutrition is yet known; but standards of experimental technique have advanced greatly in recent years, thanks largely to the Rothamsted workers, and experiments can be designed in such a way that the validity of the results can be tested. Only when satisfactory evidence can be adduced are the theories of the author's group likely to be accepted. E. John Russell

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LEEUWENHOEK

Antoni van Leeuwenhoek

Zijn Leven en zijn Werken. Door Dr. A. Schierbeek. Deel 1. Pp. 278+18 plates. 10 f. Deel 2. Pp. 281–526+10 plates. 12 f.
(Lochem: 'De Tijdstroom', 1950–51.)

THE literature that has rapidly grown up around Leeuwenhoek since the publication of Dobell's classic work in 1932 would suggest the preparation of a general treatise devoted to his scientific researches as a whole. Dobell's study, admirable as it is, covers only a small fraction of the work of the celebrated Hollander. Out of a projected total of twenty volumes of the "Opera Omnia" the Leeuwenhoek Commission of Amsterdam has so far produced only three volumes since 1939, and the War has well-nigh shelved this sumptuous and costly enterprise. If, however, as we all hope, it can be completed on the scale of the detailed magnificence of the early volumes, we shall have a monument to Leeuwenhoek worthy of the man and of the Dutch nation. The recently instituted Leeuwenhoek lecture by the Royal Society is not intended to deal with Leeuwenhoek's own work, but rather with *modern* developments in microbiology—a branch of science in which Leeuwenhoek's discoveries have earned for him the title of 'Father'.

Dr. A. Schierbeek's book, therefore, comes at a time when an inclusive and critical examination of Leeuwenhoek's researches based on a thorough knowledge of all the original letters in Dutch, and also on the labours of modern commentators, might reasonably have been expected. It is true that such an author would find his own knowledge of biology severely tested, and, moreover, several minor researches of his own would be necessary before a final judgment could be reached on those points which always emerge during the progress of such a work. Dr. Schierbeek's professional duties are sufficiently exacting to tax both energy and endurance, and he is to be congratulated on the production of a learned work which must have entailed considerable literary and objective research. Its wide scope and complexity is indicated by the following translation of the chapter and sectional headings, outlining Leeuwenhoek's personality and researches, into which the text is divided. Vol. 1. (1) Life and works. The first forty years. As a citizen, an usher in the council chamber, a wine gauger, surveyor, and an amateur scientific worker. His mentality and psychological type. (2) His microscopes and research methods. (3) His attitude towards inorganic Nature and concern with mathematics, physics, chemistry and geology. (4) As the father of microbiology. On free-living and parasitic unicellular animals, rotifers, phytoflagellates, soil micro-organisms, seaweeds, mildew, bacteria and yeast. (5) On the study of the lower animals, such as stinging animals (Cœlenterates), sponges, molluscs, worms, spiders, and the higher Crustacea. (6) As an entomologist. On the anatomy of advantageous instincts, compound eye, galls and gall insects, clothes [body] louse, flea, grain weevil and its treatment, aphis, parthenogenesis and ichneumon parasites. The first volume closes with a genealogical table of the Leeuwenhoek family.

Vol. 2. (7) On the investigation of the vertebrate animals. (8) Discovery of the spermatozoa and views on generation. (9) As an histologist. On the structure of muscle, blood corpuscles and blood vessels, digestion and microscopic structure of gut, bone, teeth, skin, sweat glands, hair, nails, structure of nerves, brain and spinal cord, lens of eye, tongue, saliva, nasal mucus, phlegm, ear, kidney, bile production, milk, fat, ciliated epithelium, chromatophores, and nuclei. (10) Medical observations. (11) On botany. Structure of wood, structure of monocotyledons, tyloses, vessels, vacuolated tissue, raphides, starch, movements of sap, fruit and seed, growth of meristem in wheat ear, laticiferous vessels, stinging hairs, hairs of Labiatæ, and plants used in medicine. (12) As ecologist. (13) Summary and appendixes. The published letters and bibliography of Dutch and Latin editions. The relevant literature.

Dr. Schierbeek surveys this comprehensive and bewildering field with the confidence of an enthusiast steeped in his subject, and, as a Dutchman, better able to unravel Leeuwenhoek's many puzzling and involved passages, often made less intelligible by his use of obsolete colloquialisms. I regret the mistake of publishing so important a work in a language unfamiliar to the larger foreign public attracted by the subject. Perhaps Dr. Schierbeek will now prepare an English translation, for which a publisher could readily be found in Britain, if not in Holland. In framing the idiom of the Dutch text of his work, I fear that Dr. Schierbeek has not always borne in mind that the affairs and work of Leeuwenhoek interest a widening non-Batavian circle.

[Since the above notice was written, Dr. Schierbeek has been approached by an American publisher with an offer for the publication of an English translation of his memoir.] F. J. Cole

The Middle East

A Physical, Social and Regional Geography. By Dr. W. B. Fisher. Pp. xiii+514. (London: Methuen and Co., Ltd.; New York: E. P. Dutton and Co., Inc., 1950.) 27*s.* 6*d.* net.

THE first problem with which Dr. W. B. Fisher had to contend was the definition of the Middle East, a term that is used in widely varying senses. He regards as a unit the area east from Cyrenaica, Crete and Egypt to Arabia and Iran and north to Turkey. No other part of Africa is included. His use of the term leaves no room for the cognate one of Near East, which is generally applied to the eastern end of the Mediterranean. But, after all, this is only a matter of nomenclature and does not affect the value of the book. The physical background outlined by Dr. Fisher is relatively slight but adequate, and his treatment of the climate and vegetation is specially good. But interest on the whole is concentrated on the social, economic and historical aspects. The book is readable and none too long for the vast scope of its subject. In places it is unduly brief, for example, on the Suez Canal in both its physical and political aspects and perhaps also on Egypt. There are many sketch maps, some a little crude, and adequate bibliographies. R. N. R. B.

Land Utilization in Australia

By Prof. O. M. Wadham and Prof. G. L. Wood. Second edition, revised. Pp. xx+376+77 plates. (Melbourne: Melbourne University Press; London: Cambridge University Press, 1950.) 30*s.* net.

THIS post-war revision of a valuable study will be read with interest by those concerned with the land resources of the world and their utilization. The special interest of this edition is twofold. There is a consideration of the impact of war-time production and trade in the Australian Continent and the influence of such factors as the closing of markets, new needs, such as the British demand for flax, and even the American soldier's non-acceptance of mutton. Then there is the assessment of the question of post-war development and the discussion of settlement possibilities, always a matter of interest so far as Australia is concerned. Here the exposition of the deterrents to any close settlement of even the more favoured regions is of particular note and should be studied by those who tend to take a facile view of migration as a cure for world population problems. The authors can scarcely be blamed for the present-day difficulties, which impose a time-lag on publication and which thus make some of the statistics seem a bit out of date and prevent any consideration of the influence of recent changes in the price of wool.

Bibliography of Electron Microscopy

Edited by Dr. V. E. Cosslett for the Institute of Physics. Pp. 350. (London: Edward Arnold and Co., 1950.) 40*s.* net.

THE electron microscope as a research tool is now about ten years old. During that period there has grown up an abundant literature, dealing with basic electron optical theory, with the production and interpretation of electron micrograms, with techniques for preparing specimens to meet the exacting requirements of the instrument and, latterly in particular, with its applications in many different branches of science and technology. Dr. V. E. Cosslett and his team have done an excellent job in preparing this comprehensive bibliography, which covers some 2,500 papers published up to the end of 1948. The field covered appears by test to be well-nigh complete, and abstracts are given of the majority of the papers included.

It is a pity, however, that the material has been arranged only in alphabetical sequence of authors. One would have thought that it would not have involved undue additional labour to have added a subject guide, or preferably to have arranged the items primarily by subject, with an alphabetical author index—a task which would have been greatly helped by numbering all the items in a single sequence. The very breadth of the subject-matter makes the lack of some such arrangement all the more regrettable, and it is to be hoped that any future volume will be improved in this respect. L. V. CHILTON

Organic Syntheses

An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Vol. 30, 1950. Arthur C. Cope, Editor-in-Chief. Pp. vi+115. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 20*s.* net.

THE thirty-nine preparations described in this volume offer, as usual in this admirable series, a wide variety of substances and methods. The formation of *trans*-2-chloro*cyclo*pentanol from *cyclo*pentene is an interesting example of the use of monochlorourea, prepared from urea, as a source of hypochlorous acid. An attractive synthesis of ethanedithiol proceeds from thiourea and ethylene dibromide via ethylene-di*iso*thiuronium bromide. Dihydropyran, obtainable by dehydrating tetrahydrofurfuryl alcohol, furnishes glutaric acid in excellent yield through hydrolysis and oxidation with nitric acid. The preparation of *cis*-Δ^4-tetrahydrophthalic anhydride by the addition of butadiene to maleic anhydride is described with a useful diagram of the apparatus furnishing a yield of 93–97 per cent. Among other preparations are fumaronitrile, methanesulphonyl chloride, 1-naphthaldehyde, phenylacetylene, *o*-tolualdehyde, vanillic acid and the vinyl esters of a series of the higher fatty acids.

JOHN READ

Tropical Fishes as Pets

By Christopher W. Coates. Reprint. Pp. xi+226+29 plates. (London: Jonathan Cape, Ltd., 1951.) 12*s.* 6*d.* net.

THIS book has a much wider market than when it was first published seventeen years ago. For in that interval the number of people who keep tropical fish for pleasure or profit has increased enormously. Mr. C. W. Coates, who is a specialist in tropical fish at the New York Aquarium, gives good descriptions of most of the exotic fishes likely to be available to British aquarists.

After stressing that nobody should attempt to keep fish unless possessed of something called 'fish sense', he also provides four informative chapters on fish management. It is an unfortunate fact that the length of the technical names of these fishes seems to be inversely proportional to their body-length. Also Mr. Coates does not help matters for the lay reader by using the full scientific names; thus *Platypoecilus maculatus* is surely long enough for a one-inch fish without making it *Platypoecilus maculatus* Guenther.

The fifty-seven photographs are a mixed lot. A few are good, but too many are so dark that the fishes can barely be distinguished.

UNDULATORY PROPULSION IN SMALL ORGANISMS

By Prof. J. GRAY, F.R.S.
Department of Zoology, University of Cambridge

DURING a recent discussion[1] on the movements of bacteria, two main theories were advanced: first, that movement is due to the active undulations of numerous fine flagella, projecting from the surface of the cell and seen as fine wavy, but disorientated, filaments when the dead cell is examined under the electron microscope; and secondly, that propulsion is due to undulations of the whole cell, the so-called 'flagella' representing material sloughed off from the cell surface to form a twisted inactive tail. The object of the present communication is to consider these two theories in the light of four principles which have emerged from a study of other types of undulatory propulsion.

(1) From a mechanical point of view, there is no fundamental difference between an undulatory change in form by the whole cell and a similar change exhibited by a filamentous flagellum. All two-dimensional undulatory movements—irrespective of the size and internal structure of the organisms concerned—are expressions of two essential facts: first, that every part of the system is, by internal effort, bending alternately towards its 'right' and 'left' side; secondly, that the phase of the bending cycle exhibited by any unit length of the system is slightly ahead of that of the unit length lying immediately behind, but is slightly behind that of the unit situated immediately in front; in other words, the curvature at any region of the body is constantly changing towards that characteristic of the immediately anterior region, thus causing the wave to travel from 'head' to 'tail'. The form of the wave depends on two factors: the radius of curvature of a unit when bent to its maximum extent and the difference in curvature between successive unit lengths of the body, that is, on the difference in phase of bending per unit length. In order to execute these co-ordinated bending movements each unit length must possess: (i) tensile elements capable of shortening in length and of developing tension against the internal and external forces which oppose the process of bending; (ii) compression elements (equivalent in function to the vertebral column of an eel) which enable the energy of the tensile elements to be expended in the form of bending couples; (iii) a mechanism which controls the phase difference between adjacent lengths of the undulating system.

(2) Forward motion of the whole organism—whether it be a snake or a spermatozoon—occurs when the organism exerts its bending movements against external environmental resistance acting normally to the surface of the body.

Fig. 1*a* shows the general distribution of external forces acting against the body of an undulating organism. The forces (*R*) acting normally to the surface of the body are equal but opposite to the frictional forces (*F*) acting tangentially to the surface. Fig. 1*b* shows the relationship of the external forces acting against a single wave to the activity of the internal contractile elements. In the leading half of the wave *AB*, the contractile elements of the right side are shortening progressively from *A* to *B* and the body is thereby braced against the external resistances S_1, S_2 and S_3. The reactions R_1, R_2 and R_3 yield a resultant P_1 equal but opposite to F_1, F_1. Between *C* and *A* the contractile elements of the left side are shortening and the body is braced against S_4, S_5 and S_6, thus yielding a propulsive force P_2 equal but opposite to F_2, F_2. When the two half-waves operate together, the reactions from S_3 and S_4 are equal but opposite, and constitute transverse shearing forces at *A*.

Hence it can be shown that the forward propulsive thrust is proportional to the rate of change of curvature along the body and to the total length of the body; in other words, it is dependent on the form and speed of the waves.

(3) Effective propulsion in water only occurs when the body is long enough to exhibit at least one complete wave of sufficient amplitude, and since the form of the wave can be controlled experimentally by varying the physical condition of the medium the form can be changed to such an extent that the animal can no longer progress. This is particularly obvious in the case of short nematodes such as *Hæmonchus* or *Anchylostoma*, which creep with great efficiency through a relatively rigid medium such as agar. When placed in water the amplitude and wavelength of the undulation are increased to such an extent that the animal fails to form a complete wavelength along its body; under these conditions the animal does not progress, although it continues to display rhythmical undulations. The forms of these nematodes when in water are very similar to those of the bacteria in Pijper's photographs. (A detailed analysis of the movements of flagellated organisms

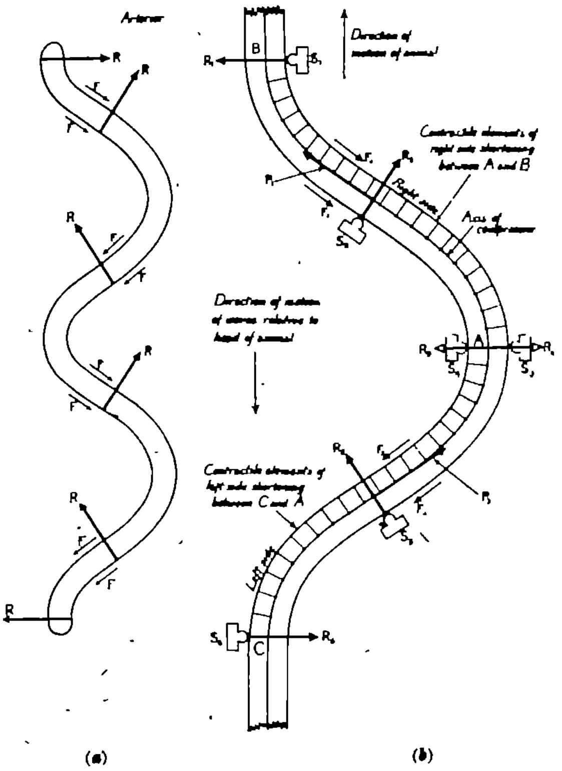
Anterior
R
F
B
R_1
S_1
Direction of motion of animal
Contractile elements of right side shortening between A and B
F_1
R_1
P_1
Right side
Axis of compression
S_2
Direction of motion of waves relative to head of animal
A
R_3
S_4
R_3
S_3
R_5
F_2
Contractile elements of left side shortening between C and A
P_2
S_5
Left side
S_6
C
R_6
(a)
(b)

Fig. 1

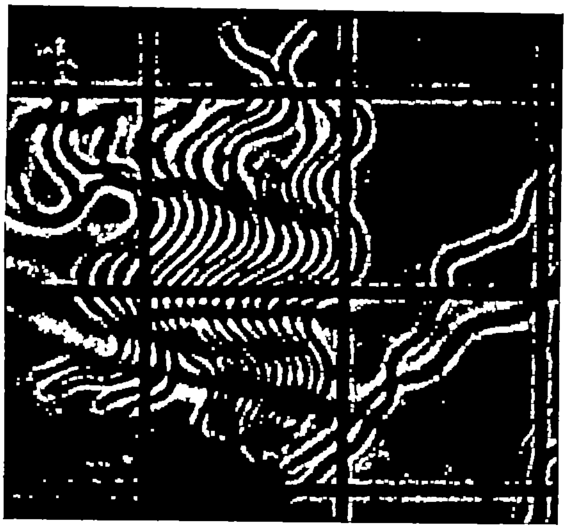

Fig. 1. Photograph of a group of living *Cristispira balbianii* showing synchronized movements in a thin film of water. The anterior ends of the organisms are attached to a glass slide. The sides of the black grid are 40 μ

in water is a formidable mathematical problem which is at present being examined by Sir Geoffrey Taylor.)

The sensitivity of wave form to external mechanical forces is a very widespread phenomenon among undulatory animals. A somewhat specialized but interesting example is shown in Fig. 2, which demonstrates the co-ordinated activity ensuing when two or more active organisms are sufficiently close together to exert mechanical forces on each other. These and other facts suggest that the difference in phase between adjacent regions of an active flagellum is controlled by the external physical forces acting against its surface.

(4) When a large animal (for example, an eel) is undulating in water, some of the energy required to bend the distal regions of the body and to drive these through the water are transmitted (by the body's own elasticity) from other regions lying nearer the head of the animal. In a flagellum, perhaps 0·5 μ in diameter, moving at 100 μ per second, the amount of energy which can be transmitted in this way is negligibly small compared with that required to move the flagellum against the viscous resistance of the water. Each short unit length of the flagellum must provide the whole of the energy necessary to maintain its own motion.

An application of these four principles to bacterial propulsion leads to the conclusion that the length of a bacterium and the ratio of amplitude to wave-length of its bodily undulations are both too small to sustain an efficient propulsive thrust. On the other hand, if the whole surface of the body were covered by an active sheet able to undulate with the wave-length and amplitude of the 'tails' shown in Pijper's figures, the organism would progress, and if some of this sheet were 'sloughed off' behind the organism, the 'tails' described by Pijper might well result. If the frequency of undulation were of the same order as that of the tail of the spermatozoon of a sea urchin, the waves would only be visible under stroboscopic darkground illumination. A post-mortem degradation of such an active sheet into a series of disoriented fibrillar elements would be in accordance with the behaviour of a wide variety of vibratile structures, and may explain the apparent existence of discrete flagella in electron micrographs of bacteria.

It is difficult to believe that disorientated fibrils such as those revealed by the electron microscope could propel a bacterium unless, during life, the fibrils are orientated in an antero-posterior direction. On the other hand, a series of active flagella in close proximity to each other would most probably develop synchronized movements. It would be very difficult to distinguish a true membranous sheath from a series of parallel filaments if both were propagating waves of identical form and frequency. From this point of view there seems little difference between the two theories.

A note of caution may perhaps be sounded concerning the functional interpretation of the fibrils and other structures revealed by methods which involve the destruction of the flagellum as an active dynamic system. The X-ray diffraction patterns of these fibrils suggest that their molecular structure is not dissimilar to that of hair and other natural fibres. The central problem is to endow such a system with three essentially dynamic properties: (1) the generation of internal bending couples; (2) the maintenance of phase difference in dynamical activity along the fibril; (3) the generation of free mechanical energy along the whole length of the fibril. To provide a picture of intra- or inter-molecular forces capable of meeting these requirements would be a major contribution to biology: at present, it is only possible to speculate how far internal bending couples could be generated within a long fibrillar molecule by a redistribution of intramolecular groupings of the type postulated by Meyer and Mark[2] and others for muscular contraction, the function of the vertebral column of the eel being performed by mutually repellent charges and that of the muscles by attractive charges. Such a system, if sensitive to mechanical stretch, would at least have some of the properties of an active flagellum, although there would still remain the necessity for periodic changes in the distribution of the charges concerned.

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[1] "The Nature of the Bacterial Surface", edited by A. A. Miles and N. W. Pirie (Oxford Univ. Press, 1950).

[2] Meyer, K. H., and Mark, H., *Nature*, 167, 736 (1951).

GEORGE FRANCIS FITZGERALD, 1851-1901

CENTENARY MEETING AT THE ROYAL DUBLIN SOCIETY

G. F. FITZGERALD is unique in the history of modern science in that the fundamental hypothesis for which he is most remembered is one upon which he himself published nothing. This is the hypothesis that a moving body is contracted in the direction of its motion. Its historical significance can scarcely be over-estimated. For it asserts that the length assigned by an observer to a rigid body depends not only upon the body but also upon its relationship to the observer. It was therefore an attack upon the whole classical concept of space, according to which space possesses a geometry identical with that of a classical rigid body, the latter being supposed the same for all observers. FitzGerald's suggestion was the first of those which led to the emergence of 'post-classical' physics.

FitzGerald's priority in this matter has never been questioned. As is well known, he made the suggestion in order to account for the null result of the Michelson–Morley experiment. Sir Oliver Lodge has told[1] how he had it from FitzGerald in 1892; H. A. Lorentz made the suggestion independently shortly afterwards, but then acknowledged FitzGerald's priority.

FitzGerald was born on August 3, 1851, the son of William FitzGerald, afterwards Bishop of Cork and later of Killaloe. His mother's brother was George Johnstone Stoney, who also anticipated a fundamental concept of modern physics, the electron, and to whom is due the current use of the term. As boys, FitzGerald and his brothers were educated at home, one of their teachers being a sister of George Boole. FitzGerald entered Trinity College, Dublin, in 1867, became a Fellow in 1877 and Erasmus Smith professor of natural and experimental philosophy in 1881. These appointments he held until his death in 1901, at the age of forty-nine.

FitzGerald was one of the prominent figures in late nineteenth century science. He is noted for a great deal more than the one hypothesis already mentioned; in fact, he is one of the most frequently quoted authors in Sir Edmund Whittaker's "History of the Theories of the Aether and Electricity" (second edition, Edinburgh, 1951). As early as 1883 he showed theoretically[2] that electromagnetic waves "of as little as 10m. wavelength or less" could be generated by oscillating electric circuits; and it is interesting to recall that in 1898 he took part in Marconi's demonstration in Dublin Bay of ship-to-shore wireless transmission which resulted in the first newspaper publication (in the Dublin *Evening Mail*) of news obtained by wireless. In 1888 he anticipated theoretically the modern use of the coaxial cable and wave-guides[3]. These are examples of his gift for throwing out brilliant suggestions which were much in advance of his time and which he himself did not pursue very far. Indeed, Oliver Heaviside wrote, "He had, undoubtedly, the quickest and most original brain of anybody. . . . He saw too many openings. His brain was too fertile and inventive. I think it would have been better for him if he had been a little stupid—I mean not so quick and versatile, but more plodding. He would have been better appreciated, save by a few." But his brilliance and versatility operated against the development of his own work also by laying him open to unceasing consultation by others, and he perhaps erred on the side of generosity in the help he gave. In addition, he played an influential part in the furtherance of university and technical education in Ireland.

A large proportion of FitzGerald's papers appeared in the *Proceedings of the Royal Dublin Society*, and he was from 1881 until 1889 honorary secretary of that body. On October 30, 1951, the Society devoted one of its scientific meetings to the celebration of the centenary of his birth. The chair was taken by the president, Major A. McMorrough Kavanagh, and afterwards by Dr. A. Went (committee-chairman). There were present one of FitzGerald's sons, Sir Raymond FitzGerald, a daughter, Mrs. Scott, and other relatives. The Physical Society of London, of which FitzGerald had been president in 1892, was represented by Prof. K. G. Emeléus. Messages were received from the Institution of Electrical Engineers, of the Irish Section of which FitzGerald was the first chairman (1899), from Sir Edmund Whittaker and from Dr. G. F. C. Searle, who had known him personally. The Provost of Trinity College, Dublin, Dr. E. H. Alton, gave personal reminiscences of FitzGerald, and quoted tributes to his character as a man in which his contemporaries had dwelt especially upon his complete freedom from considerations of his own self-interest. Dr. Alton also showed photographs[4], taken by J. Joly, of FitzGerald's pioneering experiments in human flight in a glider constructed by O. Lilienthal in Germany. Prof. F. E. W. Hackett (University College, Dublin) spoke of 'FitzGerald as revealed by his letters to Heaviside". Photostat copies of the letters, presented by the Royal Institution, were on view at the meeting. Since the exchange of views between the two men depended almost entirely upon their correspondence, these letters give much insight into the working of FitzGerald's mind. They are enlivened by that sparkle which, according to Praeger and Lodge, characterized his talk at a lunch-table or at a scientific discussion.

The main theme of the meeting was, however, the significance of the FitzGerald–Lorentz contraction. The noteworthy feature was the demonstration that this is still a live subject, the papers contributed being far from mere historical reviews. For it cannot be denied that there is at the present time a widespread reaction against the theory of *general* relativity on account of the difficulty of applying it to problems of interest, the still greater difficulty of knowing what the theory really signifies, and the lack of success of 'unified field-theories'. This situation itself was not discussed. It is mentioned here because it is resulting in the realization that there is still important fundamental work to be done in the *special* theory of relativity (using this term without reference to any one particular formulation of the theory) which is free from the objections to the general theory. The papers read at the meeting can be regarded as part of the outcome of the situation.

The chief address was by Dr. Herbert E. Ives (New York). He started his comprehensive and critical historical review with a precise statement of the relation of FitzGerald's hypothesis to the Michelson–Morley experiment. He recalled how FitzGerald's contemporary, Sir Joseph Larmor, had accepted the hypothesis and had remarked in 1900 that it required as a consequence the phenomenon of 'time-dilatation'. Dr. Ives emphasized the really fundamental step which FitzGerald made in compelling us to take explicit account of the behaviour of measuring instruments and also to scrutinize the language employed, which had been developed on the assumption of invariant instruments. Thus he saw in FitzGerald's hypothesis "the germs of what are now called 'the operational principle' and 'semantics' ".

Dr. Ives proceeded to an account of the work of H. A. Lorentz and Henri Poincaré. Lorentz endeavoured to extend to all electrodynamic phenomena the invariance with motion found in the Michelson–Morley experiment. Seeking a principle that would comprehend all the particular ideas of Lorentz, Poincaré formulated[5] in 1904 "the principle of relativity, according to which the laws of physical phenomena should be the same, whether to an observer fixed, or for an observer carried along in a uniform motion of translation, so that we have not and could not have any means of discovering whether or not we are carried along in such a motion". Poincaré then gave the Lorentz transformation in the form in which it is known to-day, though this was a modification of Lorentz's original form.

Dr. Ives then described his own[6] 'operational' derivation of this transformation, assuming only Poincaré's relativity-principle and the accepted result that the velocity of light is independent of the velocity of its source. In terms of his operationally defined quantities, the equations are complicated. "This is the price we have to pay," he said, "for equations which tell a complete and unambiguous story in symbols all of which have a definite operational meaning." However, a change of variables does, in fact, yield the standard form of the Lorentz transformation. One takes it that this substitution provides an explicit operational representation of the clock-synchronization, etc., required, but less carefully examined in more familiar treatments. Dr. Ives went on to a careful inspection of the "principle of the constancy of the velocity of light" which, as usually understood, he rejects.

He described also his well-known experimental verification[7] of the time-dilatation using the spectra of canal rays, following a suggestion originally made by J. Stark[8] and employing A. J. Dempster's method of accelerating canal-ray particles.

Dr. G. J. Whitrow (Imperial College of Science and Technology, London) contributed a paper on "The FitzGerald–Lorentz Contraction Phenomenon and the Theories of the Relativity of Galilean Frames". In the author's absence, it was described by Prof. W. H. McCrea. Dr. Whitrow started by quoting Bishop Berkeley's criticism of Newton's introduction of absolute motion into natural philosophy. The dilemma of Newtonian physics was that, while it held good for all Galilean frames in uniform relative motion, the phenomena of rotation seemed to demand an absolute standard of rest. In nineteenth-century physics this was provided by postulating the luminiferous æther. But the Michelson–Morley experiment demonstrated the impossibility of measuring linear motion through the æther. Einstein's formulation of the theory of special relativity again replaced the æther by empty space, but again gave no explanation of rotational phenomena. E. A. Milne's theory of kinematic relativity and world-structure offered a solution of the difficulty. In his view, the whole system of galaxies, or rather the substratum which in the theory represents the smoothed-out system of galaxies, provides at every point of space an absolute standard of rest and non-rotation. But the theory[9] is complicated by a distinction between fundamental and subsidiary Galilean frames. Dr. Whitrow now proposes a modification of Milne's work which restores to it the formalism of special relativity. The consequence of the work of Milne and Whitrow is thus to provide special relativity with a cosmological background. Dr. Whitrow also related the problem to a view of the philosophy of science which he has recently developed[10].

A paper by Prof. W. H. McCrea (Royal Holloway College, University of London) on "The FitzGerald–Lorentz Contraction—some Paradoxes and their Resolution" dealt with the problem of the rigid rod in special relativity theory. According to the theory, the contraction denotes no intrinsic physical change in a moving rod. Nevertheless, an observer can 'trap' the rod in the contracted state and exhibit it as having undergone such a change. If we define a rigid rod as one through which an impulse can travel with maximum permitted speed (that is, the speed of light), then it becomes clear how such a physical change is produced in the process of stopping the rod. If it is stopped at the forward end, then the shortest length momentarily attained is, in fact, less than that given by the FitzGerald factor. It can be shown that the kinetic energy just suffices to supply the energy of compression without dissipation; consequently the 'rigid' rod can be regarded as being also perfectly elastic.

Prof. J. L. Synge (Dublin Institute for Advanced Studies), in his paper on "Effects of Acceleration in the Michelson–Morley Experiment", dealt also, but more generally, with the rigid-body problem. The definition he gave was in a form due to his pupil, Mr. G. H. F. Gardner, and is based upon the concept of a 'drag-point' in the body, together with a condition requiring that any particle of the body responds to the behaviour of the drag-point only with a delay corresponding to the time of travel of light from the point to the particle. This appears to reduce to McCrea's definition in the case of a one-dimensional body. The definition enables one to study the motion of a rigid body in accelerated motion relative to a Galilean frame. As Prof. Synge pointed out, the Michelson–Morley experiment is one upon the behaviour of such a body, the instrument being in accelerated motion on account of the rotation and revolution of the earth. He stated that Gardner's hypothesis predicts a null result for the Michelson–Morley experiment if the interferometer is loosely attached to the earth, as it appears to have been in the latest repetitions of the experiment which have, in fact, given the null result. On the other hand, if the instrument is rigidly attached to the earth, then the hypothesis predicts a definite result about three times that reported by Dayton C. Miller in his particular repetition of the experiment[11]. The provisional interpretation is that Miller's interferometer had sufficient rigid connexion with the earth to show part of the acceleration effect predicted by the new theory. But, as Prof. Synge took care to state, judgment must be suspended until the theory is tested by specially designed experiments.

All these papers will be published in a special number of the *Proceedings of the Royal Dublin Society*, and will be found to contain much more information than there has been space even to mention in this report.

W. H. McCrea

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RABBIT CONTROL IN AUSTRALIA : PROBLEMS AND POSSIBILITIES

THE story of the rabbit in Australia is so well known, so familiar an instance of the spread of an innocent introduction to plague dimensions, that fresh turns in its course must be spectacular to become news. For most of the world beyond Australia, there is the pest, and there are the problems of its control. Even in Australia itself, there has been perhaps a sense of inevitability that this prolific competitor for grazing must embarrass agricultural production, impede attempts to raise both old-occupied and new land to higher levels of fertility and output, and, in fact, place a heavy burden on farmer and pastoralist to exercise control measures. But there is no complacency among the occupiers of land in Australia; in many areas the rabbit-proof fence has become almost as typical a part of the Australian scene as is the gumtree or the Merino sheep, while in Western Australia the 'rabbit-proof fences', State-erected, State-maintained, and State-patrolled, stretch hundreds of miles across the continent to appear, like the Great Wall of China, a monument to the efforts made to stem the invader.

Always the pest has proved highly resistant to any attempts to confine it to limits of area in which it could be effectively tackled by such techniques as digging out warrens, gassing or poisoning, chasing by dogs and trapping, or even to restrict its numbers by such means. The general problem of its control is so severely practical that until about the late 1920's the possibility of scientific aid appeared almost as remote as that of complete eradication of the pest population. The recognition that the virus disease, myxomatosis, might be an agent in reducing rabbit numbers directly invoked scientific inquiry, and although early investigations carried out by the Division of Animal Health and Production, of the then Council for Scientific and Industrial Research, established that the disease could work, its effectiveness was small because of its very limited powers of spreading naturally through rabbit populations and groups. What did emerge, however, was that the problem, scientifically, had to be regarded as a whole, and that the rabbit and its context were fit material for comprehensive biological study.

During the Second World War and its aftermath, difficulties of labour and increasing costs of material for control measures, among others, gave rise to conditions favouring the rabbit. Also, increasing recognition of the importance of ecological and other biological approaches to such field problems ripened the opportunities for long-term research and encouraged the Commonwealth Scientific and Industrial Research Organization to include review of the rabbit problem in the programme of its Wildlife Section, established in 1949, without at the same time offering any optimism of revolutionary systems of control. The Organization has now issued "The Rabbit Problem—a Survey of Research Needs and Possibilities"*, in which F. N. Ratcliffe, officer-in-charge of the Section, assesses the scope for the different control methods, and presents a valuable, critical appraisement of the complex position to be studied.

In broad terms, Ratcliffe distinguishes qualitative differences in the problem, in three categories of country: "(*a*) the relatively low-value, low-rainfall grazing country (typified in N.S.W. by the Western Division); (*b*) the region of high-value grazing country (sheep to an acre or better, down to, say, one sheep to two acres); and (*c*) the closely settled farming areas". In the first, real control is impracticable, mitigation is possible, but serious infestations are limited by adverse climatic conditions; in the last, good farming practice usually keeps the rabbit under control. In the better pastoral country, which includes much of the land amenable to pasture improvement and the wheat areas, the rabbit problem is most acute and most severe economically, not so much from the direct damage as from the tremendous burden, in labour and expenditure, of measures to curb infestation from attaining catastrophic proportions; here, the real need is "for ways and means of bridging the gap between partial control and eradication".

Attempts to use pathogenic micro-organisms in the control of mammal pests have not generally been promising, but there were indications that the use of myxomatosis might give a cheaper method than others of checking rabbit numbers *in the higher-value country*; accordingly, trials were begun to introduce the virus into warrens in this category of land. But the first attempts failed to induce an effective spread of infection.

The survey records the position of other control methods in use, of which fumigation is probably now the most important. Gas is either blown through a burrow system, or is laid to form a zone of lethal concentration at the burrow mouth; carbon monoxide, 'Cyanogas' and carbon disulphide are used for blowing, 'Cyanogas' and chloropicrin are used as barrier zone fumigants. Neither method gives 100 per cent kill owing to the difficult natural conditions under which the fumigants are called upon to operate in the burrows; the choice of compounds possible for use is small, and the only hope appears to be improvement of the standard materials, especially chloropicrin. No effective 'persistent' fumigant has so far been found. Mechanical treatment of warrens by digging out formed a major control method in better-class country, and is now largely superseded by tractor ripping; while this loses effectiveness on stony or hilly land and among tree roots, its potential contribution to control is high when used as part of a planned campaign. Poisoning can kill large numbers of the pest, and its most effective use in reducing infestations is achieved by specialists who have accurate knowledge of the ecology of rabbit populations. The idea of using lures to poisoned baits is popularly attractive, but the evidence is that their effectiveness depends upon prevailing conditions rather than on any special attributes of the odour employed. "Of all the methods of rabbit destruction available, poisoning stands most in need of scientific study and clarification."

No particular promising line of inquiry which might lead to revolutionary new control methods emerges from the survey. There are possible minor improvements in fumigants and fumigation; probable major developments in efficiency of poisoning, but only after prolonged investigations; and a clear need for detailed ecological studies, on the results of which a sound national policy can be planned and put into effect. The report concludes by proposing a scheme for an "experimental area-control campaign," to determine the conditions under which the various control methods can best be integrated to meet local expressions of the problem; for example, to elucidate the conditions under which the target of local eradication must be replaced by that of mitigation and control. But in any such campaign, experimental or as a widely applied policy, the provision of rabbit-proof netting is seen to be essential to separate the areas in which eradication is practicable from those in which it is not.

Thus this report. But as it was prepared, a spectacular development occurred in the development of myxomatosis epidemics. It was known that the disease could be spread from sick to healthy rabbits by certain mosquitoes. As mentioned above, the first attempts to establish the disease in experimental sites were unsuccessful, but by continuing the introduction into warren colonies in the Murray River valley into the summer months of 1950–51, conditions favourable to success were encountered and mosquitoes rapidly spread the disease, so that by February 1951 the disease was reported widely in the Murray River system and its incidence had extended northwards along the Murrumbidgee, the Lachlan, and the Darling Rivers, almost up to the Queensland border, but with a slower spread south of the Murray.

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* The Rabbit Problem: a Survey of Research Needs and Possibilities. Pp. 17. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1951.)

Most effective transmission and high rabbit mortality were largely restricted to narrow zones of river frontages and to swampy areas where the dusk-biting *Culex annulirostris* was prevalent; but it was soon evident that 'jumps' of infestation were attributable to the day-biting *Aedes*, which are more widely distributed over open country. Local recessions of the epidemic occurred as the autumn season advanced. The Commonwealth Scientific and Industrial Research Organization had issued recommendations to graziers as to how to set up fresh loci of infection by moving infected rabbits; but by June it had announced that the first great epidemic had passed, leaving a probable toll of millions of rabbits killed and a vast saving of expenditure on control measures and of valuable fodder, over an area "about half the size of the continent of Europe". While the mosquitoes had been the main agents in spreading the epidemic, it was soon recognized that the small black fly *Simulium* was also involved and, later, that the smaller 'true' sandflies are important carriers, especially in parts of Queensland.

Extraordinary local differences in infestation occurred, but there is little doubt that the general direction and vastness of spread were affected by the unusual distribution of conditions that had obtained. Many parts of Victoria had suffered from drought, and there was little spread of the disease south of the Murray valley; to the north, the season had been wetter and wetter, and in parts of northern New South Wales and Queensland the widths of the effective killing zones had become greater, to give almost a general epidemic. The region in which the disease had its most profound effects, namely, those areas west of the foothills of the dividing range watered by the upper tributaries of the Darling River, had experienced some of its worst flooding on record.

Obviously, many questions remain for scientific workers and graziers to answer regarding the potentialities of the disease as an agent, and the conditions under which it can be expected to exert its contribution to a general campaign of control. Plans have been made for future distribution of the virus; but it is emphasized that there are many areas, such as high-value hilly country, where the rabbit is a serious pest, in which it can have little effect, and other measures of control must be pursued. Moreover, recovered animals have been found in some areas, possibly due to the appearance of virus strains of lower virulence; this opens up further questions for study, although in practice any acquired immunity, or variations in virulence, would only have temporary or local effects against the influence of fresh inoculations of the lethal strain.

Among notable instances of biological control, Australia has already provided the case of the pricklypear; it may be that this further chapter in the story of the rabbit in that continent will introduce a record of an achievement of equal or higher rank in the annals of its pastoral and agricultural development. For the moment, it is appropriate that this chapter should end by noting (*vide The Times*, October 18, 1951) that three of the scientific men who had taken leading parts in the programme, Dr. I. Clunies Ross, chairman of the Commonwealth Scientific and Industrial Research Organization, Sir Macfarlane Burnett, director of the Walter and Eliza Hall Institute, and Prof. F. J. Fenner, head of the Department of Microbiology in the Australian National University, themselves were inoculated with myxomatosis to allay doubts as to possible effects of the virus on man.

J. E. NICHOLS

RECENT RESEARCH AND ADDITIONS TO THE BRITISH FLORA

THE flora of the British Isles is probably better known than that of any other area of comparable size, and yet important discoveries can still be made. The annual exhibition meetings of the Botanical Society of the British Isles afford opportunities for bringing new plants, and the results of recent research, to the notice of botanists, and the one held in the lecture room of the British Museum (Natural History), South Kensington, on October 20 provided ample evidence that field and herbarium work in 1951 had been exceptionally productive.

The outstanding discovery of the year was that of *Diapensia lapponica* L. on a Scotch mountain, thus adding a new family—the Diapensiaceae—to the British flora. This arctic-polar species, forming dense cushion-like tufts with crowded, imbricated, cartilaginous leaves, and with peduncles some 2 cm. tall bearing solitary white flowers 1·5–2 cm. across, was discovered very locally by C. F. Tebbutt, an ornithologist, on a mountain top in Westerness. It was represented at the exhibition meeting by a fine series of photographs by J. E. Raven and by the specimen sent by the discoverer to the Royal Botanic Gardens, Kew, for identification.

Mr. Raven also exhibited photographs of *Kœnigia islandica* L., a small annual member of the Polygonaceae, with a circumboreal distribution extending as far south as the Himalayas in Central Asia. This was recently detected at Kew from specimens collected in Skye in 1934 [1] and was re-found in June this year by Miss M. McCullum Webster. Mr. Raven's photographs showed that in Skye it grows in open damp places and that it is often gregarious. His observations and pictures indicate that it extends over a much wider area than could be deduced from the notes on the labels of the Kew specimens.

Two exhibits showed species originally recorded by G. Don (1764–1814), whose "reputed discoveries" have caused so much controversy among British botanists. Of these, the most surprising was *Homogyne alpina* (L.) Cass., found by A. A. P. Slack in 1951 in "the parish of Cortachy and Clova", Angus, and shown by B. W. Ribbons. Don said it occurred in the mountains of Clova "as on a rock called Garry-barns"[2]; but hitherto no other botanist has succeeded in re-finding it. The exhibitor is anxious to obtain evidence which will help in identifying "Garrybarns". *H. alpina*, formerly known as *Tussilago alpina*, is widespread in the mountains of Europe but absent from Scandinavia. The other plant originally found by Don which was represented among the exhibits was a grass, *Roegneria doniana* (F. B. White) Melderis (*Agropyron donianum* F. B. White). Since his time this has been found at intervals in the Breadalbanes[3]; but it appears to have been seen prior to 1951 by only three living botanists, and the specimens taken by two of these remained unidentified until this summer. The species was illustrated by photographs taken by Mr. Raven in the Breadalbanes and also near Inchnadamph, where he rediscovered it after identification of an earlier unnamed specimen in E. S. Marshall's herbarium.

Among the rediscoveries, though of a different status from that of the Scotch plants just mentioned, must be classed B. W. Ribbons's exhibit of *Acanthus mollis* L. from St. Agnes, Isles of Scilly. It was recorded from here in 1851[4]; but was regarded as extinct until he re-found it recently on private ground in a place which may well have been the original station.

The exhibit provided by the Department of Botany of the British Museum (Natural History) illustrated other aspects of the present phase of rapidly increasing knowledge of our flora. It included, very appropriately, a selection of specimens from the Department's herbarium connected with papers recently published in *Watsonia*, the journal of the Botanical Society, including types of new species described therein. Among the British herbarium material displayed were: *Myriophyllum verrucosum* Lindley, *x Mentha smithiana* var. *angustifolia* R. Graham, *Epipactis pendula* C. Thomas, *Rubus watsonii* W. H. Mills, *Equisetum ramosissimum* Desf., *Epipactis cambrensis* C. Thomas, *Milium scabrum* Merlet, *Orchis cruenta* Muell., and *Scutellaria hastifolia* L. (in sequence of publication[5]). An interesting fern exhibit was *Polypodium regium* as in "Hortus cliffortianus", 1737, with specimens from Vaillant and from Clifford's herbarium, and as gathered by C. E. Salmon in Teesdale in 1892 and 1911 under the name of *Cystopteris alpina*. It does not appear to have been seen in Britain recently. Dr. A. Melderis exhibited two British grasses, *Sesleria varia* (Jacq.) Wettst. and *Phleum commutatum* Gaud., for comparison with the closely related foreign *S. cœrulea* and *P. alpinum* with which they have long been confused in Britain.

Among the exhibits by workers at the Botany School, Cambridge, were living plants of the two species of *Sesleria* mentioned above, shown by Dr. S. M. Walters. The true *S. cœrulea* (L.) Ard., which can be readily distinguished by the easily removed waxy covering to the upper leaf surface, is Scandinavian and East European; our plant, which also occurs in Iceland and Western and Central Europe, is *S. varia* (Jacq.) Wettst. The remarkable difference in the appearance of the upper leaf epidermis, including the stomata, was demonstrated with the aid of a microscope slide. Dr. Walters also exhibited live and dried material of *Alchemilla subcrenata* Buser recently discovered in Teesdale. This is a common European species for which previous records in the British literature were false identifications. A sheet of *A. obtusa* Buser was shown, collected in September 1951 from the only known British locality[6]. He also included sheets of an '*acutidens*'-type *Alchemilla* from the Ben Lawers range which seems not to be identical with any described Scandinavian, British or Alpine species.

Also from Cambridge, D. E. Allen demonstrated the four species he recognizes in the aggregate *Cardamine pratensis* in Britain. The provisional names given are: *C. dentata* Schultes ($2n = 32$), *C. fragilis* (Dégl. ex Lloyd) Bor. (chromosome number unknown), *C. pratensis* L. emend. ($2n = 56$) and *C. polemonioides* Rouy ($2n = 64$). The species are morphologically quite distinct, although the last two, at least, hybridize freely wherever they meet, and each has a different geographical range. Increase in chromosome number can be correlated with a more northerly range, a greater tolerance of acid soils, and a reduction in stature, in leaf-size (especially in the lamina of the upper leaflets) and in style-length. C. D. Pigott exhibited 'point' distribution maps of the three British species of *Thymus* based wholly on localities derived from herbarium material. It was interesting to note that further work had not greatly extended the range of the rarest species—*T. serpyllum* L. em. Mill. P. D. Sell and Dr. C. West showed specimens of eight British *Hieracia*, all local endemics, which had been recently rediscovered. In some cases, for example, that of *H. macrocarpum*, more than fifty years had elapsed since their original discovery.

Recent work at University College, Leicester, was represented by several exhibits. Prof. T. G. Tutin showed *Poa annua* and the allied *P. infirma* and *P. supina*, with an artificial hybrid between the two first-mentioned species. *P. infirma* is now known from Cornwall[7] as well as from the Channel Islands, but *P. supina* has not yet been found in Britain. Prof. Tutin also showed two subspecies of *Heracleum spondylium* from England. The English common plant is subspecies *australe* (Hartm.) Neuman, but he also found subspecies *sibiricum* (L.) A. and G. in Norfolk. They differ in flower, fruit and leaf[8]. Miss E. W. Davies had an interesting example of polyploidy in *Primula farinosa*. Swedish material examined had been found to have double the number of chromosomes of plants from Widdy Bank Fell, Durham, which differed in leaf characters. She also showed Somerset material of *Carex demissa* Hornem., *C. serotina* Mérat, and a suspected hybrid between them, and also an example of hybrid vigour in *Asplenium adiantum-nigrum*.

Blackberries have long been regarded as a puzzling critical group, and W. C. R. Watson's exhibit of *Rubus villicaulis* with a revised list of the series Subvirescentes is likely to make further changes necessary in British floras. In contrast, little work has been done on the species of *Oxalis* which occur as aliens in Britain. Dr. D. P. Young displayed herbarium material of twelve alien species in addition to the native *O. acetosella* and several varieties. Most of the names will be new to workers here. *Schœnus nigricans* is generally regarded as a plant subject to very little variation; but P. J. Newbould's dissections and diagrams show that even in this species there is much to learn. Miss J. P. Pugh showed specimens of *Dryopteris borreri* with the characters indicated and the allied species, from which it has been recently separated, for comparison. Her work has already shown that this fern occurs more widely than was suspected. P. F. Yeo showed a putative hybrid between *Polygala calcarea* and *P. vulgaris* from Somerset.

Exhibits of fresh material included twenty pots of wool aliens collected by Dr. J. G. Dony and J. E. Lousley in Bedfordshire. These were mostly of Australian origin and had been brought to Britain as seeds or fruits in wool. Some of these foreign plants are now locally common in districts where 'shoddy', in the form of waste from woollen mills, is used as a valued manure. Most of them are very sensitive to frost and unlikely to persist as weeds. P. Greenfield showed a living plant of *Cystopteris dickieana*, a fern known only from sea-caves near Aberdeen, where it may be extinct.

The organization of the work of revising the Flora of Warwickshire was demonstrated by P. S. Green. This included printed cards for recorders to use in sending in records, outline maps, circulars to contributors setting out instructions for collecting material of critical groups, and the "Flora Bulletin" for circulating information about the progress of the work. Coloured drawings of plants by Miss W. M. A. Brooke, Dr. J. T. Burgess (prepared 1879–1900), Miss H. D. Garside, Miss M. Knox, Rev. W. Keble Martin, Mrs. B. H. S. Russell and Miss P. Woodlands (from the Glasgow Natural History Society), and photographs, maps, manuscripts, books and herbarium specimens from other contributors were also displayed.

The general impression which the exhibition meeting left in my mind was that work on British field botany is progressing faster than ever before. This is no doubt primarily due to the renewed interest in taxonomy at the universities, as evidenced by the exhibits. But their research is also assisting the work of other centres of study and it is helping the amateur botanist to direct his energies to more profitable channels. As a result, field botany in Great Britain has had an exceptionally successful season.

J. E. Lousley

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[7] Raven, J. E., *Watsonia*, 1, 357 (1950).

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OBITUARIES

Dr. R. G. Aitken

We have learned with much regret of the death on October 29, in his eighty-seventh year, of Dr. Robert Grant Aitken, director emeritus of the Lick Observatory, California. Born at Jackson, California, on December 31, 1864, Aitken was educated at Oakland High School and Williams College, Massachusetts. During 1891–95 he was professor of mathematics and astronomy in the College of the Pacific. In 1895 he joined the staff of the Lick Observatory, where he was to remain throughout his active career. William Joseph Hussey, professor of astronomy at Leland Stanford University, was at that time a volunteer observer at the Lick Observatory, and in 1896 he also was appointed to the staff. Aitken and Hussey almost at once embarked on a systematic survey of all stars down to magnitude 9·0 on the *B.D.* scale in the portion of the sky from the north pole to 22° south declination for the detection of double stars.

The survey was made at first with the 12-in. refractor, the great 36-in. refractor being used only to verify the duplicity of all discoveries. But soon the survey and the measures were made solely with the larger telescope. After Hussey left the Lick Observatory in 1905 to become director of the Detroit Observatory, Aitken carried on the survey alone, and eventually completed it to 18° south declination, the South African double-star observers taking over the responsibility for the remaining portion of the sky. In the course of this work, Aitken discovered 3,103 new double stars; Hussey, in his portion of the survey, had discovered 1,327. Throughout the survey an upper limit of separation of 5″ was fixed, but for more than half the new discoveries the separation was less than 1″.

Aitken did not restrict himself to discoveries of new binary systems. He re-measured each of his own stars at two subsequent epochs in order to detect orbital motion, while stars of special interest were observed more frequently. In the course of his work a large number of measures of known binaries, and particularly of those showing orbital motion, were made. He also computed a large number of orbits.

His observations were characterized by a high standard of accuracy, and the measurements of even the closest pairs were affected by only small accidental errors. Of special interest is the pair Aitken 88, which he discovered in 1901; the period of this binary system is only 12·2 years and the maximum separation 0·17″. Aitken observed it right round its orbit and computed the orbital elements, no other observations of this difficult pair being obtained by any other observer.

The homogeneous material obtained in this great survey was used by Aitken for various statistical studies. It is of interest to note that about one star in eighteen of those examined was capable of visual resolution as a binary star.

In 1932 Aitken published the "New General Catalogue of Double Stars within 120° of the North Pole". This work was planned to supplement the "General Catalogue" published by Burnham in 1900. On his retirement from the Yerkes Observatory, Burnham had turned over the material that he had collected for the revision and extension of his catalogue to Prof. Eric Doolittle, director of the Flower Observatory. After the death of Doolittle in 1920, the whole of the material was taken over by Aitken in accordance with a promise he had made to Doolittle in 1919. In this great work is given for each pair the earliest available measure and all later measures except those quoted or referred to by Burnham. The wider and fainter pairs were omitted, however, as unlikely to be physical doubles. Aitken set a limit of separation of 10″ for a pair with apparent magnitude of 9·0, with appropriate limits for brighter and fainter pairs. About thirty per cent of Burnham's pairs were thereby excluded, yet the new catalogue has 17,181 entries as compared with Burnham's 13,665.

In 1918 Aitken published "The Binary Stars", an authoritative and comprehensive survey of every aspect of double-star astronomy, which has proved invaluable both as a text-book and as a work of reference. A revised and enlarged edition was published in 1935.

The observation of double stars is of great importance for the information it provides about the masses of the stars. It remains one of the few fields of work in which observations (except for wide pairs) must be made visually. The glamour of astrophysics has unfortunately resulted in the almost complete neglect of double-star observations, at least in the northern hemisphere. Aitken was one of the great exponents of double-star astronomy in all its varied aspects; throughout his active career he pursued it with single-minded detachment, using to the full the advantages provided by the great 36-in. refractor and the excellent conditions for observation on the summit of Mount Hamilton.

Aitken was appointed associate director of the Lick Observatory in 1923 and director in 1930; he retired in 1935 with the title of director emeritus. After his retirement he continued to take a keen interest in astronomy. He was in great demand as a lecturer and was very active in the affairs of the Astronomical Society of the Pacific; at the time of his death he was chairman of its Board of Directors. He was elected an associate of the Royal Astronomical Society in 1913; he was awarded the Catherine Bruce Gold Medal of the Astronomical Society of the Pacific in 1926 and the Gold Medal of the Royal Astronomical Society in 1932. He married in 1888 Jessie, daughter of Captain W. R. Thomas, and there were three sons and a daughter of the marriage.

H. Spencer Jones

Prof. C. K. Tinkler

The death on October 25 of Prof. C. K. Tinkler, formerly professor of chemistry in King's College of Household and Social Science, University of London, will be felt as a loss in many circles, particularly in the world of women's education—a world in which he ranked as a pioneer.

Prof. Tinkler was born in 1881 and received his early education at Caterham School. It was here that he first met V. H. Mottram, who on his appointment in 1920 as professor of physiology in King's College became his colleague and close associate. Tinkler graduated from the University College of North Wales, Bangor, and afterwards went to the University of Edinburgh to work under Prof. J. J. Dobbie. In 1904 he became a lecturer in the University of Birmingham, and during the following eleven years worked intensively both in teaching and research. He published many papers on alkaloids of the berberine type and cognate compounds, made a study of fuels, and in collaboration with a fellow lecturer published a book much valued in the petroleum industry, "The Chemistry of Petroleum", by Tinkler and Challenger.

In 1915 he was appointed a reader in the University of London and head of the Chemistry Department of King's College of Household and Social Science, then the Home Science Department of King's College for Women. It was to the work and development of this College that he devoted the remaining thirty-two years of his professional career until his retirement in 1947.

To understand fully the main achievements of Prof. Tinkler's life it is necessary to look back at the history of the College with which he was so closely identified. At the time of his appointment, the College was in its infancy. Only seven years previously, in 1908, a course dealing with the scientific and social aspects of the household and institution had been run for the first time in a department of King's College for Women, a branch of King's College, Strand. In those days the idea that there could be any connexion between pure science and the mundane affairs of the kitchen and laundry was revolutionary, and still more revolutionary the idea that a liberal academic education for women could be based on subjects within their own sphere. Nevertheless, a few great men of vision, Sir John Atkins, Sir Cooper Perry, Sir Herbert Jackson and Prof. A. Smithells, were convinced of the scope and necessity for this type of education for women; they devised and initiated the course, and collected by private enterprise sufficient money to acquire a site on Campden Hill, Kensington, and to begin building a college. If any justification of their faith be required, it is to be found in the universal acceptance to-day of their ideas and in the progress and expansion that have taken place in every aspect of the field they sought to cover: for example, in the science of foods, detergents, house-heating and ventilation, and even in the study of the social and economic relationship of the home to the community and the nation.

It was by a stroke of good fortune that Prof. Tinkler became a member of the small staff in 1915, for he was imbued by the same ideas, and threw himself whole-heartedly into the task of developing the course and establishing the College and its work. His arrival took place at the opportune moment when the first instalment of the building, including the laboratories, was erected but not yet equipped. Here then was a situation calling for those qualities with which Prof. Tinkler was well endowed—organizing ability, initiative and enthusiasm born of his ever-increasing and infectious faith in the whole project.

Success came with the years: in 1920 a professorship was conferred upon him by the University of London, in 1921 the course was recognized by the University by the granting of the degree of B.Sc. (Household and Social Science), and in 1928 the College was recognized as an independent school of the University and given its present title. In the development, Prof. Tinkler was the leading spirit. His personality, combined with wisdom and knowledge, rendered him an invaluable committee member, an able representative of the College in the outside world, and the man to whom people instinctively turned for guidance in all matters, whether academic, practical, or administrative. Within his own department he applied himself from 1915 onwards to the task of devising a suitable course in chemistry to dovetail with the other subjects in the curriculum. In collaboration with Miss Helen Masters he created a course in applied chemistry unique in its scope and to the present day regarded as a model in home science departments throughout the world. The results of original work were embodied in this course from time to time. The practical work and some of the better established aspects of theory were published in two volumes: "Applied Chemistry", by Tinkler and Masters.

As a teacher, Prof. Tinkler excelled. He possessed a great store of knowledge of a wide range of practical matters and had a remarkable gift of clear exposition and a rare capacity for bridging the gap between the academic and practical aspects of his subject.

Agnes Jackman

The death is announced of Mr. J. E. Southcombe, a director of Germ Lubricants, Ltd., at the age of sixty-six. He graduated at the University of Liverpool in 1907, and after a short period of teaching in Ireland returned to Liverpool to do chemical research. He collaborated with the late Henry M. Wells in an investigation of the properties of 'fatty oils', and their use as compounding agents with mineral oils for lubrication; and afterwards specialized on 'boundary phase' lubrication problems.

NEWS and VIEWS

British Association: Officers for 1952

THE Council of the British Association announce the following appointments for 1952, which includes the annual meeting at Belfast (September 3–10): *President*, Prof. A. V. Hill; *General Treasurer*, Mr. M. G. Bennett; *General Secretaries*, Sir Richard Southwell and Dr. George Taylor; *Presidents of Sections*, *A* (Mathematics and Physics), Prof. A. M. Tyndall; *B* (Chemistry), Prof. W. Wardlaw; *C* (Geology), Dr. J. E. Richey; *D* (Zoology), Prof. A. D. Peacock; *E* (Geography), Prof. R. O. Buchanan; *F* (Economics), Prof. D. T. Jack; *G* (Engineering), Sir Ben Lockspeiser; *H* (Anthropology and Archæology), Prof. E. O. James; *I* (Physiology), Prof. R. C. Garry; *J* (Psychology), Prof. P. E. Vernon; *K* (Botany), Prof. Meirion Thomas; *L* (Education), Mr. A. L. Binns; *M* (Agriculture), Dr. N. C. Wright; *Conference of Delegates of Corresponding Societies*, Mr. J. A. S. Stendall. The Prime Minister of Northern Ireland and the Lord Mayor of Belfast will be patrons for the Belfast meeting, for which a local executive committee has been appointed under the chairmanship of the Vice-Chancellor of Queen's University, Belfast, Dr. Eric Ashby.

International Council of Scientific Unions

THE Executive Board of the International Council of Scientific Unions held its annual meeting in the rooms of the National Academy of Sciences at Washington, D.C., on October 16–17. Prof. A. von Muralt, president, was in the chair. In addition to the members of the Board, a number of American scientific men were invited to attend the meeting from the State Department, the National Academy of Sciences and various national committees, from the National Research Council and the Science Foundation. Among the items of business mention must be made of the fact that for the first time the Board allocated among the Unions the grants-in-aid for 1952 made by the United Nations Educational, Scientific and Cultural Organization. The total allowed for each category of grant was fixed by Unesco, and the internal distribution within each category by the Board. Applications for acceptance from the International Unions of Biochemistry and Scientific Psychology were deferred. A new Joint Commission on Electron Microscopy was set up, and a Committee on a Polar Year to be organized for 1957. A revised agreement with Unesco was approved. A new feature of a Board meeting was a symposium on "Development of International Co-operation in Science", at which the speakers were Prof. F. J. M. Stratton, Dr. W. A. Noyes, jun., Dr. J. N. Mukherjee, Dr. C. J. Mackenzie, Dr. Joseph B. Koepfli and Prof. A. von Muralt. Mr. William W. Rubey, chairman of the National Research Council, presided. At the close of the meeting, visits were arranged for delegates to a number of scientific institutions in Washington. Generous hospitality was offered by the National Academy of Sciences and its officers, and the Board was entertained to lunch by the Hon. James E. Webb, Under-Secretary of State.

Nature Reserve in Ross and Cromarty

THE first national nature reserve in Britain has been established by the Nature Conservancy in the County of Ross and Cromarty. A property of some 10,450 acres within the great deer forest of Kinlochewe has been purchased by private treaty and declared a nature reserve by the Conservancy. The reserve includes the woods of Coille na glas Leitre by Loch Maree (surface elevation 32 ft.) and the eastern slopes and ridges of Beinn Eighe, rising to more than 3,200 ft. The very ancient geological formations of this region are of great interest and exhibit some of their more striking features within the reserve. The mountain scenery is particularly impressive, where the white Cambrian quartzite is most prominent upon the dark torridonian sandstone. There are several small lochans and pools on the moors. The woodlands are occupied predominantly by Scots pines and birches and are of considerable scientific interest as part of a system embracing woodland and transitional moorland areas. The moorlands, which are generally very wet, reach upwards to screes and steep rocks. In the high corries and on the exposed ridges the flora is arctic–alpine in character. Among the mountain plants are: alpine bearberry, purple saxifrage, mountain azalea, alpine thrift, moss campion and the dwarf cornel. The fauna of the district includes red deer, roe deer, wild cat, pine marten, golden eagle, buzzard and ptarmigan. The reserve as a whole, with its wide range of altitudes and its various woodland, moorland and mountain top habitats, offers excellent opportunities for biological observations and research in relation to nature conservation.

M. T. Kearney Foundation of the College of Agriculture, University of California

A NEW foundation, to be known as the M. Theodore Kearney Foundation of Soil Science, has been endowed in the College of Agriculture, University of California, with the proceeds of the bequest of the late Mr. Kearney, a prominent rancher in the Fresno area in the latter part of the last century, who died in 1906, leaving his estate to the University; the endowment now amounts to 2,268,000 dollars. The Foundation will be used for the advancement of knowledge of soil science, including soil–water–plant relations, by study of the basic physics, chemistry, biology and hydrology, with particular reference to arid and semi-arid farming regions; it will also serve to strengthen the services of the University in the education and training of soil scientists and teachers of soil science and closely related subjects. Mr. Kearney's interest in soil science arose from his experience of barrenness of soils resulting from alkali accumulations following irrigation. The current programme of the College of Agriculture includes research on the physical behaviour of soils, chemical problems of alkali soils and methods of cropping on them, both in the field and the laboratory, with the view of the permanent reclamation and agricultural use of such soils. Other studies include the behaviour of important chemical ions and their uptake by plants; direct fertility studies in relation to soil types; the palatability and nutritive value to livestock of forage crops produced on soils of different fertility levels; the clay minerals of the soil and the part they play in soil chemistry and physics; and soil surveys and land classifications of the agricultural, grass and forested areas of California.

Inter-Commonwealth Postgraduate Scholarships in Science

THE Royal Society Empire Scientific Conference and the British Commonwealth Scientific Official Conference in 1946 recommended the preparation of a list of postgraduate scholarships available for scientific study within the Commonwealth. The task of compiling a list was assigned to the British Commonwealth of Nations Scientific Liaison Office in London, and it has now published the required information in a book called "The Commonwealth Post-Graduate Scholarships in Science". Since the main objective of the list is to encourage the movement of scientific workers within the Commonwealth, only those awards open to members of at least one Commonwealth country or Colony other than the awarding one have been included. The entries are set out in tabular form showing, in addition to the names of the scholarships and the agencies awarding them, details of the fields of study, where tenable, duration and value, closing dates for applications and the addresses to which these should be sent. There are more than 350 separate entries in the list: many of these cover a number of scholarships so that the total number of available awards is much greater. The list should be a valuable work of reference for students and educational authorities and is published by H.M.S.O., price 5*s*.

Costantino Gorini Foundation for Dairying, Milan

A FOUNDATION in memory of Costantino Gorini, the dairy bacteriologist, who died in September 1950 in his native city of Milan, has recently been formed, under the auspices of the Lombard Institute of Sciences and Letters of Milan, for the purpose of assisting research workers engaged in dairy science and technology, especially in the field of microbiology. Periodically, an international competition will be held and a prize awarded for results in improving the production and uses of milk and dairy products in the interest of human nutrition. Entries for the present competition, for which the prize will be 100,000 lire, must be sent in before December 31, 1952, to the Istituto Lombardo, Via Brera 28, Milan. An entry must consist of a letter of application, supporting reprints of published work and an account of the research work completed since 1949; the reprints and the letter of application may be written in Italian, French, English, Spanish or German, but the account of the work itself must be in Italian or French.

Jaina Legend in Old Gujarati

A WORK in Old Gujarati ("The Nalarayadavadanticarita (Adventures of King Nala and Davadanti)", edited and translated by Ernest Bender (*Trans. Amer. Phil. Soc.*, 40, Pt. 4, 1950) is a Jaina version of the Mahabharata story of King Nala and Queen Davadanti. Nala loses his kingdom at dicing to his younger brother and is exiled, taking the form of a hunchback at the command of his father's spirit. After adventures lasting twelve years he is reunited with Davadanti, assumes his natural form and regains his kingdom. The story is used as a discourse on the precepts of the Jaina religion, Nala's misfortunes and subsequent reinstatement being explained as the outcome of his actions in previous births. The book contains a comparison with the Mahabharata version, notes on metres and grammar, the Gujarati text in English script, and a translation, glossary and bibliography.

Isabelline Shrike on the Isle of May

IN September 1950 Miss Winifred Flower and Miss M. I. Kinnear observed on the Isle of May a shrike which did not appear to resemble any of the species described in "The Handbook of British Birds". Full details were forwarded to the late B. W. Tucker, who accepted the record as referring to the isabelline shrike (*Lanius isabellinus*). Later, Sir Norman Kinnear compared this material with specimens in the British Museum and confirmed the identification of what is a species new to the British list (*British Birds*, 44, No. 7; July 1951). The breeding-range of the species *Lanius isabellinus* extends from Transcaspia and the southern Khirgiz steppes through Turkestan and Mongolia to southern Transbaikalia and Alashan and Ordos in inner Mongolia. Various authorities are in disagreement as to the ranges of the three subspecies *L. i. isabellinus*, *L. i. phoenicuroides* and *L. i. speculigerus*, but agree that the last is found in Mongolia and Transbaikalia. On migration the isabelline shrike travels south-westward through north-western India, Persia, southern Iraq, and southern Arabia to winter in Africa from the Sudan, Abyssinia and Somaliland south to Uganda and Kenya and west to the Lake Chad region.

Acetylene Industry and Chemistry in Germany during the War

THE Department of Scientific and Industrial Research has issued a booklet entitled "The Acetylene Industry and Acetylene Chemistry in Germany during the Period 1939–1945", by Dr. R. Owens and Dr. A. W. Johnson (pp. 157; London: H.M.S.O., 1951; 3*s*. 6*d*.). This is a substantial pamphlet and gives very detailed information on all aspects of acetylene chemistry, in which important advances were made in Germany during the war period. The processes include the thermal cracking of methane and other saturated hydrocarbons, and the manipulation of acetylene under pressure. The chemical industry will undoubtedly be grateful to H.M. Stationery Office for making available (and at such a low price) a compilation of this size and content.

Proceedings of the International Conference on Low Temperature Physics

THE *Proceedings of the International Conference on Low Temperature Physics* held in Oxford during August 22–28 (see *Nature*, November 10, p. 807) are now available and are being sent out to those who ordered them at the conference. The publication consists of illustrated reports of 106 papers on 165 foolscap pages produced by the 'Rotaprint' process together with a short summary of the discussions. It is of interest to see how prompt publication of this report has been achieved. Fifty reporters, drawn from research workers in the Universities of St. Andrews, Bristol, Cambridge and Oxford and Queen Mary College, London, were used, each of whom was allotted about an hour of conference time. They were asked to write about 350–400 words, and to choose the minimum number of diagrams, for each fifteen minutes they were 'on duty', and in most cases they were confined to lectures given by people from the same laboratory as themselves. Manuscripts submitted in advance were also dealt with by the reporters on this basis. In this novel way, the organizers of the Conference were able to receive promptly short trustworthy accounts of papers presented, and also adequate reports of the actual discussions, with the result that the present useful summary has been prepared under the editorship of Dr. R. Bowers and produced within three months of the close of the Conference itself. Copies of the *Proceedings* can be obtained, price 15*s*., if orders are received by the Low Temperature Conference Secretary, Clarendon Laboratory, Oxford, before the end of the year.

Rhodes–Livingstone Museum

A SOMEWHAT unusual museum report is that of the Rhodes–Livingstone Museum in Northern Rhodesia (Pp. 44. Livingstone: Rhodes–Livingstone Museum, 1951. 2*s*.). The period covered is 1934–51, and it includes an account not only of its first home in the old Magistrate's Court in Livingstone, but also its present position in the United Services Club building, to which it moved in 1937. Finally, new buildings were completed in November 1950, mainly due to the generosity of local firms and private subscriptions. The aim in arranging the collections has been to create a friendly, pleasant atmosphere in which the visitor immediately feels at ease. Pale pastel shades predominate, and everything has been done to make a visit to the Museum a worthwhile adventure. The report also includes an excellent summary of the aims of museums in general and the policy of the Rhodes–Livingstone Museum in particular. This is a report of particular value to curators and all those who are interested in modern museum development.

University of Birmingham

DR. O. E. LOWENSTEIN, senior lecturer in zoology, University of Glasgow, has been appointed Mason professor of zoology in the University of Birmingham, in succession to Prof. P. B. Medawar. The following have been appointed lecturers in the University: Dr. H. R. Mulholland (mathematics); Dr. C. E. Harrold (botany); Dr. F. J. Wallace (mechanical engineering); and W. M. Crooks and D. C. Freshwater (chemical engineering). The following have been appointed research fellows in the University: Dr. J. M. Rushforth (mathematics); J. D. Lawson (geology); and Dr. A. R. Harding and T. Broom (metallurgy). The title of reader in thermodynamics has been conferred on Dr. F. K. Bannister, lecturer in the Department of Mechanical Engineering. Dr. R. T. W. Hall has resigned from his lectureship in chemical engineering on taking up an appointment with Esso Motor Spirit Co. at Fawley, Hants.

The Night Sky in December

FULL moon occurs on Dec. 13d. 09h. 30m., U.T., and new moon on Dec. 28d. 11h. 43m. The following conjunctions with the moon take place: Dec. 7d. 10h., Jupiter 4° S.; Dec. 22d. 23h., Saturn 6° N.; Dec. 23d. 03h., Mars 6° N.; Dec. 25d. 14h., Venus 8° N.; Dec. 27d. 06h., Mercury 8° N. In addition to these conjunctions with the moon, Mars is in conjunction with Saturn on Dec. 19d. 13h., Mars being 0·7° S. In the early part of the month Mercury sets about an hour after the sun and is in inferior conjunction with the sun on December 17, after which it becomes a morning star and at the end of the month rises nearly two hours before the sun. Venus, a morning star, rises at 3h. 20m., 3h. 55m. and 4h. 35m. on December 1, 15 and 31, respectively, stellar magnitude varying from − 3·9 to − 3·6 and the visible portion of the illuminated disk varying between 0·58 and 0·70. Mars is a morning star, rising at 1h. 40m. on December 1 and at 23h. 50m. on December 31; in the early part of the month the planet is close to η Virginis. Jupiter is visible up to about midnight, setting at 1h. 40m. and 23h. 50m. on December 1 and 31, respectively. Saturn, a morning star, rises at 2h. 25m., 1h. 40m. and 0h. 40m. at the beginning, middle and end of the month, respectively, and in the last case is a little north-west of θ Virginis. Occultations of stars brighter than magnitude 6, observations being made at Greenwich, are as follows: Dec. 3d. 18h. 26·7m., 30 Capr. (*D*); Dec. 10d. 16h. 08·5m., ε Arie. *m*. (*D*). *D* refers to disappearance. The Geminid meteors are active during the first week of December. Winter solstice occurs on Dec. 22d. 16h.

Announcements

H.R.H. THE DUKE OF EDINBURGH will open the new laboratories at Stoke-on-Trent of the British Ceramic Research Association on December 12.

PROF. ALBERT VANDEL, professor of zoology in the University of Toulouse, has been elected a *correspondant* for the Section of Anatomy and Zoology of the Paris Academy of Sciences in succession to Prof. Emile Guyénot, professor of zoology and comparative anatomy in the University of Geneva, who has been elected a non-resident member of the Academy.

THE degree of D.Sc. in the University of London has been conferred on D. R. Bates (University College), Prof. C. H. Gray (King's College Hospital Medical School) and Miss Florence N. David (University College).

THE Centre National de Coordination des Études et Recherches sur la Nutrition et l'Alimentation is arranging a symposium on meat production, to be held in Paris during December 18–20, at which scientific research workers and technologists will present papers on different aspects of the subject, both from the point of view of the producer and from that of the consumer. Further information can be obtained from the Secrétariat, Centre National de Coordination des Études et Recherches sur la Nutrition et l'Alimentation, 71 Boulevard Péreire, Paris, 17ᵉ.

THE annual exhibition of the Television Society will be held during December 28–29 at Century House, Shaftesbury Avenue, London, W.C.2. The exhibition will be open as follows: December 28, 6–9.30 p.m., members and friends; December 29, 10.30 a.m.–5.0 p.m., members. The public is admitted by invitation card. All exhibits are closely related to television engineering or production or to the production of television programmes. Tickets of admission may be obtained from Society or patron members, or from the Lecture Secretary at 10 Tantallon Road, Balham, London, S.W.12.

THE Institute of Rural Life at Home and Overseas is organizing a conference entitled "Rural Life at Home and Overseas", to be held at High Leigh, Hoddesdon, Herts, during January 1–4, 1952, under the chairmanship of the Rev. Dr. W. E. Farndale, a former president of the Methodist Conference and moderator of the Free Church Federal Council. Three lectures will be delivered: "Progress in British Agriculture", by Prof. H. G. Sanders; "A Sudan Experiment in Education", by V. L. Griffiths; and "The Church in the Village", by the Rev. A. K. Mathews. The fee for the conference (inclusive of board) is £3. Registration forms and further information can be obtained from the secretary of the Institute at 84 Eccleston Square, London, S.W.1.

ISOLATION OF NUCLEI FROM PLANT CELLS

By DR. R. BROWN

Botany Department, University of Leeds

A CHANCE observation on the effect of pectinase solutions on plant tissues has led to the development of a technique for the isolation of nuclei. This technique may have several applications, since it can be used with the root tip, which is an important experimental object, and it yields nuclei in a comparatively undamaged state.

A method that can be used with certain plant tissues has already been described by Feulgen, Behrens and Mahdihassan[1]. These workers, after grinding dry rye embryos in a specially designed mill, centrifuged the dismembered tissue in a mixture of benzene and carbon tetrachloride. During centrifugation, nuclei collected in the upper layer and other cellular components settled into the lower. With this technique after drying the nuclei, Feulgen *et al.* were able to demonstrate the presence in them of deoxyribonucleic acid. It is evident, however, that with this procedure mechanical damage is likely to be extensive, and the solvent action of the organic fluids considerable.

The technique that is being used in this laboratory has been developed primarily with onion roots. Tips about 5·0 mm. long are taken from vigorously growing roots. After excision the tips are transferred immediately to a 1·0 per cent solution (pH 6·6) of a commercial pectinase preparation, in which they are allowed to stand for three hours at 5·0° C. At the end of this period the material is transferred to a glass mortar in which it is ground lightly. The tissue breaks down rapidly, yielding a thick mush which is immediately suspended in a 1·0 per cent pectin solution. The suspension is filtered twice through a coarse sintered glass filter and finally centrifuged twice, as slowly as possible. A suspension is obtained in which the surfaces of many of the nuclei are apparently unbroken and completely free of adhering cytoplasmic fragments. The suspensions, however, are not free of cellular debris. They contain occasional fragments which limit the value of the preparations for cytochemical observations; but they are probably sufficiently clean to be used for cytological and some physiological purposes.

The pectinase treatment tends, of course, to disintegrate the wall and thus to facilitate the release of protoplast components. The separation of the nuclei from the cytoplasm is no doubt primarily simply a consequence of a loose connexion between these two components of the protoplast. At the same time, certain observations suggest that the enzyme preparation may have some effect on the cytoplasm itself. Although occasional nuclei may be obtained by grinding tissue without previous treatment, these are usually covered with a mantle of cytoplasmic threads. Further, prolonged treatment reduces markedly the yield of nuclei. It may be emphasized, however, that since the pectinase preparations used here undoubtedly contain a considerable proportion of impurities, the possibility cannot be disregarded that the apparent effect on the cytoplasm is due to substances other than the pectinase.

After grinding, the nuclei are dispersed in the fluid released from the tips. In this they remain intact for about an hour at room temperature. When they are transferred to water or to an inorganic salt solution they disintegrate immediately. Some nuclei survive for short periods in dilute solutions of citric acid. Many, however, do not, and those that do tend to have a granular abnormal appearance. It was thought in an early stage of the investigation that the possible effect of pectinase on the cytoplasm might be due to the disintegration of a polysaccharide which binds the nucleus to the cytoplasm and has a stabilizing effect on it. The effect of suspending the nuclei in a pectin solution was accordingly explored. It was found that a 1 per cent solution of a commercial pectin preparation sold for domestic jam-making preserved the nuclei for periods up to 9 hr. At the same time it was also found that a 1 per cent solution of bacteriological peptone gave the same result. Since pectin involves fewer complications than peptone, the use of a dilute solution of the former has been adopted as a standard procedure. It may be noted that the effects of pectin and peptone suggest that in the cell the stability of the interphase nucleus may be promoted by the action of certain polymers on the nuclear surface.

The filtration through sintered glass removes the bulk of the larger fragments, and the subsequent centrifugation the majority of the smaller. Slow centrifugation is important. With rapid centrifugation the nuclei tend to disintegrate into a thick, viscous mass which settles to the bottom of the tube. It has been found convenient to use a small hand-centrifuge for 6–7 minutes.

The rapid disintegration in water suggests that immediately after isolation the proteins of the nuclei are in an undenatured state. When any treatment is applied which tends to coagulate the proteins, then the nuclei remain completely stable in water. The suspensions that have so far been obtained consist almost entirely of interphase nuclei in which with normal visual light no structures other than nucleoli are discernible within them. The number of these

Isolated nuclei. × 500

varies between 1 and 4. A surface membrane cannot be identified either with the visual or the ultra-violet microscope. After isolation the nuclei behave as simple gels. They do not markedly contract or expand with changes in the osmotic pressure of the external fluid, which suggests that they do not contain a free liquid phase.

The variation within the suspension is large. The shape, optical properties and resistance to chemical treatment vary considerably. While most of the nuclei are circular in surface view, many are rod-shaped with rounded ends. Some are clear and translucent, whereas others appear to be more opaque. It appears to be the large translucent nuclei which are most unstable after isolation. Such variations are no doubt to be expected in a region such as the root tip in which the cells are in different stages of development, and in which those that are meristematic are in different phases of the division cycle.

Finally, although the technique described above has been developed with onion root tips, it has been shown that free nuclei may be obtained from root tips of other species, from mature regions of the root, and from immature leaves. From these other materials, however, suspensions relatively free from cellular components other than nuclei have not been obtained. With onion root tips the most satisfactory preparations have been obtained from young, vigorously growing roots.

The initial observation on which this work is based was made while I was a guest in the laboratory of Dr. V. M. Cutter, of the Osborn Botanical Laboratory of Yale University, and I wish to thank Dr. Cutter for his help at that time. I also have to acknowledge my indebtedness to Prof. I. Manton for considerable advice, and Mr. B. Clarke for taking the photograph which accompanies this article.

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PROPERTIES AND REACTIONS OF MIXTURES OF TRIFLUOROACETIC ANHYDRIDE AND OXY-ACIDS

By Dr. E. J. BOURNE, Dr. J. E. B. RANDLES, Dr. J. C. TATLOW and Dr. J. M. TEDDER

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FOR some time, with other colleagues, we have been studying the physical and chemical properties of mixtures of trifluoroacetic anhydride and certain oxy-acids, and our observations have now reached a stage where they may be summarized and correlated. All the data so far obtained conform with the hypothesis that, when a weak oxy-acid (HOX) and trifluoroacetic anhydride are mixed in approximately equimolecular proportions, the main product of the reaction, which is often vigorous, is the 'unsymmetric' anhydride (CF_3COOX), which exists to a small degree as the ions CF_3COO^- and X^+, as is shown in equations 1 and 2. The alternative mode of ionization into CF_3CO^+ and OX^- is improbable, because of the strong electronegative character of fluorine. We propose to present the evidence upon which this hypothesis is based.

$$\begin{array}{c}(CF_3CO)_2O + HOX \\ \updownarrow \\ CF_3COO^- + X^+ + CF_3COOH \\ \updownarrow \\ CF_3COOX + CF_3COOH\end{array}\qquad\begin{array}{r} \\ (1) \\ \\ (2) \\ \end{array}$$

If the hypothesis be true, then a mixture of an oxy-acid (HOX) and trifluoroacetic anhydride should effect substitution by the reactive electrophilic X^+ ion. For example, when HOX is a carboxylic acid (RCOOH), the mixture should furnish a source of acylium (RCO$^+$) ions, and should be a powerful acylating, rather than trifluoroacetylating, medium. In conformity with this, we have already shown experimentally that such a mixture reacts readily with hydroxy-compounds to give esters of the carboxylic acid[1,2], and with activated aromatic compounds (for example, polyalkyl benzenes, phenyl ethers, furan and thiophen) to form the corresponding ketones[3]; in neither of these two types of reaction was the formation of the trifluoroacetyl derivative observed. In an analogous fashion, mixtures of sulphonic acids and trifluoroacetic anhydride have been employed for the preparation of sulphonate esters[2] and of sulphones[3].

The introduction of basic substances has a pronounced effect on the chemical reactions of carboxylic acid – trifluoroacetic anhydride mixtures. Thus, the introduction of sodium acetate into a mixture of acetic acid and trifluoroacetic anhydride greatly reduces the acetylating power of the medium, which then forms both the acetate and trifluoroacetate esters when it is allowed to react with an alcohol[4]. Likewise, the treatment of primary amines with acetic acid and trifluoroacetic anhydride affords mixtures of the acetyl and trifluoroacetyl derivatives in which the latter frequently predominate[5]. These observed effects of bases find a logical explanation in the above theory, for the introduction of a base into the system would be expected to increase markedly the concentration of the trifluoroacetate anion, which in turn would decrease the concentration of the reactive cation (CH_3CO^+ or X^+) in favour of the molecular anhydrides [$CH_3COOCOCF_3$ and $(CF_3CO)_2O$], both of which are capable of promoting trifluoroacetylation (compare Emery and Gold[6], who studied the reactions of unsymmetric anhydrides derived from acetic acid and chloroacetic acids). The fact that sodium trifluoroacetate itself, when introduced during an esterification process involving acetic acid and trifluoroacetic anhydride, similarly increases the trifluoroacetate/acetate ratio, lends support to these arguments[4].

Evidence of the validity of our hypothesis has been obtained also by physico-chemical methods. Cryoscopic data furnished by Morgan[7] revealed that, when trifluoroacetic anhydride is dissolved in a large excess of acetic acid, each anhydride molecule gives rise to two other molecules. His results eliminated the possibility that the reaction proceeded solely according to equation 3, which requires that each trifluoroacetic anhydride molecule should afford three other molecules, but they agree with equations 1 and 2 if it be assumed that the degree of ionization of the unsymmetric anhydride is very small. We have obtained proof, by measurements of electrical conductivities, that ions are formed in mixtures of acetic acid and trifluoroacetic anhydride. The addition of acetic acid to excess trifluoroacetic anhydride, and likewise the addition of trifluoroacetic anhydride to excess acetic acid, resulted in a very marked rise in conductivity, which, although it still remained quite small, was much too large to be due to the trifluoroacetic acid formed according to equations 1 and 2, and was slightly greater than could be accounted for by the two molecules of acid formed as in equation 3.

$$(CF_3CO)_2O + 2CH_3COOH \rightleftharpoons (CH_3CO)_2O + 2CF_3COOH. \quad (3)$$

It should be noted that, for the acylation of hydroxy-compounds[6] and of anisole[7], the carboxylic acid – trifluoroacetic anhydride mixture may be replaced by one consisting of a carboxylic anhydride and trifluoroacetic acid. For use in a general method of acylation the latter mixture is less convenient, for it entails the preparation of each individual carboxylic anhydride; however, it does possess the advantage that a stoichiometric amount of trifluoroacetic acid is not required. As will be seen from equations 4 and 5, the trifluoroacetic acid which is utilized in the formation of the unsymmetric anhydride is regenerated when this anhydride reacts, for example, with an alcohol ($R'OH$). In support of the theory that the unsymmetric anhydride is an intermediate in this reaction, we have shown that aniline reacts with a mixture of acetic anhydride and trifluoroacetic acid to form both acetanilide and trifluoroacetanilide[5].

$$(RCO)_2O + CF_3COOH \rightleftharpoons RCO.O.COCF_3 + RCOOH. \quad (4)$$

$$RCO^+ + CF_3COO^- + R'OH \rightleftharpoons RCOOR' + CF_3COOH. \quad (5)$$

From the above evidence, it will be seen that there is strong factual support for our hypothesis concerning the mode of reaction between weak oxy-acids and trifluoroacetic anhydride. Since this support has been drawn from experiments in which the oxy-acid is of either the carboxylic or sulphonic type, it should not be assumed that other oxy-acids do not react in a similar fashion. Indeed, it has already been shown in these laboratories that trifluoroacetic anhydride promotes the formation of phosphate esters from phosphoric acid derivatives, of nitrate esters and nitro-compounds from nitric acid[8], and of nitrocompounds, nitroso-compounds and diazonium salts from sodium or amyl nitrites[8]. All these reactions, details of which will be published later, can be explained satisfactorily on the basis of equations 1 and 2.

We are greatly indebted to Prof. M. Stacey for his interest in this work, to Imperial Chemical Industries, Ltd. (General Chemicals Division), for part of the trifluoroacetic acid used, and to the Department of Scientific and Industrial Research for a grant towards the expenses. [June 26.

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THE ELECTRICAL RESEARCH ASSOCIATION

During October 10–12 the laboratories at Perivale of the Electrical Research Association were open for general inspection by some seven hundred members of the Association and others interested in its work, this being the first time they had been on view since the official opening by the late Duke of Kent in 1935. Some of the researches of the intervening years were exhibited, though the emphasis was naturally on current work. In view of the limited size of the Laboratories themselves and of the Association's income the range of exhibits was noteworthy, and the exhibition may be expected to expedite the provision of improved facilities in the Association's accommodation at Leatherhead.

Of necessity, the presentation conformed with the organization of the Association's researches into switch and control gear, surges and transformers, insulating materials, transmission and utilization, rural electrification and wind power, space and water heating, ignition and the welding arc. In addition, the important work carried out extra-murally on magnetic materials, power plant materials, meter bearings, and electrical discharges in gases was also displayed, though necessarily in a less complete manner.

A series of introductory displays were shown which aimed at summarizing aspects of the Association's work that cut across the organizational divisions. These dealt with the important parts played by the Association in the fields of national and international co-operation, standardization, and in the study and developments of materials (including a separate exhibit on electrical discharges in gases). Other displays outlined the contributions made in education, instrumentation, earthing and the application of mathematical methods, while another indicated the valuable facilities which the library and information bureau offers to members.

Switch and Control Gear. A striking exhibit in this field was a display illustrating the genesis, development and industrial applications of two basic principles of arc extinction, namely, the axial air-blast circuit-breaker with a short, fully scoured arc-gap and the oil-filled, side-blast baffle pot, which have formed the basis of nearly all modern switchgear development in Great Britain.

Most of the present work is of a fundamental character and was well illustrated by the demonstration of the oscilloscopic, stroboscopic and spectroscopic study of low-power arcs in hydrogen, which has clarified the phenomena observed at much higher powers, and by the photographic study of arc form and movement in an axial air-blast circuit-breaker. A semi-commercial axial gas-blast breaker is being used for studying the aerodynamics of arcs in high-speed gas flow, and *Schlieren* pictures of the shock waves in cold gas flow in a nozzle were demonstrated.

Since the electrical characteristics of the circuit of which the breaker forms a part influence its operation, another display illustrated the results of a survey of the restriking voltage characteristics of British high-voltage networks.

A bridge-connected fuse of novel design giving improved performance, and a miniature electromagnetic pressure-recorder were features of the fuses laboratory. Work on contactors, air-break switchgear and flameproof electrical gear was also displayed.

Surge Phenomena. The study of surge phenomena has, as its main objective, the increased reliability of overhead transmission systems during thunderstorms. The work includes the collection of data on the occurrence of thunderstorms, the correlation of these with data on lightning faults supplied by the area electricity boards, measurement of lightning currents, the effects of lightning on insulators and substation plant, and the study of all problems associated with methods of protecting against lightning.

Demonstrations included the calibration of magnetic links (surge current indicators), the distribution of various types of surge in transformer windings, detection of transformer faults due to surges, protection of a transformer by a surge filter, and the protection of a wooden stay insulator by an air gap. Most of the recording apparatus was designed and constructed by the Association, a notable example being an automatic, three-element oscillograph for continuous recording on lines operating at voltages up to 132 kV.

Transformers. The investigation in the Association of transformer problems, other than those associated with surge phenomena, is of comparatively recent growth, but already it includes transformer noise, the experimental investigation of mechanical forces, the general study of temperature distribution, the application of the capacitor transformer to the measurement of very high transmission voltages, and various problems associated with parasitic losses. Demonstrations included investigations of mechanical forces and of temperature distribution in experimental transformers.

Transmission and Utilization. The great use made nowadays of model and analogue techniques was illustrated by a pilot network analyser suitable for steady-state and transient solutions and incorporating novel features leading to low cost and versatility, and by a model high-voltage D.C. transmission system. This has yielded important information on starting, operation and protection, which will undoubtedly facilitate progress with a pilot full-scale project, when the necessary resources are marshalled.

A diagram entitled "Control of Radio Interference" summarized the work in a field in which the Association is widely recognized as an authority, and interference measuring sets and examples of suppression components were exhibited.

The detection of incipient failure in insulation provided an interesting example of the logical development of a method of assessment of a property not itself measurable, through the following stages: study of the material for the selection of an associated measurable property, construction of precise equipment for measurement in the laboratory, and, finally, reduction to a portable and simple instrument for field use.

The sensitive recording magnetometer, now used for measuring small changes in the earth's magnetic field to permit ionospheric predictions, is a modified form of the magnetic bomb and mine locator developed during the Second World War.

Dielectric Materials. The majority of the exhibits in the section on materials illustrated various mechanisms of electrical breakdown, a subject to which the Association has made very great contributions. Ionic discharge within voids in insulation were shown by an artificial transparent cable, with a series of oscillograms, electrophotographs and photomicrographs demonstrating the behaviour of the discharges and the nature of the microscopic breakdown paths which they erode in insulation.

Electrochemical reactions due to leakage currents through materials have only recently been recognized as an important factor in breakdown. Tests were in progress on insulation 'stabilized' against such reactions by the addition of hydrogen-accepting compounds. Other electrochemical work included a study of ionic exchange reactions in paper as a means of reducing its electrical conductivity, and an investigation of reactions in electrolytic capacitors. Several compounds were exhibited, including long-chain paraffins, alcohols and ketones, which had been synthesized in the laboratory in connexion with the foregoing, or for investigations on the relation between crystal structure and dielectric behaviour.

Notable in this section was the wide range of physical methods which can be adapted to the study of electric properties. These included the development of photographic emulsions by electrolysis for detecting minute faults in insulation; the polarizing microscope applied to the study of molecular orientation in polystyrene; a vacuum torsion balance accurate to 10^{-7} gm. in 0·1 gm. for the measurement of moisture sorption; X-ray diffraction as a means of identifying compounds or for following changes in their structure; apparatus giving hydrostatic pressures up to 1,000 atmospheres for the study of structural changes; and a high-temperature furnace adapted for single-crystal growth in connexion with the study of ferro-electric compounds.

Reports and published papers indicated the major contributions to the theory of the solid state (including a new theory of superconductivity) made by leading scientific workers in this sphere under the ægis of the Electrical Research Association.

Magnetic Materials. A selection from the large number of reports available illustrated the work done on sheet steel and permanent magnet materials. Important results were obtained from the work on sheet steel at Cambridge, now concluded, and its continuance on a larger scale is being considered. On permanent magnets, X-ray studies are being made at Cambridge with the fine-beam technique on precipitation states in iron–copper–nickel alloys and alloy phase structures. At Sheffield precipitation-hardening alloys of nickel, chromium, iron, etc., and the mechanism of hysteresis are being investigated. At Nottingham the Bitter powder technique is being applied to domain structure and formation, and was demonstrated on a magnetized crystal of cobalt. Co-operative research with member organizations of the Association on the commercial production of permanent-magnet materials, including crystals, has led to the development of magnetic bodies with remarkable properties.

Power-Plant Materials. To improve generating efficiency in steam power stations, higher temperatures and pressures are being used, and the Electrical Research Association, jointly with the British Iron and Steel Research Association, supports an extensive investigation at the National Physical Laboratory on the creep and corrosion resistance of steels under these conditions. Corresponding extensions of the steam tables are naturally essential, and the Electrical Research Association, having sponsored the development of the Callendar tables from the start, has put in hand a further extension. The general nature and results of this work were illustrated by diagrams and specimens. It has been estimated that, as a result of twenty years of research and development, the increased efficiency of generation results in an annual saving of 18·5 million tons of coal.

Rural Electrification. Practical, rather than fundamental, problems are met with in the applications of electricity to agriculture, stress being placed always on the attainment of low electric loading and high load factor. The exhibits demonstrated how these essentially economic aims have been achieved in various aspects of soil- and space-heating and crop-drying by electrical methods.

Electric Power from the Wind. Photographs illustrated the type of hill usually found suitable for wind-power sites, on which studies of wind regime and wind structure have been made. The model wind-generators exhibited included one of the 100-kW. pilot plant now erected on Costa Hill, on the Orkney mainland.

Space- and Water-Heating. The work deals with the fundamental side of problems arising from the use of electricity for space- and water-heating, mainly from the domestic aspect. The major current research is an all-round study of the heat pump. One small installation using static water as a heat source is in operation at Perivale, and other work on heat sources such as the earth is in progress. A model house was on show which could be operated to show the possible saving effected during transient warming periods by the use of reflecting wall papers.

Ignition Research. Investigations on the electrical equipment of vehicles, including novel types of sparking plugs and the suppression of radio interference, constituted an important contribution to the national effort during the Second World War, and this work has continued with the support of the Ministry of Supply. A major aspect is the study of ignition by electric sparks, and this is also of considerable interest to the Safety in Mines Research Establishment of the Ministry of Fuel and Power, which maintains close liaison with the Association.

A high-speed single-transient oscillograph, giving a temporal resolution of 10^{-8} sec., has been developed by the Association for these researches and is being extensively used.

The Welding Arc. The detailed investigation of ferrous welding arcs was recently interrupted so that a study might be made of A.C. argonarc welding of non-ferrous metals. The result has been the development of a surge injector which maintains the arc with an A.C. r.m.s. voltage of less than 50, and is free from radio interference.

RHEOLOGY OF FILMS AND SURFACES

THE annual conference of the British Society of Rheology was held jointly with the local section of the Chemical Society at the Washington Singer Laboratories of the University College of the South-West of England, Exeter, during September 27–29. The conference was opened by Prof. H. T. S. Britton and by Dr. G. W. Scott Blair, president of the Society. On the afternoon of September 28 a visit was arranged to St. Mary's Abbey, Buckfast, when Brother Adam demonstrated the thixotropic breakdown and other rheological properties of honey in production processes. Papers were read by B. A. Pethica and by J. H. Schulman and M. Z. Dogan (Department of Colloid Science, Cambridge) dealing with the properties of insoluble monolayers at an air/water interface in the presence of some soluble long-chain electrolytes of strong activity. Comparison of the Langmuir isotherms for penetration of liquid-condensed chloresterol with a series of straight-chain C_{16} compounds has shown that the polar head group specificity falls off in the order:

$$SO_4^- > SO_3^- > NH_3^- > COO^+ > NMe_3^+.$$

In the case of the interaction of saponin with condensed chloresterol, where a stoichiometric complex is formed, the penetration isotherm shows a transition corresponding to the formation of a two-dimensional solid film. The areas of the saponin show a corresponding change in the transition zone.

Studies have also been made of the penetration of myristic acid by dodecylamine hydrochloride and of the properties of protein films in the presence of electrolytes in relation to the tanning industry. Prof. F. H. Garner and Dr. C. W. Nutt (Department of Chemical Engineering, Birmingham) read a paper on cybotactic phenomena at interfaces, describing experiments on the movement of droplets in viscous media. Evidence on the molecular orientation into a quasi-crystalline structure was discussed in its relation to chemical engineering phenomena, for example, mass transfer across interfaces.

E. Eisma (Netherlands) described experiments on the rheological properties of interfacial films on water. For films of high yield-stress and small viscosity the rotating disk method is suitable, while in the case of purely viscous interfaces the torsion oscillation method has an advantage.

Under the chairmanship of Prof. M. Reiner (Haifa), K. V. Shooter (Research Laboratory for the Physics and Chemistry of Surfaces, Cambridge) described the mechanism of boundary lubrication at light loads taking into account the pressure-dependence of viscosity of oil films. H. J. Bezer and Dr. R. Schnurman (Manchester Oil Refinery) discussed experiments with extreme-pressure lubricants using a four-ball apparatus of the Boerlage type. There was no evidence for a defined 'breakdown load' of a lubricant. An energy balance would appear to allow for an appreciable proportion, up to 10 per cent, of the mechanical energy to be available for the separation of electrostatic charges.

At another session, with Dr. R. N. Saal (Netherlands) in the chair, C. C. Mill (Printing and Allied Trades Research Association) spoke on the rheology of printing, mainly of letterpress and lithographic processes, the photogravure process being fundamentally different and generally simpler rheologically. There was a discussion on the significance of the phenomenon of parallel ridge formation in the ink film on rotating rollers in contact. M. R. Hopkins (British Iron and Steel Research Association) spoke on the mechanics of the coating of steel sheet with molten tin between rollers. A mathematical investigation based on arguments similar to those used in the theory of lubrication gives a relation between the coating thickness and the relevant variables for a single pair of rollers. This relation was found to be in accord with experimental results obtained with a sheet of nickel foil emerging from a bath of oil through a pair of polished stainless-steel rollers under precise conditions of test. A. de Wael and G. L. Lewis (Gestetner) read a paper on the electrical behaviour of oil-pigment dispersions. They have found that a dispersion with electrically conducting particles behaves differently according to the state of flocculation, whereas with non-conducting particles there is little difference. Conductive systems do not seem to obey Ohm's law. It is possible to correlate the electrical with the rheological behaviour. Materials exhibiting dilatancy—for example, titanium oxide in liquid paraffin—increase in conductivity during shear and rapidly decrease to a constant value on arrest of shear. In strong deflocculating media, such as carbon black in polymerized linseed oil, the dispersions with high yield values show neither conductivity nor high dielectric constant.

D. W. Jopling (Kodak, Ltd.) described apparatus with a servo-mechanism, designed to measure the rate of radial flow of a liquid between parallel surfaces, for the purpose of ascertaining the rate of swelling of colloidal films. The swelling of a film on one of the parallel surfaces alters the rate of flow between the plates, making it possible to calculate the increased thickness. E. Bielak and Dr. E. W. J. Mardles (Royal Aircraft Establishment), in a paper on the flow of liquid films over solids, reported that from experiments on the flow of drops along inclined planes and through capillaries, and on the radial spread of liquid pools over and between surfaces, anomalous flow-rates have been found. The flow behaviour over any one surface varies considerably with the chemical character of the liquid. Between surfaces, with films of thickness less than 10 μ, there is a tendency for the film to disrupt with the formation of pin holes and with a consequent onset of film plasticity and thixotropy, noted by earlier investigators with lubricants. This phenomenon appears to be significant in relation to the 'wringing' together of flats, hydraulic 'stiction' and the development of rigidity in lubricant films. E. W. J. MARDLES

MARINE BIOLOGICAL STATION ON INHACA ISLAND, MOZAMBIQUE

By MRS. OLIVE S. TATTERSALL

FOR several years certain biologists in South Africa have realized that the waters in and around Delagoa Bay are particularly favourable for work in marine biology. In spite of many difficulties, parties of students with the late Prof. C. J. van der Horst, of the University of the Witwatersrand, have paid regular visits to this area and have explored its varied collecting grounds. They found that there are particularly good centres for work along the western shores of Inhaca Island, which forms part of the eastern boundary of Delagoa Bay. There they worked under considerable difficulties, camping out on the foreshore in great heat, preyed upon by mosquitoes and working with inadequate and improvised apparatus. To-day, thanks to the generosity and sympathetic co-operation of the Government of Mozambique and to the enthusiasm of Prof. van der Horst, a remarkably fine biological station has been built on Inhaca Island.

In the early part of this year I was able to spend a few weeks working at this Station. On arrival at Lourenço Marques a small tug-boat was placed at my disposal by the Department of Maritime Services, and at 5 a.m. we left for the Island, 22 miles due east of the city. As we approached, the Island looked flat and uninteresting, and it was not until we were almost at the shore that the few native huts of the fishing village on the north-west coast of Inhaca appeared nestling at the foot of the low hills which rise close to the shore. We then turned south for about three miles when, on rounding a rocky promontory, we saw, on a flat stretch of dazzling white sand, three low white modern buildings, looking startlingly out of place in this scene which appeared never to have been touched by Western civilization.

Although there are more than four thousand Africans living on the Island, there is not a trace of any human habitation as one approaches from the sea. For the most part the western shores facing on Delagoa Bay have a short foreshore with low hills rising sharply as steep cliffs, densely covered with tropical vegetation. The site chosen for the Biological Station has a wider foreshore, and the hills behind it rise less steeply, though they are near enough to afford shelter from the east.

The Station consists of three detached buildings, connected by a paved causeway: the laboratory, with a wide shady veranda specially designed to meet the climatic conditions; the refectory, with kitchen, storehouses, dining-room and a wide veranda; and the dormitory, with comfortable cool rooms, modern sanitation, running water, shower baths and most appropriate modern furniture. The buildings are thoroughly mosquito-proofed so that one may enjoy the cool of the evenings in comfort. The whole of the cost of the buildings, water, electricity and sanitation has been borne by the Government of Mozambique, while the scientific equipment and furnishing has been provided by the University of the Witwatersrand.

Delagoa Bay is for the most part very shallow, though there are deep channels which will yield rich harvests to the dredge, and large sandbanks are exposed at low water. Here, among the weed and coral, one can find the utmost profusion of marine life—ascidians and sponges of the most wonderful colours, delicate planarians, sea anemones, nudibranchs, echinoderms and many worms and crustaceans.

The shore off the Station slowly shelves, and the sea goes out for a very great distance at low water. Then beyond the low-water level, for an equally long distance, there is water of not more than a foot in depth, so that good collecting is available at practically all stages of the tide. The littoral fauna is particularly rich, and my only regret was that I knew so little of it and that there were not enough books to enable me to identify the animals I found. It will, of course, be years before one can expect to build up an adequate library to cope with such abundance of life. In the meantime, I can imagine no finer holiday than a few weeks spent here, away from all the turmoil of the modern world, in a realm of Nature which man has not yet spoilt. Every possible facility is given by the Portuguese authorities to workers, and it is most refreshing to find such a sympathetic attitude existing in which the scientific investigator is allowed to work for the love of the work and is not hampered by the knowledge that he has to produce results at all costs. Although Inhaca may appear to be very remote, it is actually quite easy of access. The Union Castle ships call weekly at Lourenço Marques, and transport from the city to the Island is generously provided free of cost to the scientific worker by the Captain of the Port at Lourenço Marques. Fishing-boats pass daily between the Island and Lourenço Marques, and the Africans are always willing to bring goods from the mainland and to supply food cheaply.

I had no experience of dredging, for facilities for this type of collecting are not yet available; but nets are being bought, and it is hoped that before long a suitable boat will be attached to the Station to make their use possible. Judging by the shore fauna, there is no doubt that the dredge will reveal as rich a bottom fauna as any biologist could desire. The real industry of the Island is fishing, and it is an experience never to be forgotten to watch the small boats gathering at about 4 p.m. each evening off Inhaca village and transferring their day's catch to the larger boats, which will sail all through the night to deliver it in time for the early morning markets in Lourenço Marques. Many an interesting fish or other animal can be 'collected' by the biologist at these evening gatherings.

It is a brave venture to have established so fine a station in this spot, and it is to be hoped that many workers will be able to avail themselves of the unique opportunities for research which it affords.

THE BRITISH COUNCIL

REPORT FOR 1950–51

IN the annual report of the British Council for 1950–51*, which covers the year ended March 31, 1951, the general plan is that adopted for the first time in last year's report, though some of the chapter headings are different and that on the Council and the sciences disappears. A series of eleven chapters reviews in general terms the work of the Council in promoting cultural relations in four main territorial regions—Latin America, the Middle East, the Far East and the Commonwealth—then the work of the institutes, advisory visits abroad, work in the United Kingdom for the welfare of overseas students, and, finally, finance. Detail for the most part is given in a series of appendixes which occupy roughly half the report, of which those dealing with university interchange, lecturers overseas, and courses organized by the Council are of chief interest to the scientific worker.

In view of the publicity which the closing of three hostels for overseas students in Britain has received during the year, the section of the report which deals with the welfare of overseas students will be read with special interest. The scheme which the Council prepared, in consultation with the government departments concerned, for covering its wider responsibilities for the welfare of Colonial and overseas students generally for the period January 1, 1950, to March 31, 1954, was based on the view that, since it is undesirable to segregate Colonial students, hostels should not, if it could be avoided, be used by Colonial students only; and that, ideally, hostel accommodation should be regarded as a temporary necessity and that accommodation should be found for as many as possible either in permanent halls of residence, or with private families or in lodgings. Where hostel accommodation was unavoidable, it should be of a standard comparable with that of a university hall of residence.

The three hostels were closed in accordance with this policy and replaced by one residence housing 200 men, which was opened in Hans Crescent, London, in October. Planned and equipped to the standard of a modern university hall of residence, this is intended also to become a live centre for the Colonial student population of London. Those selected to spend a year there were mainly freshmen. A hostel in Edinburgh for twenty-eight men was taken over from the Colonial Office, and one for twenty-five men was re-opened in Newcastle. The small hostels in Manchester and Leeds had been established before the Council assumed its new responsibilities from the Colonial Office, and were not a part of the Colonial student welfare scheme. As a measure of economy, arrangements had to be made to close them at the end of the year; but the Leeds hostel was reprieved later through private generosity. Most Colonial students have to be accommodated in private houses, and the finding of suitable billets has not been easy. The report states that by the end of the year it was clear that additional hostel accommodation is required in London. The report stresses the value and far-reaching effects of this work; but points out that what really matters is how much the British public can be stimulated to do for such students.

Other work in the United Kingdom of particular interest to the scientific world is that of the Students Department, where the awards were re-distributed in view of the withdrawal of the Council from work in Czechoslovakia, Hungary and Bulgaria and the cessation of the flow of scholars from China. The number of scholarships for Germany and Yugoslavia was increased, and students from Burma, Indonesia and Thailand partly offset the loss of Chinese scholars. In October 1950 scholars came for the first time from India and Pakistan, the demand from India being such that for the present the field is to be restricted to candidates holding first-class honours degrees and who are to study education and public administration. In general, the proportion of applicants offering the sciences, notably medicine, economics and agriculture, is increasing. The number of bursaries, which provide opportunity for short-term intensive study in industry or the professions, was increased from 125 to 197, more than two-thirds being drawn from industry, agriculture and the social services. Five tours were organized for Greek provincial governors for the study of local government administration. New commitments in the Fellowships Section of the Visitors Department, which deals with all fellowships awarded for study in the United Kingdom by the United Nations and its Specialized Agencies, are in connexion with the International Labour Office Fellows and technical students under the Colombo Plan. Of the visitors, 258 were concerned with the social sciences, which displaced medicine (191) as the principal interest, education (147) coming third.

Departments constituting the Science Group further scientific exchanges with other countries, and as a result of last year's visit to Great Britain of the Secretary-General of the Spanish Higher Council for Scientific Research, several Spanish science students have received training in Britain and a delegation of British scientific workers attended the Higher Council's tenth annual congress at Madrid. The correction of the texts of Scandinavian scientific papers for publication in English continued on an increasing scale, and the Medical Department alone handled some sixteen hundred miscellaneous inquiries. The *British Medical Bulletin* continues to be the most successful scientific publication of the Council, and the monthly *British Medical Book List* has been launched to meet the overseas demand for a comprehensive list of this kind. In view of a comment by the Select Committee on Estimates, the size of the staff employed in the United Kingdom by the Council has been investigated by the Organization and Methods Division of the Treasury, as part of a wider inquiry into the

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* Report on the Work of the British Council for the Year ended 31st March, 1951. Pp. v+120. (London: British Council, 1951.)

Council's organization and methods which lasted nearly two years. Only in the clerical and typing grades were any posts considered redundant by the investigators.

Besides the withdrawal from Czechoslovakia and Bulgaria, the feature of the Council's work in Europe during 1950–51 was the opening of a new branch in Düsseldorf to take over the work previously done by the cultural department of the High Commission in Germany. The European work bore a major share of the reduction made in the Council's grant-in-aid as a whole, and the European budget for 1950–51 was about £100,000 less than that for the previous year. With Latin America this budget still accounts for more than half the Council's expenditure on overseas services, though expenditure in the Middle East comes next to that in Europe in magnitude. Lack of funds compelled withdrawal from the Sudan. Outside education in its narrower sense, the report suggests that the bringing of specialists and influential visitors to Great Britain and the giving of lectures, with supporting illustrative material, on agriculture and its associated sciences are the best means of maintaining and strengthening the interest of the Middle Eastern countries in the culture and institutions of the United Kingdom. In the Far East, with the exception of China, where a marked increase in the work of the local centres at Nanking, Shanghai and Peking was noted during the year in spite of Government interference with the Council's work, the main difficulty has been lack of funds; but as regards Latin America, commenting on the value of British publications for the propagation of knowledge, the report observes that in some countries currency restrictions or complicated import requirements constitute the chief obstacle and one which the Council can do little to overcome.

The British Council is responsible for the operation of schemes for the interchange of university teachers, scholars and scientific workers under the cultural conventions into which Great Britain has entered. Thirty-nine regular interchange visits of this type are already arranged each year with Austria, Belgium, France, Italy, the Netherlands and Norway. Negotiations are proceeding with Denmark, Western Germany, Spain, Sweden and Switzerland, which would bring the total to fifty-two, while under a scheme established at the request of the Conference of the Universities of the British Commonwealth at Oxford in 1948, thirty-three university teachers from eighteen Commonwealth universities visited the United Kingdom and one scholar from Britain visited Commonwealth universities. Seventy-two scholarships were offered to British students by Austria, Belgium, Brazil, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Persia, Portugal, Spain, Sweden and Switzerland, in return for the scholarships offered by the Council for many years to students from foreign universities. The number of advisory visits has also increased, and the report cites in illustration those to France on recent developments in stock-breeding; and visits of a team of three surgeons, led by Mr. C. Price Thomas, to Yugoslavia; of Dame Katharine Watt to India, Pakistan, Syria, Egypt, Iraq, Jordan and the Lebanon, to advise on nursing services; and of Dr. Mouat Jones to the Middle East and India, to advise on the development of technical education.

The net expenditure of the Council during 1949–50, the last year for which figures of actual expenditure are available, was £3,045,321, and the total sum available from public funds for 1950–51 was £3,233,700. There were, however, considerable changes in the distribution of expenditure, the estimates providing for major expansions in the work carried out for the Colonial Office, the Commonwealth Relations Office and Colonial Development and Welfare, and for a contraction, under instructions, of the provision for work in foreign countries of £325,000; the devaluation of sterling added a further £206,000 to this last figure. In the estimates for 1951–52, the Council has been called upon to reduce the provision for work in foreign countries by a further £364,000, although the Foreign Office is pressing for the expenditure of £49,000 on new services regarded as of the highest importance. Such reductions must entail drastic changes, and it is a matter for regret that neither in this report nor elsewhere is there any indication of a real inquiry into how far there is overlapping in the work of the British Council with that of the Central Office of Information, the Foreign Office itself, and the Overseas Service of the British Broadcasting Corporation which could be eliminated to the general advantage.

ELECTRONICS IN NUCLEAR SCIENCE AND ENGINEERING

Many visitors from overseas have been attracted to Great Britain in this Festival Year, not only to attend the Festival, but also to participate in the various supporting conferences arranged by the professional, scientific and technical institutes. The British Institution of Radio Engineers, the silver jubilee of which was to have been held last year, delayed its celebrations of this event and planned instead a Radio Convention for 1951. The Council of the Institution considered it appropriate that the Convention should aim at covering the whole field of electronics. In fact, the conference was probably the most comprehensive in its field ever to be held in Great Britain, and more than seventy papers were presented covering applications of electronics in all fields from nuclear physics to audio-frequency engineering. All the papers are being published in the *Journal* of the Institution.

The first session of the Convention was held at University College, London, during July 3 and 4 and dealt with the applications of electronics in nuclear science and engineering. The chair at these meetings was taken by Dr. Denis Taylor, of the Atomic Energy Research Establishment, Harwell, and his address, which was illustrated by lantern slides and ciné-film, was a survey of the radiation and particle detectors used in modern nucleonic instruments. The paper included a discussion of the long-term stability of the detectors used in assay and other instruments, and summarized from this point of view the relative advantages and disadvantages of Geiger–Muller counters, proportional counters and scintillation counters. In particular, the paper gave consideration to the problem of industrial instrumentation where high reliability is the first consideration. Graphs were presented showing the changes of counting efficiency of typical Geiger–Müller counters over a period of time, and it was noted that with counters filled with argon and ethyl alcohol large changes in the efficiency can occur during their working life. Some of these changes are related to photoelectric effects of the counter, variations of temperature, electrostatic effects on the window of the counter, etc.; but it was pointed out that, even when proper precautions are taken to avoid variations in the measured counting-rate due to all these effects, some fluctuations in the counting-rate outside those to be expected on statistical grounds are still obtained.

Dr. Taylor showed some typical curves for a Geiger–Müller counter and, in the cases shown, the counting-rate dropped by about 5 per cent in the first few minutes of use and then fluctuated over narrower limits during the course of the next hundred hours or more, the fluctuations being much larger than would be expected from the statistics. He pointed out that in laboratory experiments it is always possible to wait until the counter has settled down, and it is usually possible to determine the counting-rate of the unknown and a standard source and express the first result in terms of the second. This course allows all but the short-term variations to be eliminated, and very accurate measurements can then be made. However, in many instruments this second measurement with a standard leads to considerable complication and, in the case of industrial instrumentation, it is desirable to use more stable detecting elements both on the grounds of reliability and on the grounds of time-saving. Dr. Taylor showed graphs which indicate that Geiger–Müller counters using bromine as the quenching agent give an improved performance from this point of view, but that still better results can be obtained by using a counter operating in the proportional region, and he showed an apparatus of this type capable of giving a precision of measurement of ± 0·1 per cent and suitable for adaptation as an industrial instrument.

The two following papers were presented by K. Fearnside and Dr. J. E. Johnston, respectively, and dealt with various aspects of the use of radioactive tracers in industry. Mr. Fearnside reviewed the development of the beta-ray thickness gauge and described a number of preferred designs, dealing not only with the transmission gauge, but also with the back-scattering type. He gave details of the applications of these gauges in industrial work and information about their reliability and accuracy. It appears that they are already being used on a large scale, but that the obvious step of controlling the manufacturing process by a servo-mechanism operating directly from the gauge still remains to be done. The gauges in use at the present time simply measure the thickness of the manufactured material (strictly speaking, the mass per unit area, which is usually proportional to the thickness), and an attendant must make the necessary alterations to the machine if the thickness is outside the prescribed limits.

Dr. Johnston's paper covered a very wide field of applications, and the discussion which followed was equally wide. The main applications discussed were: determination of the presence of arsenic impurity in the germanium used for making crystal diodes (Dr. E. Billig, of the Laboratory of the Associated Electrical Industries, Ltd.); determination of the rate of wear of the dies used for making wire (Dr. J. W. Drinkwater, of the Thornton Research Centre); testing the uniformity of mixed cattle foods (British Oil and Cake Mills); testing the ventilation system of a factory (British Belting and Asbestos, Ltd.); and measuring the rate of wear of blast furnace linings (Mr. E. W. Voice, of the British Iron and Steel Research Association).

One of the most interesting papers presented at the conference was on the subject of the self-balancing potentiometric recorder. This instrument has proved to be one of great versatility and importance, and R. S. Medlock and W. A. Kealy in their paper gave a comprehensive review of the applications of this type of instrument in research and in industrial measurements. A large proportion of the applications discussed were those which have been developed for use in atomic energy plants—a novel example being the measurement of pile power. It is interesting to note that the self-balancing potentiometric recorder competes in many cases with the more orthodox instruments depending on the use of thermionic valve circuits, and for certain classes of problem offers a simpler and more satisfactory solution; moreover, in many cases the completed instrument is more compact.

The remaining three papers dealt more particularly with design of nucleonic instruments and were as follows: "Counting of Random Pulses," by E. H. Cooke-Yarborough; "Design of Portable Beta- and Gamma- Measuring Instruments," by E. Franklin and J. Hardwick; and "Pulse Circuits for the Millimicrosecond Range," by F. H. Wells. The paper on portable measuring instruments contained a great deal of new design data, and included details, to mention just a few of the novel ideas presented, of the use of cold-cathode valves in place of filament valves in these instruments, the replacement of the battery by a clockwork-driven electric generator, the replacement of the meter presentation system by a 'fluid light' type of indicator, and the use of infinite-life Geiger counter tubes. The majority of the instruments described were designed for use in the nuclear physics laboratory, or for field use by geologists or mining engineers, but some of the designs would be suitable for use by the civil defence authorities in the event of atomic warfare.

The paper by Mr. Wells dealt with a subject of more general interest, and gave a review of the circuit techniques used in measurements on short pulses and time intervals between pulses in the range $10^{-9} - 10^{-7}$ sec. The circuits described have been developed for use with scintillation and spark counters, and include pulse-shaping circuits, pulse generators, amplifiers, scaling circuits and oscilloscopes; and Mr. Wells gave examples of the use of these circuits for high-speed coincidence measurements, millimicrosecond time-interval measurements and fast counting. Probably the most interesting of the many circuits described is the fast coincidence circuit. This is essentially a mixer circuit, which will accept a pulse from each of two input channels and, if these pulses arrive at the same time, or within a given short time interval of each other, will give an output signal. In Mr. Wells's instrument the two input pulses are first shaped to give voltage impulses of defined duration, and these pulses are amplified so that each output pulse is of 10 V. amplitude. If, therefore, pulses from the two input channels arrive at exactly the same time, a double-amplitude pulse of 20 V. will be obtained. Hence, coincident pulses may be sorted out from non-coincident pulses by the use of a pulse-amplitude discriminator set to 15 V. following the amplifier, the output of the amplifier being the coincidence unit output-pulse. Mr. Wells gave details of a number of circuits he has built making use of this principle, and reported that the minimum coincidence resolving time readily obtainable is 10 millimicroseconds.

DENIS TAYLOR

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Protein Synthesis in Nucleated and Non-nucleated Halves of *Acetabularia mediterranea* studied with Carbon-14 Dioxide

It is generally assumed, after Caspersson[1], that the nucleus is the main centre of protein synthesis in the cell. However, this opinion is based on cytochemical and biological observations only (for example, the incapacity for sustained regeneration in many unicellular organisms), and it appeared desirable to test this assumption on biochemical grounds also.

An especially well-suited material has been found in the giant unicellular alga *Acetabularia mediterranea*, which has been extensively studied by Hämmerling[2]. The algæ were collected at the marine laboratory of Villefranche-sur-Mer, thanks to the kindness of Prof. Tregouboff, and they were grown according to Hämmerling's technique. Our biological observations concerning the extensive capacity for regeneration of nucleated fragments entirely confirm Hämmerling's; non-nucleated fragments of this alga are also able to initiate regeneration and even the formation of an umbrella. However, as Hämmerling has rightly noted, it is not easy to decide whether this corresponds to a real synthesis or to a mere elongation, due, for example, to a change in hydration.

In order to clear up this point, we carried out the following experiment: 50–100 nucleated and as many non-nucleated fragments, carefully washed and cleaned by means of a small paint-brush, were put into 12 c.c. of sterile medium (Hämmerling's) in a 50 c.c. Erlenmeyer flask; 2–4 mgm. radioactive barium carbonate (containing 1–2 μcuries of carbon-14) were placed in a small vial hanging from the stopper; radioactive carbon dioxide was liberated by adding a few drops of perchloric acid to the barium carbonate and the flask was immediately closed. The fragments thus kept in the presence of carbon-14 dioxide were exposed to the light of two 40-watt fluorescent tubes at a distance of 50 cm. After 24–38 hr., the fragments were rapidly washed free of radioactive medium, and sorted out (nucleated and non-nucleated fragments are readily distinguished, for the nucleus is located in the rhizoids of the alga).

The two groups of fragments were ground in 10 per cent trichloroacetic acid in a small homogenizer, the insoluble substances were washed once with trichloroacetic acid, and then hydrolysed for 18 hr. at 145° in 6 *N* hydrochloric acid, in sealed tubes. The amino-acids resulting from the hydrolysis of the proteins were decarboxylated with ninhydrin according to Van Slyke[3]; the carbon dioxide liberated was trapped in sodium hydroxide, then precipitated as barium carbonate, the specific radioactivity of which was determined by means of a thin-window counter.

The results of such experiments, performed with different batches of algæ that have been studied at different times after sectioning into two fragments, are given in the accompanying table.

Time since sectioning	Time of CO_2 incorporation	$\frac{\text{Specific activity of } CO_2 \text{ groups of proteins}}{\text{Specific activity of } CO_2 \text{ in the medium}} \times 100$		$\frac{\text{Specific activity of non-nucleated fragments}}{\text{Specific activity of nucleated fragments}}$
		Nucleated	Non-nucleated	
9 days	38 hr.	8·6	8·7	1·01
11 ,,	26 ,,	6·4	6·5	1·02
16 ,,	24 ,,	8·3	7·6	0·92
23 ,,	24 ,,	7·2	4·4	0·61
33 ,,	24 ,,	4·1	3·2	0·78
38 ,,	27 ,,	4·5	3·1	
		4·8	2·9	0·70

Preliminary experiments had shown that the incorporation of carbon-14 dioxide into the carboxyl groups of the amino-acids is linear for at least 48 hr.; it seems thus that we are very probably dealing with a real protein synthesis. It might be added that control experiments have conclusively shown that the whole of the carbon dioxide liberated by ninhydrin really came from protein amino-acids and that the contribution in this process of contaminating organisms is negligible.

In conclusion, it can be advanced that, contrary to the generally accepted views, but in harmony with Hämmerling's biological observations, the presence of the nucleus is not necessary for protein synthesis to continue for a considerable time. It is not until two weeks after enucleation that incorporation of carbon dioxide in the protein begins to drop; but even after more than five weeks this incorporation is very far from negligible. The fact that according to London, Shemin and Rittenberg[4] hæmin synthesis takes place in reticulocytes (that is, basophilic non-nucleated erythrocytes) and that the same is probably true for globin and other proteins (Borsook *et al.*[5]) suggests that our conclusions are probably also valid for animal cells without photosynthetic activity. Our results agree also with those of Hultin[6], Keller[7], Siekewitz and Zamecnik[8], according to which cytoplasmic microsomes rich in ribonucleic acid show the highest rate of incorporation of labelled amino-acids into proteins of all cellular fractions obtainable by differential centrifugation, including nuclei.

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A Technique for taking Successive Shadowgraphs of Oat Seedlings

Owing to the great variability in growth-rate and tropic curvature of the coleoptile shown by oat (*Avena*) seedlings similarly treated, it is for many experimental purposes desirable to be able to take successive measurements of growth or curvature on the same individuals rather than on a fresh sample each time. Thus in experiments involving curvatures, in view of the difficulty in obtaining really straight seedlings to start with, doubtless partly due to nutation[1], it is most desirable to have initial records before treatment; it may also be useful to record the degree and kind of curvature at successive intervals after stimulation or application of growth substance. This is, however, unsafe, with the usual technique, in which the shadowgraphs are taken with white light, since the exposure itself induces curvature. Schneider and Went[1] therefore constructed their ingenious "photokymograph"; but this is only suitable for *decapitated* coleoptiles and for curvature but not growth measurements: it is, moreover, somewhat elaborate for routine or class use. The essence of the present technique is simply to use more-or-less panchromatic photographic paper for the successive shadowgraphs, and to make the exposures with light passed through an orange or red filter such that no phototropic or growth response can be detected even when the photographically necessary exposure is multiplied many times. These requirements have been met by the use of Kodak RP 15 "Reflex" paper and light from a tungsten filament lamp passed through a single layer of 'Chromex 2202/C10' orange cellulose acetate filter which has a cut-off at about 0·530 μ wave-length and a high transmission throughout the red. With a total intensity, at the position occupied by the seedlings, of 0·08 foot-candles, adequate shadowgraphs can be obtained with one minute's exposure. One hour's exposure of intact seedlings under these conditions has been found to cause no detectable growth response or subsequent curvature. It should therefore be safe to take a long series of successive records of the same seedlings.

With a double layer of the somewhat more red filter, 'Chromex 2436/C10', giving a cut-off at about 0·580 μ, and the somewhat higher total intensity of 0·48 foot-candles, an hour's exposure was found in one experiment to cause a slight but definite subsequent phototropic response. This indicates the importance of specifying not merely the colour but also the intensity and duration of the illumination in coleoptile experiments, a matter which is often overlooked; and it may, in fact, be doubted whether any wave-length in the visible spectrum is entirely inactive in affecting the growth and tropic curvature of the *Avena* seedling[2].

All the above results are for seedlings grown in deep red light (wave-length > 0·63 μ, total intensity about 0·17 foot-candles) and it must not be assumed that the technique developed would be safe for seedlings grown in complete darkness.

Full details of this work will be published elsewhere.

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Iron/Sulphide Ratios in Corrosion by Sulphate-reducing Bacteria

THE stimulation of iron corrosion under anaerobic conditions by *Vibrio desulfuricans* is well known, and the organism has recently been shown[1] to be a facultative autotroph. Several laboratory investigations of this type of corrosion have been described[2–4]. But, to our knowledge, there has, as yet, been no published comparison of the corrosion under heterotrophic and under autotrophic conditions. We have felt that such a comparison should throw further light on the mechanism of this type of corrosion and on the explanation first proposed by von Wolzogen Kuhr[5]. This worker considered that the stimulation of corrosion was due to the utilization by the bacteria of cathodically produced hydrogen, by which the corrosion reaction would otherwise be polarized.

$$4Fe + 8H^{+} \rightarrow 4Fe^{++} + 8H \quad \text{(corrosion)}$$
$$8H + SO_4'' \rightarrow 4H_2O + S'' \quad \text{(bacteria)}$$
$$Fe^{++} + S'' \rightarrow FeS.$$

From these equations von Wolzogen Kuhr showed that, if no organic hydrogen donors were present and the hydrogen for sulphate reduction came solely from iron corrosion, then the ratio $\frac{\text{total Fe corroded}}{\text{Fe present as FeS}}$ should have a value of 4. This ratio is closely related to the ratio

$$N = \frac{\text{gm. atoms Fe corroded}}{\text{mol. } SO_4'' \text{ reduced}},$$

and this, as may be seen from the equations, should also have a value of 4, if von Wolzogen Kuhr's mechanism is correct and if no organic hydrogen donors are present. The presence of such hydrogen donors, as in heterotrophic medium, should result in additional reduction of sulphate, not accompanied by corrosion, leading to values of N lower than 4. In no case, however, should values greater than 4 occur, as this would imply more iron corrosion (and, therefore, hydrogen production) than that corresponding to the amount of sulphate reduced.

For our experiments, we used specimens of Armco ingot iron, 6·5 cm. × 1·25 cm. × 0·05 cm. These were exposed to the activity of the bacteria in test-tubes containing exactly 12 c.c. of suitable media, the test-tubes themselves being contained in closed vessels in which anaerobic conditions could be maintained. The basic medium used for experiments under autotrophic conditions was of the following composition: 1 gm. dipotassium hydrogen phosphate, 1 gm. each of ammonium and sodium sulphates, 0·1 gm. calcium chloride ($CaCl_2.6H_2O$), 2 gm. magnesium sulphate ($MgSO_4.7H_2O$) and 1 litre of water. For experiments under heterotrophic conditions, sodium lactate was added to this medium, concentrations of 2·3 gm./l. and 8·1 gm./l. being used. The *p*H of the media was about 7·1 after sterilization. The atmosphere in the anaerobic vessels consisted of nitrogen and carbon dioxide, the latter being at a partial pressure of about 0·3 atmosphere, which was maintained by a solution containing sodium carbonate, sodium bicarbonate and pyrogallol. This solution was contained in the base of the anaerobic vessels and had a *p*H of about 8·6. It also ensured oxygen-free conditions. The experiments were carried out for periods of 8–56 days. The iron specimens, after abrasion and degreasing, were weighed before the experiment and again at its conclusion, after removal of corrosion products by washing and cathodic treatment in ammonium citrate solution. Residual sulphate in the culture liquids was determined gravimetrically as barium sulphate, and the consumption of sulphate was calculated by subtraction from the original sulphate content of the medium. We were thus able to calculate values of the ratio N.

We found, under heterotrophic conditions, values of N ranging from 0·9 to 1·5. In view of the relatively large amount of easily oxidizable lactate present, this result can be regarded as in accord with expectation. In autotrophic medium, however, we obtained values from 5 to 9. By decreasing the sulphate concentration in the medium to 18 mgm./l., we were even able to obtain values of N as high as 48.

We feel that the demonstration, under autotrophic conditions and with pure cultures, of ratios greater than the theoretical limiting value predicted by von Wolzogen Kuhr's theory is of considerable interest. It indicates that, under the conditions of the experiments, only part of the hydrogen liberated in the corrosion of iron is utilized for sulphate reduction. The remainder of the hydrogen may be accounted for by: (1) evolution as hydrogen gas; (2) reduction of carbon dioxide in building up cellular material; (3) reduction of carbon dioxide to synthesize organic compounds not suitable as hydrogen donors for the bacteria. With regard to (2), the quantity of cellular material formed seemed insufficient to provide an explanation. Of the other possibilities, our present views tend to favour (1). This contention is supported by the results of mass-spectrometer analyses of samples of gas taken from the anaerobic vessels at the end of corrosion experiments. These analyses showed the presence of significant amounts of hydrogen, in the case both of autotrophic-medium and of heterotrophic-medium experiments. We have also carried out corrosion experiments in sterile autotrophic medium, under anaerobic conditions: in this case, any corrosion must necessarily be accompanied by the evolution of hydrogen. We found that the corrosion-rate in such experiments was not significantly different from that in inoculated autotrophic experiments.

It would seem, therefore, that in autotrophic medium the ratio *N* is merely a measure of the extent to which the bacteria utilize the hydrogen liberated by iron corrosion, and that no acceleration of corrosion is produced by such hydrogen utilization. Further support for this view arises from potential measurements, to be reported separately, in which we have studied the influence of inoculation with sulphate reducers on the corrosion potential taken up by an iron electrode in air-free autotrophic medium. These measurements revealed no significant cathodic depolarization. We therefore consider that the acceleration of corrosion caused by sulphate reducers in heterotrophic medium is not due to the removal of hydrogen, but to some other action of the bacteria. It seems likely that it is in virtue of their sulphide-producing action that the bacteria stimulate corrosion. This point will be dealt with further in the publication on potential measurements.

Permission to publish this note has been granted by the South African Council for Scientific and Industrial Research.

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Sept. 24.

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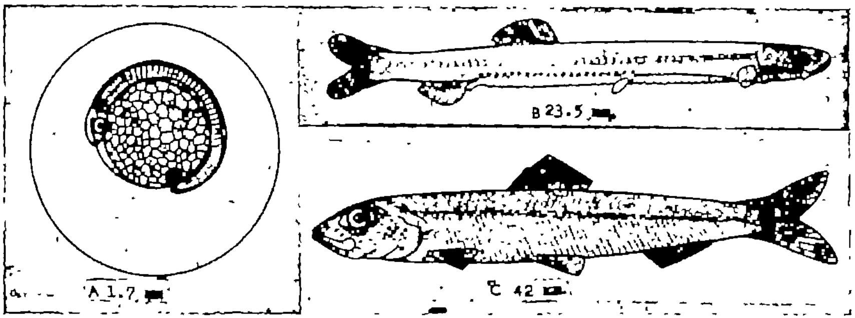
Breeding of Pilchards off the West Coast of South Africa

It was recently stated by T. J. Hart and N. B. Marshall in *Nature* of August 18 (p. 272) that the breeding ground of the pilchard, *Sardina sagax* (Jenyns), had been found off the coast of South-West Africa by the R.R.S. *William Scoresby*. Large numbers of eggs and larvæ were found in March and smaller concentrations in September of 1950.

During the course of investigations started in April 1950, and carried out by the Union of South Africa Fisheries Research Division's R.S. *Africana II*, the pilchard was found to have spawned off the west coast of South Africa over a large area. This area lies between 32° S. and 34° 25′ S., that is, between Lamberts Bay and Cape Point, a distance of approximately 140 nautical miles, and extends from 3 to 90 nautical miles from the coast in depths between 0 and 100 metres. Spawning took place over the period August 1950–February 1951.

A developmental series from the recently fertilized ovum through to the juvenile fish has been obtained. Three of these stages are shown in the accompanying illustrations.



Stages in the life-history of the pilchard (*Sardina sagax*). (*A*) Developing egg, diameter 1·7 mm.; (*B*) late post-larva, total length 23·5 mm.; (*C*) juvenile pilchard, total length 42 mm. These ova and larvæ were found under the following conditions:

	0 Metres	0–50 Metres
Temperature range	14·1–18·4° C.	11·4–18·0° C.
Salinity range	35·0–35·6‰	34·9–35·5‰
Phosphate range	0·23–0·78 P mgm.-atoms/m.³	0·30–1·45 P mgm.-atoms/m.³

Hitherto, it has been impossible to carry out artificial fertilization of the pilchard. This is due to the fact that female pilchards in a ripe and running condition have not so far been caught in South African waters. Data on counts of ova and larvæ, condition of gonads in mature fish from commercial catches and analyses of changes in condition factors show that the spawning season of the pilchard caught in South African waters is mainly in spring and summer, that is, from August to February, with greatest activity in January. It may be mentioned, however, that in no instance have large numbers of either ova or larvæ been obtained, and it is therefore thought that spawning in this area may well be incidental to the presence of great numbers of fish, and that the main focus of spawning of this species lies elsewhere. Unfortunately, no data on the South-West African pilchard are available for comparison with those of the fish caught in Union waters, and it is therefore not certain whether there are two distinct populations or a single population of varying density. The findings of the *William Scoresby* may therefore be an indication of the main spawning area of the species or another example of incidental spawning. It has shown without doubt, however, that there is a very extended area in which the pilchard may spawn.

The main planktonic organisms found in association with pilchard eggs and larvæ have been found to vary considerably. At times *Sagitta* has been the dominant organism; but eggs and larvæ have also been found in association with *Ctenophores* (*Pleurobrachia*), *Doliolum* and Copepoda. *Cladocera* have been present but only on a few occasions.

It may be mentioned that large numbers of ova, larvæ and juvenile stages of the Cape anchovy *Engraulis japonicus* (Houttyn) have been found in the St. Helena Bay area 1–100 nautical miles offshore. This may prove to be the main spawning ground of this species.

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Antennæ and Mating Behaviour in *Drosophila melanogaster*

THE gene 'antennaless' of *Drosophila melanogaster* does not necessarily express itself fully in individuals homozygous for it[1]. In the course of a programme of work designed to isolate, by means of inbreeding and/or selection, a series of families all homozygous for this gene, but differing in degree of exhibition by reason of the various gene milieux present in the various families, it was noticed that high exhibition lines were conspicuously difficult to maintain. In view of the known chemoreceptive function of the antennæ in insects in general[2] and in *Drosophila* in particular[3], and the importance of the antennæ in the mating behaviour patterns of various species, experiments were started to see whether the poor results obtained with high exhibition lines could be ascribed to failure of adequate mating responses consequent upon absence of stimuli normally reaching the animal *via* these organs. Evidence that males were attracted to females by olfactory stimuli had not been obtained in previous experiments[3].

Three main types of individuals occur in cultures of antennaless stock: those with two antennæ (A_2), one antenna (A_1) and no antennæ (A_0). It is thus possible to set up nine different sorts of mating with respect to two parents. One hundred such 1 × 1 matings were tried for each mating type, and the percentage of successful (that is, fertile) matings was recorded. Results are shown in Table 1.

Table 1

Mating	Total crosses	Successful matings (per cent)
A_0 ♂ × A_0 ♀	100	6
A_1 ♂ × A_0 ♀	100	31
A_2 ♂ × A_0 ♀	100	46
A_0 ♂ × A_1 ♀	100	44
A_1 ♂ × A_1 ♀	100	63
A_2 ♂ × A_1 ♀	100	69
A_0 ♂ × A_2 ♀	100	32
A_1 ♂ × A_2 ♀	100	72
A_2 ♂ × A_2 ♀	100	75

Statistical analysis indicates that it matters little whether an animal has one or two antennæ. What is important is that it should possess at least one antenna. This point is perhaps best made by arranging the crosses in terms of whether neither, one or both parents are antennaless. Such an arrangement is shown in Table 2, where A^- represents a male or female without antennæ, A^+ a male or female with one or two antennæ.

Table 2

Mating	Successful matings (per cent)
$A^- \times A^-$	6
$A^- \times A^+$	31–46
$A^+ \times A^+$	63–75

If we leave aside at present the rather unlikely possibility that the suppression of antennæ in an individual fly is always associated with a corresponding structural or physiological abnormality of the sexual apparatus, we must conclude that the antennæ in *Drosophila* play an important, but as yet undetermined, part in mating behaviour. Their precise function is being investigated at present, and results will be fully published elsewhere.

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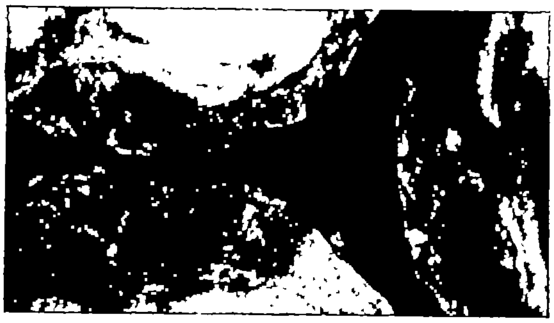
An *Odostomia* attacking Oysters

A DETAILED account has recently been given[1] of the structure and mode of life of several members of the Pyramidellidæ. It has been shown that they are parasitic and feed by sucking the juices of lamellibranchs and tube worms. The normal hosts are known for only a small number of species, principally of the genus *Odostomia*.

The first species recognized as a parasite was *Odostomia eulimoides*, stated by Jeffreys[2] to occur "chiefly (if not only) on the ears of *Pecten opercularis* and *P. maximus*, in the coralline zone; it is widely distributed and rather common". This description of its mode of life was repeated by Fretter and Graham in their review of the family. It was of interest, therefore, to find the same species attacking oysters in the River Roach, Essex. A sample of a hundred two-year-old native brood oysters dredged from near Paglesham in early June 1951 contained no less than 46 which showed evidence of attack, and many of them actually contained living *Odostomia* when opened at Conway.

The parasites were lodged in small pockets just inside the ventral margin of the shell (see photograph). These pockets result from the withdrawal of the mantle in response to the irritation caused by the proboscis of the parasite during feeding. Apparently the parasites are sedentary, and as a result of continual attack at one point both the right and left mantles are more or less permanently withdrawn for a short distance from the free edge of the shell. In consequence, new shell is laid down in an arc some distance inside the ventral margin and a permanent pocket develops. The parasites occurred mainly in pairs; but in one pocket three were found. Several pockets contained no parasites; but as the oysters had been dredged in Essex, washed, packed and dispatched by post to Conway, some loss during these processes must be expected.

Normally, only one pair of parasites occurred in a single oyster, but one was found with two pockets



Ventral margins of three shells of *Ostrea edulis* attacked by *Odostomia eulimoides*. The parasites are shown *in situ* with hatching spawn alongside. × 2

each containing a pair of *Odostomia*. In many pockets spawn had been deposited and was about to hatch; it appears as a fine granular deposit alongside the parasites.

Although *Odostomia* cannot be regarded as a major parasite of oysters, its attack on the scale recorded must result in considerable irritation, some loss of condition and possibly small permanent malformations. That the irritation is intense is shown by the deposit of patches of conchiolin at the points of attack; such deposits are also laid down in oysters heavily attacked by *Polydora*[3].

It is interesting to note that, in the River Roach, species of *Pecten* or *Chlamys*, the usual hosts of *Odostomia eulimoides*, are absent; apparently it can attack a wide range of lamellibranch molluscs.

I am indebted to Dr. Vera Fretter for the determination of the species of the parasite and to Mr. H. P. Sherwood for the photograph.

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Colour Vision of an Albino

According to Gates[1] the frequency of pure albinos is about 1 in 15–25,000 of the population in Scotland. Owing to the kindness of Miss E. C. MacQuade, an albino woman aged about 45–50 years was brought for colour vision tests. She was a pure albino, according to Gates's classification, having cream-white hair, eyebrows and eyelashes, and only a very slight trace of pigment in the iris. She had a continuous nystagmus owing to photophobia, and a divergent squint, for the same reason, using mainly the left eye while the unused eye wandered. She was very short-sighted. Her mother had fifteen children, seven boys and eight girls. She and a younger sister, now deceased, were the only albinos known among all her relations.

Her colour vision was tested with Pickford's four-colour test[2] and the Ishihara test. She was almost red anomalous, without darkening of the red, since the Rayleigh equation for her fell between those of the normal and of the red anomalous shown by Pickford in his Diagram 32 [2]. Her red–green matching range was normal, but she was on the first occasion of testing a yellow deviant. On the second occasion, about three weeks later, her red–green vision was the same, but she was now very blue–yellow weak, with three times the blue–yellow modal matching range. She failed on the Ishihara test, with 15 errors on 24 plates.

Her son and one sister were also tested, and their colour vision was quite normal. Owing to death, age, infirmity or difficulties due to residence and occupation, it was not possible to test any more of her relatives at the time, though further efforts will be made. It is impossible to say definitely whether the red anomaly and the blue–yellow weakness were due to the effects of the albinism or separately inherited.

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The *Rh* Chromosome C^wdE (R_y^w) occurring in Three Generations

Fisher and Race[1] postulated the existence of the gene combination CdE, and to date four examples have been found (van der Bosch[2], Wiener[3] and Johnson[4]).

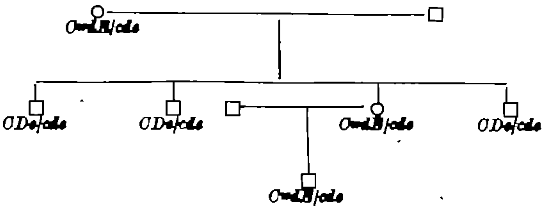
Race *et al.*[5], after reporting the discovery of the Willis antigen, further postulated the existence of the combination C^wdE, but until now this exceedingly rare blood group has not been found. This communication reports the finding of the genotype C^wdE in three generations.

The blood of the propositus—Mrs. "O", an antenatal case—gave no reaction with anti-D sera but was agglutinated with anti-C, anti-E and anti-c. Therefore, her genotype was either Cde/cdE or CdE/cde, which are serologically indistinguishable. Samples of blood from her relatives were investigated with all available sera, including anti-C^w, and a study of the results showed her to be of the genotype C^wdE/cde.

The possibility of the propositus or her relatives having a D^u antigen (Stratton[6]) was excluded by testing their cells with a series of twenty incomplete anti-D's followed by anti-human globulin serum to detect sensitization.

In forecasting the genotype CdE/cde, Fisher[1] estimated its frequency should be about 37 in a million, or that one in eight of bloods behaving as Cde/cdE would, in fact, be CdE/cde. It is interesting to note that we have examined bloods from the families of seven persons behaving as Cde/cdE or CdE/cde, and Mrs. "O" is the first of the type CdE/cde to be found among them.

The frequency of Mrs. "O's" Rhesus genotype can only be estimated approximately. In its commoner combinations, the C^w allelomorph is about fifty times less frequent than C, so on this basis the chromosome C^wdE should occur about twice in a million. There



are, however, no strong grounds for expecting the same proportion in the rarer groups; and until we know more, perhaps as many as one in five of the rare chromosomes *CdE* should be regarded as C^wdE.

Mrs. "O'g" blood groups are: O, H+ve, C^wdE/cde, $MsNS$, P, $Le(a-b+)$, $Lu(a-)$, kk, $Jk(a+)$.

We should like to express our thanks to Lieut.-Col. R. H. Malone, director of these laboratories, for permission to publish this communication, to Dr. R. R. Race for his criticism, to Prof. R. A. Fisher for his advice on frequencies, and to Miss E. W. Ikin, Blood Group Reference Laboratory, Lister Institute, London, for confirmation of our findings.

Note added in proof. Since submitting this communication for publication, the *Rh* chromosome *CdE* (R_y) has been proved to exist in two other families; see Grove-Rasmussen, M., *et al.*, *Ann. Eug.*, 16, Pt. 2, 131 (1951); and Sussman, L. N., and Wald, N., *Amer. J. Hum. Genet.*, 2, 85 (1950).

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Relative Importance of Free α- and ε-Amino Groups for the Biological Activity of the Growth Hormone

THE biological activity of growth hormone[1] is found to be greatly reduced following treatment with acetic anhydride, which is known to acetylate protein amino groups specifically[2]. The relative importance of free α- and ε-amino groups has not hitherto been investigated. Purified growth hormone has now been acetylated according to the conditions of Li and Evans[1], but with smaller amounts of acetic anhydride so as to avoid complete inactivation.

The fluorodinitrobenzene technique of Sanger[3] was applied to untreated growth hormone in the first instance. The α-dinitrophenyl amino-acids liberated by acid hydrolysis were extracted with ether, and, after passage through a silica gel column, were identified by paper chromatography as dinitrophenylalanine and phenylalanine, in accordance with the results obtained by Li and Porter[4] in a preliminary study of the terminal amino groups of growth hormone. Spectrophotometric determination of the α-dinitrophenyl amino-acids was carried out on the eluate from the column. The ε-dinitrophenyl lysine hydrochloride remaining in the ether-extracted hydrolysate was estimated spectrophotometrically after passage through an acidic silica gel column.

DATA FOR ACETYLATED GROWTH-HORMONE PREPARATIONS

Acetic anhydride moles per mole of growth hormone	Residual free amino groups per mole of growth hormone*		Growth-promoting potency, % of original potency
	Alanine + phenylalanine	Lysine (ε)	
—	1·4	19	(100)
120	<0·1	15·5	53
800	<0·1	13·5	20
2,700	<0 1	9·5	11

* Not corrected for losses in hydrolysis, etc.

When acetylation was performed with a relatively small amount of acetic anhydride, no α-dinitrophenyl amino-acids could be detected following fluorodinitrobenzene treatment of the acetylated product (see table). There was, however, only a partial reduction in the ε-dinitrophenyl lysine content of the hydrolysate and only partial loss of growth-promoting activity (assayed in intact female rats[5]). With larger quantities of acetic anhydride, there was a marked lowering of growth-promoting activity concomitant with increased acetylation of ε-amino groups, as shown by the ε-dinitrophenyl lysine determinations (see table). It thus appears that the growth-promoting activity of the growth hormone depends on the integrity of the ε-amino groups, but not on that of the terminal α-amino groups. The acetylated products were assayed for diabetogenic activity in the intact cat, as will be reported elsewhere. The results indicated that the diabetogenic activity of growth hormone also depends on the presence of ε-amino groups, but not on that of the α-amino groups.

The finding that acetic anhydride can be employed to acetylate selectively the free α-amino groups of growth hormone may be applicable to other proteins possessing both free α-amino groups and free ε-amino groups.

I am indebted to the Beit Memorial Trust for the award of a fellowship, to Dr. F. Sanger for advice on the use of his technique, and to Prof. F. G. Young for helpful advice and criticism.

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Bacterial Enzyme Preparations oxidizing Inositol and their Inhibition by Colchicine

PREVIOUS studies in this laboratory have brought to light a number of regularities governing the oxidation of isomers of the inositol group by resting *Acetobacter suboxydans*[1,2]. If the hexahydroxy *cyclo*hexanes are formulated as existing in the chair configuration, the minimum steric requirements for the oxidation of the various isomers by the resting cells are described in the statement that only those hydroxyl groups are oxidized that are situated in a polar plane.

The study of many aspects of these oxidative reactions required enzyme preparations in the cell-free state[3]. A thick suspension in 1/15 *M* phosphate buffer (*p*H 6·4) of the organisms, grown and harvested as described previously[1], was passed through a bacterial mill (Unicam, Cambridge). About one-half of the cells was broken. After centrifugation of the mixture (30 min., 2,000 *g*) and re-extraction of the sediment with buffer on a vibrator (60 vibrations per sec.) for 12 hr., followed by an intermediate centrifugation cycle at 11,000 *g* (1 hr.), the combined supernatants were finally centrifuged at 20,000 *g* for 2 hr. The reddish-brown pellet was suspended in phosphate buffer of *p*H 6·4. All operations were carried out in the cold.

The oxidation of glucose to gluconic acid and of sorbitol to sorbose are among the well-known activities of resting *Acetobacter suboxydans*. The first function was retained in the cell-free enzyme preparations. Glucose was attacked with the consumption of 1 gm.-atom of oxygen per mole of substrate. During the oxidation the *p*H changed from 6·4 to 5·8; neither carbon dioxide nor lactic acid was formed. Sorbitol, however, was not oxidized.

The abilities of the organisms to oxidize *meso*-, *d*- and *epi*-inositol, *d*-quercitol and *dl*-*epi*-inosose all were preserved in the cell-free enzyme preparation, but not without the presence of an additional factor, which was, however, not required for the oxidation of glucose. Suspensions of the pellet alone oxidized *meso*-inositol only very slowly. The addition of washed, heat-inactivated *Acetobacter* cells accelerated the reaction very markedly. 1 gm.-atom of oxygen was consumed by 1 mole of *meso*-inositol. Although the monocarbonyl or dicarbonyl derivatives, previously shown to be formed from the various stereoisomers by the resting organisms[3,4,5], were not isolated, the manometric experiments left little doubt that the same reaction products were formed by the isolated enzyme system. The latter, as was previously also found with resting cells[6], failed to attack pinitol, a methyl ether of *d*-inositol.

The enzyme preparations were completely inactivated by heating (20 min., 80°). The *p*H optimum at 36° (in phosphate or veronal buffer) was at 6·4. The Michaelis constant was 0·0036 *M* (compare curve *A* in Fig. 1). Saturation of the enzyme system was achieved when 3–4 mgm. (dry weight) of the enzyme preparation and 20–30 mgm. of heat-inactivated cells were contained in 3 c.c. of a 0·0365 *M* solution of *meso*-inositol in buffer. Potassium cyanide, in a 0·001 *M* concentration, totally inhibited the enzyme system.

What appears to be a more specific inhibition was discovered when it was found that colchicine and some related compounds containing a seven-membered ring prevented the oxidation of the inositols, but not of glucose, by the isolated enzyme preparations. (No effect on intact resting organisms was observed, owing, probably, to the slowness of permeation.) Several representative experiments are assembled in Figs. 1 and 2. This inhibition seems to be non-competitive. Both the slopes and the intercepts increased with increasing concentrations of colchicine, when the reciprocals of the velocity constants were plotted against the reciprocals of substrate concentration (Fig. 1). Experiments with varying concentrations of the components of the complete enzyme system showed that the effect of colchicine was exerted on the cell-free enzyme itself and not on the additional heat-stable factor. A fivefold increase in the concentration of the latter doubled the rate of oxygen uptake, but scarcely changed the extent of inhibition.

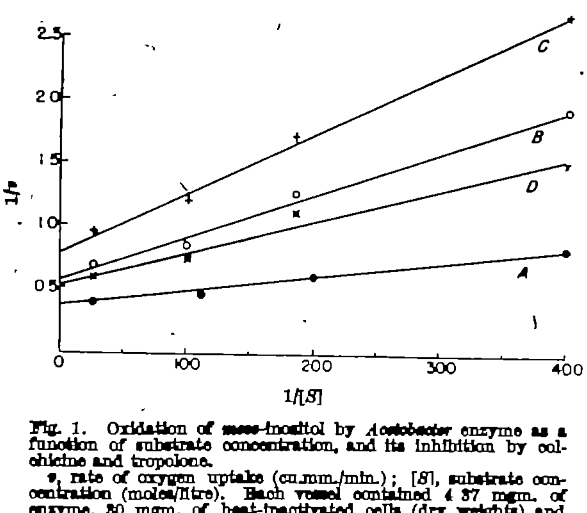

Fig. 1. Oxidation of *meso*-inositol by *Acetobacter* enzyme as a function of substrate concentration, and its inhibition by colchicine and tropolone.

v, rate of oxygen uptake (cu.mm./min.); [*S*], substrate concentration (moles/litre). Each vessel contained 4·37 mgm. of enzyme, 30 mgm. of heat-inactivated cells (dry weights) and varying amounts of substrate in a total volume of 3 c.c. of 1/15 *M* phosphate buffer (*p*H 6·4, 36°). Curve *A*, no inhibitor; curve *B*, 0·0033 *M* colchicine; curve *C*, 0·0066 *M* colchicine; curve *D*, 0·0056 *M* tropolone. In the inhibition experiments, the enzyme was left in contact with the inhibitor for 20 min. at 36°, before the substrate was added

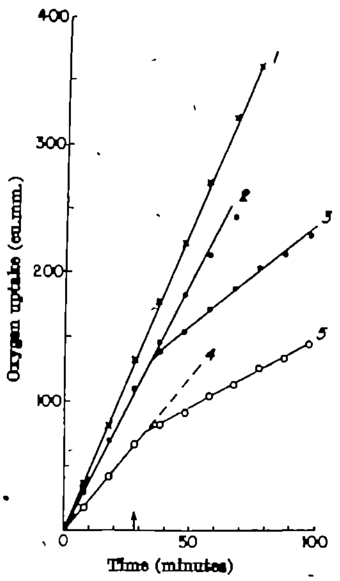

Fig. 2. Effect of colchicine on the oxidation of glucose (curve 1), *meso*-inositol (curves 2 and 3), and *d*-inositol (curves 4 and 5) by *Acetobacter* enzyme.

Each vessel contained 3·8 mgm. of enzyme and 25 mgm. of heat-inactivated cells (dry weights) in 3 c.c. of buffer. The concentration of colchicine, added 28 min. after the beginning of the experiments (indicated by arrow), was 0·0067 *M*. Substrate concentrations: glucose, 0·019 *M* (curve 1, with and without inhibitor); *meso*-inositol, 0·0089 *M* (curve 2 without, curve 3 with inhibitor); *d*-inositol, 0·0081 *M* (curve 4 without, curve 5 with inhibitor)

Preliminary results indicate that simpler *cyclo*heptane derivatives[6], namely, tropolone[7–9] and 4,5-tetramethylene tropolone, have a similar inhibiting effect on the oxidation of inositols (compare curve *D* in Fig. 1). At the level of enzyme-saturation, tropolone inhibited the system almost completely at a 0·011 *M* concentration and to the extent of 60 per cent at a 0·0056 *M* concentration; 0·0067 *M* colchicine showed a 70 per cent inhibition. The oxidation of smaller quantities of substrate (0·018 *M* *meso*-inositol solution) was completely blocked by 0·006 *M* colchicine.

It would be premature to construct analogies between the effects described here and the well-known action of colchicine as a mitotic poison. It may, however, not be entirely irrelevant that recent work in this laboratory has shown *meso*-inositol to have a specific effect in preventing colchicine from producing metaphase arrest[10,11].

We are greatly indebted to Drs. Doering and Knox for supplying the tropolone specimens and to Hoffmann–LaRoche, Basle and Nutley, for a supply of colchicine. This work, which will be presented in detail at a later date, has been supported by grants from the American Cancer Society, on the recommendation of the National Research Council Committee on Growth, and from the Nutrition Foundation.

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Dephosphorylation of Adenosine Triphosphate in Muscular Contraction

CONTEMPORARY views on the role of adenosine triphosphate in contractile activity include the assumption that the breakdown of this substance is the immediate chemical source for mechanical energy[1,2]. However, as has recently been emphasized by A. V. Hill[3], there is no proof that such a dephosphorylation occurs as an early event in contraction. Furthermore, it has been shown[4] that the effects of adenosine triphosphate upon certain physical properties of actomyosin do not primarily involve splitting of the nucleotide. The experiments reported here were undertaken in order to decide whether, indeed, any dephosphorylation of adenosine triphosphate occurs during the contractile phase of a twitch.

It appears unfavourable to attempt the detection of a diminution of adenosine triphosphate by analysis of the hydrolysable phosphate (compare Lundsgaard[5]), since one would have to evaluate small differences between large numbers, which might furthermore be distorted by the formation of other labile phosphate compounds. Instead, we have employed a chromatographic assay method, closely resembling that of Cohn[6], to determine adenosine mono-, di- and triphosphate separately by their ultra-violet absorption.

The experiments were carried out with the combined leg muscles of frogs. Muscles from the two legs were isolated, care being taken to subject the two sets to the same manipulations. Starting at a temperature of about 20° C., one set was immediately extracted with ice-cold 1 *N* perchloric acid, whereas the other set was fixed at the height of contraction by sudden submersion into liquid air (compare Lundsgaard[5]). The results are shown in the accompanying table.

It is seen that in contraction there is a pronounced decrease of adenosine triphosphate, and that its breakdown goes in part beyond the stage of the diphosphate, probably by the myokinase mechanism. The decrease of adenosine triphosphate averages about one-fifth of the total nucleotide, which is about twice the expected amount[7]. If confirmed, this would indicate that precipitous cooling mobilizes the contractile apparatus to a somewhat greater extent than occurs physiologically in a single twitch, or else that in this mode of stimulation part of the muscle twitches more than once. We intend to study various other ways of eliciting contraction in different types of muscles.

DISTRIBUTION OF ADENINE NUCLEOTIDES AS A PERCENTAGE OF THE TOTAL NUCLEOTIDE FRACTION, FOR FROG MUSCLE AND (LAST LINE) FOR RABBIT PSOAS MUSCLE

Control			Contracted			Difference		
AMP	ADP	ATP	AMP	ADP	ATP	AMP	ADP	ATP
7·5	14·5	78·0	9·0	26·8	64·2	+1·5	+12·3	−13·8
6·3	13·5	80·2	10·0	15·9	74·1	+3·7	+2·4	−6·1
8·6	14·0	77·4	5·5	37·4	57·1	−3·1	+23·4	−20·3
8·6	44·7	46·7	14·8	55·8	29·4	+6·2	+11·1	−17·3
5·3	22·3	72·4	6·0	44·9	49·1	+0·7	+22·6	−23·3
12·8	12·2	75·0	16·8	39·8	43·4	+4·0	+27·6	−31·6
2·2	12·7	85·1	5·2	16·2	78·6	+3·0	+3·5	−6·5

In sustained muscular activity, and possibly also in a completely reversed twitch, a breakdown of phosphocreatine rather than of adenosine triphosphate is generally detected (see ref. 2). Our present results suggest, however, that it is primarily adenosine triphosphate which is dephosphorylated in the contractile phase. Apparently, a transfer of phosphate from phosphocreatine to adenosine di- and monophosphate by the Lohmann reaction[8] occurs only in later phases of the contractile cycle. We suggest that actually the Lohmann reaction is specifically connected with relaxation.

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Transaminases in *Neurospora crassa*

THE presence of a wide range of transaminases in both animal tissues[1] and bacteria[2] has recently been reported. A rather similar array of enzymes appears to be present in the mould *Neurospora crassa*.

Mycelium of the wild-type strain *E5297a* was grown for three days at 25° in 'minimal' Fries No. 3 medium, and cell-free extracts were obtained by grinding with phosphate buffer and powdered glass followed by centrifugation as described in detail elsewhere[3]. The extracts, which were free of large particles but turbid owing to the presence of small particles just visible under the high power of the microscope, were dialysed against cold $M/15$ phosphate at *p*H 7·4. Dialysed extracts contained about 1 mgm. of nitrogen per ml.

The formation of glutamate following the incubation of extracts with α-ketoglutarate and different amino-acids was shown by paper chromatography of the deproteinized digests[4], phenol saturated with water being used as the running solvent. It was possible to obtain a roughly quantitative estimate of the glutamate formed by visual comparison of the experimental glutamate spots with a graded series of glutamate standards chromatographed under identical conditions. Glutamate concentrations were recorded as either intermediate between two standards or as approximately equal to one of the standards when they could not be seen to differ from it in intensity.

Table 1. Test-tubes each containing: 0·45 ml. $M/15$ L-Amino-acid; 0·15 ml. $M/5$ Sodium α-Ketoglutarate at *p*H 7; 0·40 ml. Mycelial Extract Dialysed against $M/15$ Phosphate at *p*H 7·4. Incubation at 34° for 3 hr.

Amino-acid	Conc. of glutamate (millimoles/l.)	Amino-acid	Conc. of glutamate
Water control		L-Tryptophan	2–3
(a) Zero time	0	DL-Methionine	3
(b) Incubated	1–2	DL-α-Aminobutyric acid	4–6
Glycine	2	DL-*nor*Valine	6
L-Lysine	1–2	DL-Valine	10
L-Serine	1–2	DL-*nor*Leucine	10
DL-Threonine	1–2	L-*iso*Leucine	10–13
L-Proline	1–2	L-Leucine	10–13
L-Cysteine	1–2	L-Aspartate	13*
L-Histidine	2	L-Alanine	16†

* Some alanine also formed. † Approximating to 50 per cent transamination.

All amino-acids tested showed some degree of transamination except glycine, serine, threonine, lysine, histidine and cysteine, which, if they reacted at all, gave less than 3 per cent transamination during three hours. The apparent small formation of glutamate in the cases of methionine and tryptophan was confirmed in repeated experiments. It has been found repeatedly that incubation of *Neurospora* extracts with α-ketoglutarate and ammonium chloride yields no glutamate under the conditions of these experiments.

To determine whether the transaminases were attached to particles (as found by Hird and Rowsell) or present in solution, a turbid extract obtained by the usual procedure was filtered by suction through a 4-mm. pad of kieselguhr to give an opalescent solution free of particles. As shown in Table 2, the greater part of all the transaminases tested were found to be present in the filtrate; part, at least, of the loss of activity on filtration can be attributed to dilution by moisture present in the filter pad. This experiment, and many others involving relatively short incubation times, shows that transamination at *p*H 7·4 is most rapid with alanine as the amino donor.

In addition to the amino-acids listed in the tables, ornithine has been shown to be acted upon by a *Neurospora* transaminase, its effectiveness as an amino donor being about equal to that of *nor*valine in the type of experiment outlined above.

It was found that amino-group transfer to α-ketoglutarate from *iso*leucine, ornithine or phenylalanine was more rapid at *p*H 8 than at either *p*H 7 or *p*H 9, while in the case of aspartate the reaction was rather more rapid at *p*H 9 than at *p*H 8. At *p*H 9 aspartate reacted faster than alanine. The behaviour of alanine was strikingly different, the apparent optimum *p*H in this case being in the region of 5·5–6·0. The formation of glutamate from alanine and α-ketoglutarate was, at initial *p*H 5·5–6·0, accompanied by a rise in *p*H of about one unit, and it seems likely that the rate of decarboxylation of pyruvate was a factor contributing to the rate of transamination.

Table 2. Test-tubes each containing 0·3 ml. $M/15$ L-Amino-acid, 0·1 ml. $M/5$ Sodium α-Ketoglutarate, and 0·2 ml. Extract buffered as in Table 1. Incubation at 34° for 1 hr.

Amino-acid	Conc. of glutamate formed (millimoles/l.)	
	Extract filtered	Extract unfiltered
Water control	1	1–2
L-Alanine	12	15
DL-α-Aminobutyric acid	3–4	4
DL-*nor*Valine	4	6
DL-Valine	8–10	10
DL-*nor*Leucine	5–6	6
L-Leucine	6	8–10
L-*iso*Leucine	5–6	8–10
DL-Phenylalanine*	3	5
L-Tryptophan	1–2	1–2†
DL-Methionine	2	3
L-Aspartate	8	10

* Concentration $M/30$ of L-isomer. † More than control.

It is interesting to note that the activities of the different amino-acids in transamination *in vitro* show a rather close correlation with their effectiveness in supporting growth of 'amination-deficient' mutant strains[3] which apparently lack glutamic dehydrogenase[5] and require exogenous α-amino-nitrogen for growth. Methionine, which is a relatively very effective amino donor for the intact mould, while being acted on only slowly by extracted transaminase, is the only striking exception.

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Proteolytic Activity in Hen's Egg prior to Incubation

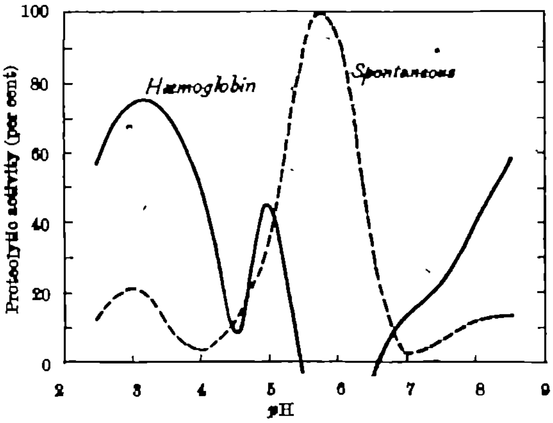
For this investigation, I used highly fertile eggs of pure breed (White Leghorn), laid in the afternoon. The eggs were stored at low temperature for a maximum of three days.

For chromatographic assay of free amino-acids, white and yolk were homogenized separately and extracted with alcohol in final concentration of 80 per cent. Two-dimensional chromatograms were run in (1) butanol – acetic acid – water and (2) phenol – water. The chromatograms were dried in an air current at approximately 50° C. and developed with ninhydrin. Munktell *OB* paper was used. For hydrolysis tests extracts were treated with 6 *N* hydrochloric acid for six hours. Chromatograms sprayed with basic copper carbonate gave no spots with ninhydrin. The results of chromatography are evident from the accompanying table.

Substance	R_F value in butanol–acetic acid–water	R_F value in phenol–water	Intensity of spots	Approx. conc. in yolk (mgm. per cent)
Peptide containing lysine	0·09	0 21	+	
Lysine*	0 07	0 35	+++	150
Aspartic acid	0·21	0·40	++	
Unknown*	0·23	0·34	+	
Arginine	0·13	0 45	+++	150
Glycine	0·22	0 45	+	
Glutamic acid	0·30	0·45	++	
Threonine	0·28	0·54	++	
Citrulline	0 20	0 64	+	
Alanine	0·34	0·58	+++	60
Unknown	0·22	0·81	+	
Tyrosine	0 46	0·64	+	
Valine	0 52	0 79	++	
Leucine	0·68	0·85	+++	100

* Obtained after hydrolysis.

The various amino-acids are all among those reported from yolk-protein[1]. In the white, there are no demonstrable free amino-acids; but in the yolk freed from the blastoderm the concentration is exceptionally high. Consequently, mobilization of amino-acids occurs in the yolk apparently independently of the embryo. For this reason it may be assumed that pre-formed proteolytic enzymes are active in the yolk.



pH-Activity of yolk proteinases in the hen's egg

For determination of this expected proteolytic activity, extracts of yolk freed from blastoderm were made with glycerol–water (30 per cent) and used immediately. As substrate undenatured hæmoglobin was used in 1 per cent solution. Merthiolate was added. Samples mixed with buffer solution (MacIlvaine's standard buffer) were incubated at 39° C. for 2 hr. The proteolysis was stopped by adding trichloracetic acid (5 per cent). Samples were examined in the spectrophotometer at 2750 A. for liberated cyclic amino-acids. Rectilineal curves were obtained for at least five hours. From the accompanying graph it is apparent that there are at least three proteinases in the yolk, acting at different pH's. The spontaneous activity around pH 6 is very high, and addition of hæmoglobin has apparently an inhibiting effect thereupon.

The work is being continued and further results will be published elsewhere.

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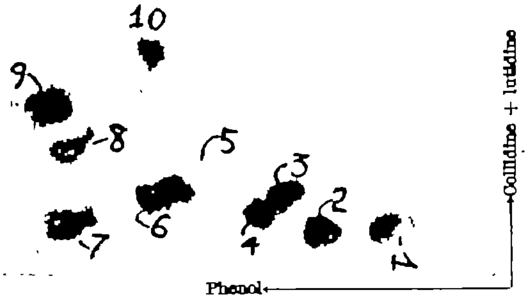
Chromatographic Analysis of Amino-acids of Molasses and other Beet-sugar Industry By-products

WE have applied chromatographic analysis to the detection of the amino-acids present in beet molasses and other by-products of the sugar-beet industry.

We used the descending paper-chromatography technique described by Consden, Gordon and Martin[1]; Whatman No. 1 paper, and the phenol, lutidine + collidine system were used. A 0·1 per cent solution of ninhydrin in butanol was used for detecting the spots.

Most of the chromatograms were obtained without any purification of exhausted molasses; in every run we used 5 mgm. of substance dissolved in distilled water (1 : 10 w/v). The chromatograms show nine spots well separated; after several trials we are able to attribute the spots to the following amino-acids: aspartic, glutamic, γ-aminobutyric, serine, glycine, alanine, valine, leucine, tyrosine. A good deal of pyrrolidone carboxylic acid is also present. This does not give a spot with ninhydrin; but the chromatograms made after treatment by acid hydrolysis of the molasses show a broader and more intense spot of glutamic acid. No traces of basic or sulphurated amino-acids were found. A detailed account of this work will be published elsewhere.

Applying a desalting procedure to the molasses solutions we obtained clearer chromatograms, with sharper spots. For this purpose we used a desalting apparatus analogous to that described by Consden, Gordon and Martin[2]. The chromatograms obtained in this way give, besides the nine spots already identified, another spot, much weaker than the others, due to threonine. The accompanying photograph is of a chromatogram obtained with desalted molasses.



(1) Aspartic acid, (2) glutamic acid, (3) serine, (4) glycine, (5) threonine, (6) alanine, (7) γ-aminobutyric acid, (8) valine, (9) leucine, (10) tyrosine

Regarding the quantity of amino-acids, in so far as the spots show, we can say that the most intense spot is that due to alanine; the γ-aminobutyric, glutamic and leucine spots follow in order of intensity. The spots due to aspartic acid, glycine, serine, valine and tyrosine are less intense.

We have found the same amino-acids in a sample of concentrated baryta-process waste liquors, and in different samples of first-run molasses.

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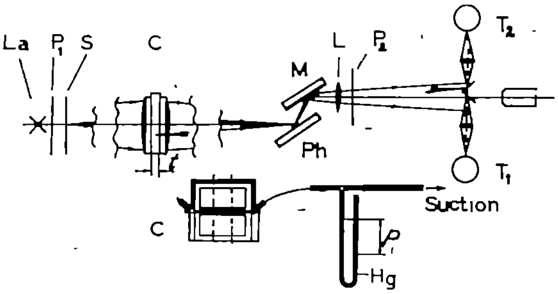
A Highly Sensitive Phase-Contrast Refractometer for Liquids and Gases

THE accompanying diagram shows the essential parts of a refractometer using the principle of phase contrast, which is new for this class of instrument. It gives relative measurements, like most of the applications of the Jamin and the Rayleigh refractometers depending on interference. The liquid or gas to be measured is enclosed in the central horizontal cell C about 1 mm. in height, the reference liquid or gas filling the upper and lower portions. The plane-parallel frame forming the middle of the cell, and made of glass, plastic or stainless steel with its plane sides lapped, is made tightly adherent to the two highly polished plano-convex lenses of selected homogeneity.



The optical system is symmetrical about this lens-like cell. An image of the entrance slit S, illuminated by monochromatic 5461 A. light from a mercury lamp, is formed by this cell on the central part of the phase mirror Ph. Then the light is passed, by means of the mirror M, through the lens L, which forms, in the plane dotted in the diagram, the phase-contrast image of the cell C. This image can be viewed by an eyepiece or a microscope. But in order to measure the intensity of a defined part of the image of the central cell, compared with the intensity of a second defined part of the image field, these two parts are projected on to the two photomultiplier tubes T_1 and T_2, respectively.

The phase mirror is based on the principle described by Françon and Nomarski[1] and modified by me[2]. To render the instrument uniformly sensitive over the whole region of measurement, it consists of several portions giving different phase-turning angles. Two 'Polaroids' P_1 and P_2 serve to determine and vary the vector origin.

According to the theory previously given[3,4], the difference of refractive index between the two liquids, $n_2 - n_1$, is determined by the intensity ratio between the two fields. This is a function of the path difference or, more exactly, of the phase difference angle $(n_2 - n_1)t.2\pi/\lambda$. It may be an arbitrary part of a complete turn, or several turns, but full details of the procedures cannot be given here, only mentioning that the number of whole turns is counted as the displacement of the zero order fringe from a double slit system as used in Young's experiment.

A very simple experiment is to make the optical path difference exactly one wave-length, that is, the phase angle exactly 2π, since it can be done visually by equalizing the intensities as in a Lummer–Brodhun photometer. The air of the central cell is pumped out, and the positions of the manometer corresponding to equal field intensities are noted. The difference of pressure equivalent to one wave-length was found to be 149 mm. of mercury; the thickness t being 10·4 mm. and the air temperature 22·4° C. This gives a refractive index of $2 \cdot 68 \times 10^{-4}$ for air of the same temperature and 760 mm. mercury pressure. When reduced to 20·0° C., the result is $2 \cdot 70 \times 10^{-4}$, which, considering the very simple means used for making the measurements, is in good accordance with the precision measurements of $2 \cdot 731 \times 10^{-4}$ [5].

In this Laboratory we measure photoelectrically with an accuracy of 0·5 per cent per amplitude in a phase-contrast field. As the vector is about unit length, the accuracy approximates to $0 \cdot 5 \times 10^{-2}/2\pi$ of a turn, or for the refractive index difference at $t = 10$ mm., which thickness contains 18,300 periods, the precision is 5×10^{-8}. This is more than ten times better than the results obtained by any interferometer[5]. An amount of at least 0·1 cm.^{3} of the liquid under examination is necessary and about 10 cm.^{3} of reference liquid. For a mixture of heavy and ordinary water, this means an accuracy of analysis of 0·001 mole per cent. Measurements have not yet been made on account of the lack of precise reference standards.

The precision can be reduced by making t smaller, and it can probably be raised by increasing it to some centimetres. This is possible with maintained focusing of the image, as the focal lengths must be rather long for other reasons. The temperature remains fairly well constant because the measuring cell is surrounded by the reference liquid and separated from it by thin walls.

I am now working with Mr. Lars Johansson, chemical engineer, to elaborate the apparatus for routine use.

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Fly Reactions to Insecticidal Deposits: a New Test Technique

MOST laboratory methods for evaluating residual insecticides involve crowding a number of flies together in rather small containers. Such crowding stimulates activity, which may cause the flies to pick up abnormal amounts of insecticide. These conditions are unnatural, and while useful and reproducible results may be obtained, their relevance to field performance is doubtful.

We have found that the difficulties can be overcome by using a 'single fly' technique, based on the exposure in a large treatment cage of one fly at a time. Interference from other flies is avoided and fly behaviour can be studied in detail. Three-day-old well-fed female houseflies, which, if undisturbed, normally remain immobile on an untreated surface for three to five hours at 24–26° C., were used in all tests.

A cubical cage of 2-ft. side forms the container, and is about the minimum size in which a fly shows no reaction to confinement. The cage consists of a light wooden frame having a paper back as the treatment surface, the sides and top covered with mosquito netting, and the bottom open and resting on a table covered with clean paper. The fly is introduced by tilting the cage, allowed to settle, and induced by tapping the sides to come to rest on the treated surface. It is then left undisturbed and watched. When it leaves the surface, and when it is knocked down, the time is recorded; the fly is caught and placed in a separate small individual cage for subsequent observation. Before and after test the flies are fed on milk and kept at 24–26° C. It was found that minor changes in environment affected the results, hence comparative tests were run concurrently in adjacent cages.

The results obtained in a typical series of tests are summarized in the accompanying table, in which averages and standard deviations are given. The tests were made with a normal strain of *M. domestica* with unglazed wallpaper as the treatment surface; there were ten replicates.

Treatment	Resting period (min.). Average and standard deviation	Time to knock-down (min.) from beginning of resting period. Average and standard deviation	Mortality % after 24 hr.
DDT dispersible powder at 250 mgm. *pp'* isomer per sq. ft.	10±2·8	See below*	20
Crude BHC dispersible powder at 25 mgm. γ per sq. ft.	22±4·8	38±7·9	100
γ BHC dispersible powder at 25 mgm. γ per sq. ft.	29±3·2	35±4·8	100

* No knockdown in eight cases; knockdown in 3½ and 24 hr. for remaining two.

The results show that consistent treatment differences can be obtained with very few flies. The most striking observation is that the flies on BHC deposits do not leave the surface until they have acquired a lethal dose, whereas the flies on DDT deposits leave the surface much earlier, and mainly survive. Before leaving the surface, the DDT flies are obviously disturbed, as shown by the frequency of cleaning operations and erratic movements, whereas the BHC flies are comparatively quiescent. This abnormal behaviour of the DDT fly persists for about an hour after the surface is left. Many similar comparisons were made and gave the same results. At 100 mgm. of DDT per sq. ft. no knockdown or kill resulted in twenty-four hours from this single contact.

Preliminary tests with *Aedes aegypti* on similar lines have shown similar results on a much reduced time-scale, and further tests with this and *Anopheles* spp. are in hand.

It is felt that differences in behaviour of this kind must operate, to some degree, in the field and that, therefore, laboratory data obtained by this method can be of help in interpreting and predicting field results. The study of such differences in behaviour may throw light on the development of resistance by insects to certain chemicals.

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Gravitation in Kinematic Relativity

A crucial test of a relativity theory of gravitation is its ability to explain (*a*) the perihelion advance of a planetary orbit as observed in the case of Mercury, and (*b*) the deflexion of light in a gravitational field as observed in the field of the sun. Another, completing the trio of tests which Einstein's general theory satisfied with such notable success, is in a different category, since it involves some hypothesis concerning the 'proper' frequencies of atomic vibrations; this is (*c*) the shift of the spectral lines emitted by atoms near a massive body, as observed in the case of light from the sun and from the companion to Sirius. It is not difficult to apply tests *a* and *b* to the gravitational part of Milne's theory[1], assuming that the equations of motion given by Milne hold in the field of the sun. The results are that, first, there is a perihelion motion, but it is in the wrong direction, and secondly, there is no gravitational deflexion of light. The failure under the first test could perhaps be accounted for by the fact that the sun is not at rest in the substratum; but if this were so, the perihelion effect would depend critically upon the sun's velocity relative to the substratum and upon the orientation of the planetary orbit under consideration. On the whole, it appears that Milne's dynamical theory does not compare favourably with Einstein's general theory.

This conclusion should not be regarded as reflecting on the whole of Milne's kinematic theory, for it has already been remarked[2] that Milne's system of dynamics is not an inevitable consequence of his fundamental principles, but is only one of a number of possible systems. A theoretical defect of Milne's system is that it does not satisfy a least action principle. This can be remedied by starting with a variational equation having the required Lorentz invariance; and one of the systems arising in this way, analytically the simplest, is particularly interesting because it leads to precisely the same perihelion motion and deflexion of light as given by general relativity. This system can be described briefly in terms of Newtonian space and time, the curvature of space-time being neglected since we are now concerned only with local effects.

Consider the variational equation

$$\delta \int \exp\,(-2\varphi/c^2)\,(c^2 + \mathbf{V}^2)\,dt = 0, \qquad (1)$$

where $\mathbf{V} = d\mathbf{r}/dt$ is the velocity vector, c is constant, and $\varphi(\mathbf{r})$ is the Newtonian potential function. This leads to equations of motion which can be written:

$$\frac{d}{dt}\left(\frac{\mathbf{V}}{1-\mathbf{V}^2/c^2}\right) + \frac{1+\mathbf{V}^2/c^2}{1-\mathbf{V}^2/c^2}\,\mathrm{grad}\,\varphi = 0, \qquad (2)$$

and an 'energy integral':

$$\varphi + c^2 \log\,(1 - \mathbf{V}^2/c^2)^{-1/2} = \text{constant}, \qquad (3)$$

giving the classical $\varphi + \frac{1}{2}\mathbf{V}^2 = \text{constant}$ when $c \to \infty$.

The scalar velocity of a test particle cannot exceed c, and a particle moving initially with speed c continues to move with this speed. Identifying such particles with light photons, it follows that their paths are given by the variational equation

$$\delta \int \exp\,(-2\varphi/c^2)\,ds = 0, \quad ds^2 = d\mathbf{r}^2. \qquad (4)$$

Thus light paths are the geodesics of a conformally flat 3-space.

Motions in the field of a massive particle M, for example the sun, are found by substituting $\varphi = -\gamma M/|r|$. It can be calculated from (2) that an orbit has an advancing perihelion, and from (4) that light is deflected towards the sun. In each case the formula is exactly the same as that given by general relativity[3].

An attempt to introduce the third Einstein test could be made by interpreting the variational equation (4) as giving least time in accordance with Fermat's principle; this would suggest that the frequency of an individual photon at any point of its path is proportional to $\exp(-2\varphi/c^2)$. In the case of light from a massive body the resulting spectral shift would be twice as large as that predicted by general relativity.

The simplicity of equation (1), with its success in giving at least two of the observed relativistic effects, suggests that it should be applied to material systems which are too complicated to be handled by the field equations of general relativity. It would be interesting to see if it leads to the prediction of any new observable relativity effects.

A. G. WALKER

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June 26.

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[1] For an account of this theory, see Milne, E. A., "Kinematic Relativity" (Oxford, 1948).

[2] Walker, A. G., review of "Kinematic Relativity", *Math. Gaz.*, 33, 304 (1949).

[3] See Eddington, A. S., "Mathematical Theory of Relativity", Chapter 3 (Cambridge, 1930).

An Attempt to Measure the Annual Parallax or Proper Motion of Four Radio Stars

PREVIOUS attempts to measure the annual parallax of intense radio stars[1,2] have indicated that their distances exceed 1/50 parsec. These results were obtained by using an interferometer arrangement to determine the positions of individual stars over a period of many months. Observations of this type are limited[4] by inconstancy of the phase retardations in the transmission lines connected to the aerials of the interferometer. This source of error, which is analogous to the collimation error of a visual transit telescope, may, however, be largely eliminated if observations are made of the *relative* positions of a number of radio stars. The difference of the right ascensions of two stars of considerable angular separation should vary periodically as the earth goes round its orbit. It can be shown that a determination of the amplitude and phase of this periodic variation leads to a knowledge of the true parallax of each star separately. In addition, if no relative angular motion between a number of stars can be detected, it is unlikely that any of them has a proper motion greater than the accuracy of the observations.

The accuracy with which the difference of the right ascensions of two or more radio stars may be determined is very much greater than the absolute accuracy of the interferometer system, since th collimation error need only remain constant for th duration (a few hours) of the experiment. The mos serious remaining error is caused by ionospheri refraction near dawn and dusk, when the ionospher is not horizontally stratified. This produces deviation in apparent right ascension and affect observations of parallax but not of proper motion. Th magnitude of the error is greater at the longer wavelengths.

Two series of observations have been carried ou in an attempt to measure the annual parallax o proper motion of the four intense radio stars 05·01 12·01, 19·01, 23·01 [3]. The first series was made wit the large 3·7 m. interferometer[3], and has lasted fo one year. Accurate observations were made of th apparent right ascension of each star on about fou days each week. Such frequent observations wer necessary owing to the large number of occasion on which irregular ionospheric refraction prevente accurate measurements[4]. The second series consiste of similar observations on a wave-length of 1·4 m. these observations have been maintained twice week for four weeks in each of the periods shown i the accompanying table.

For each group of observations lasting two or fou days a value of the collimation error was found b taking the mean of the deviations of the recorde positions from a fixed position for each of the fou stars. The difference between the recorded deviation and this mean value was then taken as th apparent movement of the star. Allowance wa made for the effects of aberration, nutation an precession.

The observations on 3·7 m. wave-length clearl showed the dawn and dusk refraction mentione above; the angular movements due to this wer approximately ½ minute of arc. An analysis of thes results is being made which may give information o the magnitude of the horizontal gradient of electro density in the ionosphere throughout the day. N angular movements were observed which could no be ascribed to this cause, and the experiment show that there is no annual variation greater than minute of arc for any of the four stars.

DEVIATION IN SECONDS OF ARC OF MEAN POSITION OF EACH OF THE FOUR STARS. WAVE-LENGTH, 1·4 M.

Period 1951	05·01 (Taurus)	12·01 (Virgo)	19·01 (Cygnus)	23·01 (Cassiopeia)
Jan.–Feb.	0±7	0±12	0±5	0±3
April–May	−27±11	+7±7	−2±2	−3±4
July	−11±6	+22±15	−5±7	−4±2

The results of the series on 1·4 m. wave-length ar shown in the table. This series shows that there i probably no annual variation greater than 20 second of arc in the positions of 05·01 and 12·01, or 5 second of arc for 19·01 and 23·01. It may therefore be concluded that these four stars must be at distance greater than 1/20 parsec, and that 19·01 and 23·0 are more distant than 1/5 parsec; the absence o any detectable proper motion further suggest that they are probably at distances greater tha ½ parsec.

This work was carried out as part of a programm of radio research at the Cavendish Laboratory, supported by the Department of Scientific and Industri Research. Thanks are due to Mr. B. Elsmore fo help with the observations, and to Mrs. A. C. Hollis

:allett, who analysed a large proportion of the :eoords.

F. G. SMITH

Cavendish Laboratory,
Cambridge.
Sept. 28.

Ryle, M., *Proc. Phys. Soc.*, A, 62, 491 (1949).
Mills, B. Y., and Thomas, A. B., *Aust. J. Sci. Res.*, A, 4, 158 (1951).
Ryle, M., Smith, F. G., and Elsmore, B., *Mon. Not. Roy. Astro. Soc.*, 110, 508 (1950).
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Effect of a Magnetic Field on the Propagation of Sound Waves in a Ferromagnetic Material

EXPERIMENTS in progress on the propagation of igh-frequency longitudinal acoustic waves along a od of ferromagnetic material have shown such waves o be influenced by the application of an external nagnetic field in two ways. First, the velocity of ropagation is modified, as is to be expected from the o-called ΔE effect in magnetostriction experiments, hich refers to the change of Young's modulus with he applied magnetic field, and is of the order of a w per cent. Secondly, the attenuation of the waves s in general reduced as the applied field is increased, hus confirming the observations briefly noted by . F. Rogers and S. J. Johnson[1].

In the present work, both transerse and longitudinal magnetic ields have been employed, and the ffects are similar, in each case howing a decrease of attenuation owards a minimum value as the nagnetization approaches saturaion (see Fig. 1). μ is the attenuaion coefficient defined by $\alpha =$ $_{0}$ exp $(-\mu x)$, where α is the pulse mplitude corresponding to the ath-length x.

The experimental arrangement s essentially that shown in Fig. 2. ulses of variable frequency and ength are generated and fed to an X-cut quartz ransducer, which acts as the transmitter and reeiver of the sound waves, and is placed in close conact with the material under test. A film of oil is sed as a coupling medium between the quartz and he material. The received signals are displayed on a cathode-ray oscillograph and typical records are shown in Fig. 3, the operating frequency being 2·5 Mc./s., and the materials refer to nickel and nickel–iron. The magnitude of the attenuation effect varies considerably with the material as indicated in Fig. 1.

The curve in Fig. 4 is derived from the direct observations by plotting $(\mu_0 - \mu_H)$ against the appropriate field-strength H, and it is evident that this form of presentation shows a striking similarity to the I–H initial curves of magnetization of a ferromagnetic material (I being the intensity of magnetization).

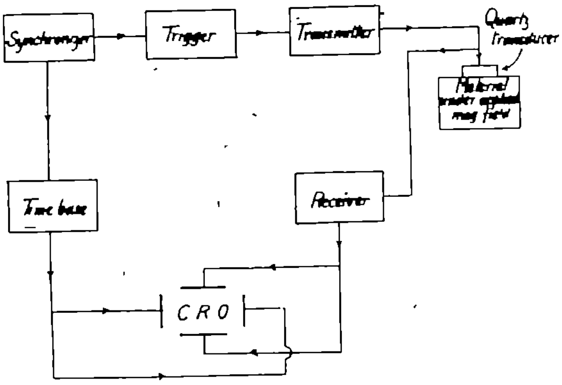

Fig. 2. Block diagram of experimental arrangement

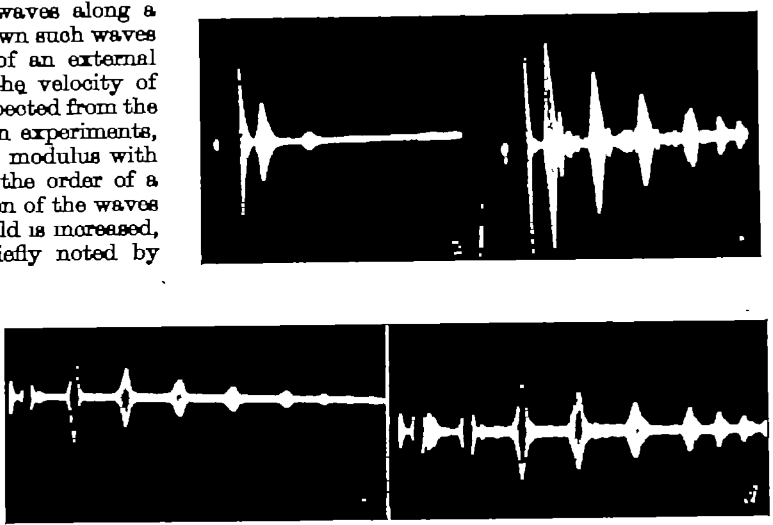

Fig. 3. Longitudinal waves in nickel - iron with: (a) zero applied magnetic field; (b) longitudinal applied magnetic field of strength 1,000 oersteds approximately. Longitudinal waves in nickel with: (c) zero applied magnetic field; (d) transverse applied magnetic field of strength 1,000 oersteds approximately

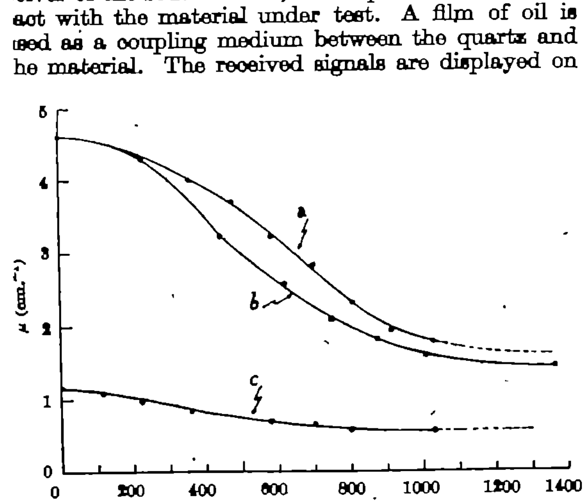

Fig. 1. Curve a, transverse field (nickel - iron); curve b, longitudinal field (nickel - iron); curve c, transverse field (nickel)

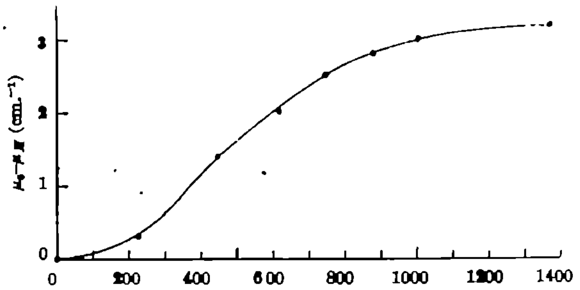

Fig. 4. Derived from Fig. 1 (b)

These results are a preliminary account of comprehensive investigations at present being undertaken with respect to type of wave, range of materials, magnetic field-strength and frequency of the pulse. Velocity measurements are also being correlated with the observations on attenuation.

Thanks are due to Sir George Thomson for providing facilities for this work in the Physics Department of the Imperial College.

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July 3.

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[1] *J. App. Phys.*, 21, 10, 1067 (1950).

A New Surface Viscometer

Of the methods which have been used to measure the viscosity of surface films on a liquid substrate only one, the canal or surface-slit method, is amenable to rigorous mathematical treatment. Harkins and Kirkwood[1] derived an equation which could be applied to this method provided that certain modifications could be made to the apparatus as used by Joly[2]. To measure the viscosity of dilute soluble films (to which the surface-slit method cannot be applied), a new method has been developed which is capable of rigorous interpretation.

The substrate (water or solution) is made to flow at a constant volume rate, V, through a horizontal channel of rectangular cross-section which it fills completely. The velocity, v_m, of an element of the surface along the centre of the channel may be measured by observing the passage of a floating particle of graphite between marked positions.

So long as there is no surface-pressure gradient, the flow velocity, v, satisfies, besides the Navier–Stokes equation, the boundary condition in the surface ($z = 0$):

$$\mu \partial^2 v/\partial x^2 + \eta \partial v/\partial z = 0,$$

where the distance, x, is measured across the channel and z vertically downward. For a channel of width a and depth b and a very small hydrostatic pressure gradient, A, in the direction of flow we find:

$$v_m = \frac{4Aa^3}{\pi^3} \Sigma' \sin \frac{n\pi}{2} \frac{\tanh (n\pi b/2a)}{n^3 a\eta \coth (n\pi b/a) + n^4 \pi\mu} \quad (1)$$

and

$$V = \frac{Aba^3}{12\eta} - \frac{8Aa^4}{\eta\pi^5} \Sigma' \frac{a\eta + 2n\pi\mu \tanh(n\pi b/2a)}{n^5 a\eta + n^6 \pi\mu \coth (n\pi b/2a)}, \quad (2)$$

where the sum is to be taken over all odd values of n. The ratio v_m/V is independent of A, and for $b > 3a$ simplifies to:

$$\frac{v_m}{V} = \frac{48 \Sigma' (-1)^{(n-1)/2} \dfrac{1}{n^3 + n^4 \pi\mu/a\eta}}{\pi^3 ab - \dfrac{96a^2}{\pi^2} \Sigma' \dfrac{1}{n^5} \dfrac{a\eta + 2n\pi\mu}{a\eta + n\pi\mu}} \quad (3)$$

The only unknown in this equation is μ; for given values of a, b and η, it is a simple matter to plot the ratio v_m/V against μ. The measurement of v_m, to give less than 5 per cent error, must be confined to particles floating along the central 20 per cent of the channel surface.

To illustrate the sensitivity of the method, for $a = 0{\cdot}153$ cm., $b = 0{\cdot}60$ cm., and $\eta = 0{\cdot}01$ poise, the following table shows values of v_m/V corresponding to a range of values of μ:

$\mu \times 10^4$ (surface poise)	0	0·5	1	2	5	10	20
v_m/V	17·8	16·8	15·1	13·1	9·3	6·3	3·

An experimental difficulty occurs in measuring the surface viscosity of some surface-active solutions. A negative surface-pressure gradient is set up along the channel, tending to retard the surface flow. If a barrier is placed across the surface of the channel before commencing the bulk flow, the surface pressures at the ends of the channel may be kept the same. When the flow has reached a steady state, the barrier is lifted and measurements of v_m are made after measured intervals. The value of v_m for zero surface-pressure gradient is then obtained by extrapolation. The form of the v_m versus time curve, and the difficulty of obtaining measurements at short intervals after lifting the barrier, sometimes makes this method impracticable and recourse is being made to a second method. After a period, v_m approaches a constant value, apparently indicating that a steady state with a constant surface-pressure gradient has been set up. By making further assumptions it is possible to make allowance for this back pressure (a measurable quantity) and to calculate the surface viscosity from the steady-state flow.

It must be assumed, with Harkins and Kirkwood[1], that the surface film is incompressible, that surface viscosity is independent of surface pressure and that there is no slip between surface film and substrate. Equations for v_m and V, obtained in the same way as the Harkins and Kirkwood equation in terms of a surface-pressure drop B, may be superposed linearly on the equations (1) and (2) to give equations for the flow when both hydrostatic and surface-pressure gradients are operative. The hydrostatic pressure gradient, A, is again eliminated between these equations to obtain an equation of the form:

$$VK_1 + BK_2 - v_m K_3 = 0,$$

where K_1, K_2 and K_3 are analytical functions of μ, η, a and b. By plotting v_m/V against μ, a family of curves is obtained for various values of B/V.

Where the surface film is moderately close packed, for example, in condensed insoluble films and in concentrated soluble films, a back pressure develops so rapidly that extrapolation to zero back pressure is impossible and v_m becomes so small that accurate determination of its steady value becomes impracticable. This constitutes a major limitation on our method of measuring surface viscosity. For dilute gaseous films, soluble or insoluble, the method appears most promising.

A more complete description of the experimental methods and the mathematical treatment will be published later.

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June 26.

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[1] Harkins, W. D., and Kirkwood, J. G., *J. Chem. Phys.*, 6, 53 (1938).

[2] Joly, M., *J. Phys. et Rad.*, 8, 471 (1937).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, December 3

University of London (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. W. S. Feldberg, F.R.S.: "Acetylcholine and the Central Nervous System".*

Society of Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. H. Gray: "Some Aspects of Industrial Filtration".

Society of Chemical Industry, London Section (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. W. A. M. Edwards: "The Sulphuric Acid Industry—Changing Raw Materials and Processes".

South-East London Technical College (at Lewisham Way, London, S.E.4), at 7 p.m.—Mr. W. Stern: "The Production of Sapphire Bearings".

Pharmaceutical Society (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Mr. C. H. Hampshire: "The International Pharmacopoeia".

Tuesday, December 4

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. Matthews, Mr. H. F. Goodman and Mr. G. H. Botham: "The Design of Process Equipment with special Hygienic Requirements".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Servicing of Electrical Instruments in Large Industrial Undertakings" (to be opened by Mr. A. J. Young); Discussion on "The Maintenance of Electrical Instruments in Atomic Energy Factories" (to be opened by Dr. Denis Taylor).

Society of Chemical Industry, Crop Protection Panel of the Agriculture Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. W. H. Read: "Chemical Control of Glass-house Pests and Diseases".

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. L. J. Witts: "The Scientific Basis of Medicine, 17, The Rate and Materials of Blood Formation".* (Further Lectures on December 6 and 11.)

Society of Chemical Industry, Microbiological Group (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.15 p.m.—Dr. M. Horwood: "Industrial Microbial Enzymes".

Wednesday, December 5

Joint Committee on Materials and their Testing and the Institute of Welding (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 10 a.m.—Symposium on "Recent Developments in the Notch Bar Testing of Materials and their Relation to Welded Construction".

Physical Society, Colour Group (in the Lecture Theatre, Victoria and Albert Museum, South Kensington, London, S.W.7), at 2.30 p.m.—Dr. H. Ruhemann: "Great Painters' Techniques and Colour Reproduction".

Aslib (at the British Council Film Theatre, 6 Hanover Street, London, W.1), at 5.30 p.m.—Mr. Bernard Chibnall: "Shell Film Unit Stock Shot Library".

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. P. E. Axon: "An Investigation into the Mechanism of Magnetic-Tape Recording".

Royal Meteorological Society (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5.30 p.m.—Mr. J. Paton: "The Optical Properties of the Atmosphere". (Sixth-form Scholars are invited to attend.)

Society of Chemical Industry, Food Group (joint meeting with the Society of Public Analysts and Other Analytical Chemists, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Discussion on "The Food Standards Issue—What does the Future Hold?".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Science in the Mountains" (Speakers: Dr. M. F. Perutz, Dr. E. P. George and Dr. B. H. C. Matthews, F.R.S.).

British Psychological Society (in the Psychology Department, University College, Gower Street, London, W.C.1), at 8.15 p.m.—Prof. T. M. Newcomb: "Some Contemporary Developments in Social-psychological Research".

Thursday, December 6

University of London (at the Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5), at 3 p.m.—Prof. J. Z. Young, F.R.S.: "The Anatomy of Learning".*

Physical Society, Low-Temperature Group (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5 p.m.—Sixth Annual General Meeting; at 5.15 p.m.—Mr. B. Blay and Mr. K. W. Glover: "The Measurement of Flow and Level of Liquefied Gases".

British Glaciological Society (at University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. J. F. Nye: "The Mechanics of Glacier Flow".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. H. L. Haslegrave: "Technical Colleges and Education for the Electrical Industry".

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. L. J. Witts "The Scientific Basis of Medicine, 18, Alimentary Factors in Blood Formation".* (Further Lecture on December 11.)

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. P. B. Medawar, F.R.S.: "Some Unsolved Problems of Biology".*

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. J. Seddon "Air Intakes for Gas Turbines".

College of Preceptors (at 2 Bloomsbury Square, London, W.C.1), at 6 p.m.—Mr. Geoffrey Gorer: "The Limitations of National Thinking and Feeling" ("Horizons in the School", 1) (Joseph Payne Memorial Lectures).*

Society of Chemical Industry, Bristol Section of the Chemical Engineering Group (in the Chemical Department, The University, Woodland Road, Bristol), at 6.30 p.m.—Mr. K. Sharples and Mr. F. G. Shepstone: "Chemical Engineering Applied to the Fertilizer Industry".

Television Society (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. Bryan R. Overton: "Television Receiver Design for British and European Systems—a Comparative Study".

Friday, December 7

Royal Meteorological Society, Scottish Centre (in the Department of Natural Philosophy, The University, Drummond Street, Edinburgh), at 5.15 p.m.—Dr. R. C. Sutcliffe: "The Use of Upper-Air Contour Charts in Forecasting".

Institution of Mechanical Engineers (joint meeting with the Industrial Administration and Engineering Production Group, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. C. H. Bradbury. "The Measurement and Interpretation of Machinery Noise with Special Reference to Oil Engines"

Society of Chemical Industry, London Section (joint meeting with the London Group of the Industrial Applications Section of the Royal Statistical Society, at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. G. E. P. Box: "The Planning of Experiments in the Chemical Industry".

North-East Coast Institution of Engineers and Shipbuilders (at the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Dr. W. S. Patterson: "External Ship Corrosion due to Bacterial Action".

Society of Chemical Industry, Manchester Section (joint meeting with the Local Sections of the Chemical Society and the Royal Institute of Chemistry, at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Sir Ben Lockspeiser, F.R.S.: "Scientific Problems in the D.S.I.R.".

Saturday, December 8

British Mycological Society (at the Linnean Society of London, Burlington House, Piccadilly, London, W.1), at 12 noon.—Annual General Meeting; at 2.30 p.m.—Dr. Lilian E. Hawker. "The Physiology of Myxomycetes" (Lister Memorial Lecture).

British Psychological Society (in the Eugenics Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Prof. C. A. Mace. "Education for Management in the United States—a Psychologist's Impression".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant (Grade A) in Physics and Physical Chemistry, and an Assistant (Grade A) in Mechanical Engineering, at the Birkenhead Technical College—The Director of Education, 63 Hamilton Square, Birkenhead (December 8).

Head of the Pure and Applied Science Department (with good academic qualifications in physical chemistry, and experience in teaching to B.Sc. and A.R.I.C. standard)—The Principal, Mining and Technical College, Church Street, Barnsley (December 8).

Lecturer in Physical and Inorganic Chemistry at the Rutherford College of Technology—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 1 (December 8).

Statisticians (with honours degree in mathematics and training or experience in statistics) to initiate and take charge of the Centre, under the supervision of the Honorary Director—duties will be (*a*) the collation of world data on blood groups in relation to anthropology, including their analysis, and (*b*) the anthropological analysis of blood records of Great Britain—The Hon. Director, Nuffield Blood Group Centre of the Royal Anthropological Institute, 21 Bedford Square, London, W.C.1 (December 8).

Lecturer in Mathematical Physics—The Secretary, The University, Edgbaston, Birmingham 3 (December 10).

Lecturer in Public Health—The Secretary, The University, Aberdeen (December 10).

Lecturer in Oral Anatomy and Histology, combined with preventive dentistry, and a Demonstrator and Research Assistant in Dental and Oral Pathology—The Registrar, The University, Sheffield (December 15).

Scientist III (with an honours degree in science, preferably in chemistry and physics, or an equivalent qualification) in the Records Section of the Scientific Department at London headquarters, to assist in the collection and interpretation of scientific data and to prepare information reports—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/399 (December 18).

Meteorological Officers (6) in the Department of Industry and Commerce, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (December 21).

CHIEF COAL SURVEY OFFICER (with high academic scientific qualifications; sound all-round knowledge of fuel technology and some research experience are desirable) in the Scottish Division—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/403 (December 22).

SITE SUPERINTENDENT, a DEPUTY SITE SUPERINTENDENT, EXPERIMENTAL OFFICERS, and ASSISTANT EXPERIMENTAL OFFICERS by the **MINISTRY OF FUEL AND POWER** for experiments in underground gasification—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting F.862/51A (December 22).

ANIMAL HUSBANDRY OFFICER—The Secretary, Southern Rhodesia Government, 429 Strand, London, W.C.2 (December 24).

CIVIL ENGINEERS, SANITARY ENGINEERS, and STRUCTURAL ENGINEERS (all with the appropriate professional qualifications and experience) in a number of Departments in England and Wales—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3405.LA (December 31).

READER IN THE DEPARTMENT OF GEOGRAPHY IN THE RESEARCH SCHOOL OF PACIFIC STUDIES—The Administrative Officer in the United Kingdom, Australian National University, 27 Russell Square, London, W.C.1 (December 31).

SENIOR LECTURER, and a LECTURER, IN CIVIL ENGINEERING, at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 31).

SENIOR LECTURER IN VETERINARY PATHOLOGY AT THE UNIVERSITY OF QUEENSLAND—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 5).

SCIENTISTS II or III (Ref. TT/400) (with honours degree in electrical engineering or physics, with good knowledge of electronic techniques) in the telecommunications and light electrical engineering fields, and **ELECTRONIC ENGINEERS** (Ref. TT/401) to design and construct electronic devices for research, at the Central Research Establishment, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (January 12).

SENIOR LECTURER IN GENERAL BACTERIOLOGY at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 14).

AERONAUTICAL AND MECHANICAL ENGINEERS (Principal Scientific Officer grade) in the Structures Department of the Royal Aircraft Establishment, Farnborough, for work on the design approval of aircraft structures or on the solution of airworthiness problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting C.684/51A.

ELECTRICAL ENGINEERS AND PHYSICISTS AT THE ROYAL AIRCRAFT ESTABLISHMENT, South Farnborough: **PRINCIPAL SCIENTIFIC OFFICER** (Ref. D.501/51A) to act as Deputy Leader of a team engaged on the research and development of novel applications of radio techniques, **SENIOR SCIENTIFIC OFFICER** and **SCIENTIFIC OFFICER** (Ref. A.345/51A) to assist in various aspects of the work detailed above; **SENIOR SCIENTIFIC OFFICER** (Ref. A.346/51A) to work on novel forms of sighting equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

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PLANNING THE LAND OF BRITAIN

THE title of the Ministry in which Mr. Harold Macmillan has succeeded Dr. H. Dalton has been changed from 'Local Government and Planning' to 'Housing and Local Government'. The word 'planning' thus disappears from ministerial titles for the first time since it was added to that of the Ministry of Works in 1942. It has not, however, been suggested that the fresh emphasis now placed on the housing responsibilities of Mr. Macmillan's office implies any shedding of responsibilities for the planning of the use of land from a national point of view, or that the National Parks Commission will no longer be responsible to him.

Planning responsibilities in Great Britain are likely to be increasingly onerous in the immediate future, and though to some extent the requirements of housing and town-planning for land may place Mr. Macmillan in an invidious position in co-ordinating rival claims for the use of land, it can be safely assumed that such functions will be discharged with good sense and imagination. Long-term national interests, which, as *Planning* has rightly insisted in a recent broadsheet on "Land-Use Planning", are the decisive element in such planning, will undoubtedly suffer if Mr. Macmillan's co-ordinating powers are no wider than those of his predecessor, and if they are not exercised with vision and energy as well as tact. Claims for the use of land in the national emergency are no less acute and conflicting than at any time during the past two decades, and unless wisely and firmly resolved may do irreparable damage to long term interests, especially in respect of those amenities which the National Parks and Access to the Countryside Act is intended to safeguard.

Mr. Macmillan, moreover, has taken office at a time when Dr. Dalton's handling of the question of administration of the proposed parks had engendered profound scepticism as to whether any really national parks would be established. Designation orders for four of the proposed parks were signed during Dr. Dalton's term of office, and the boundaries of the Peak District, the Lake District and the Snowdonia National Parks were confirmed by him. The order designating the Dartmoor National Park has since been confirmed by Mr. Macmillan. The route for the Pennine Way was also approved by Dr. Dalton, and this fine project should now go to fruition with little need for personal attention from the new Minister, who will, however, be expected to watch over it benevolently, since in the austere conditions which the nation is called upon to face, access to the countryside may play a vital part in maintaining health and morale.

The situation as regards the national parks is otherwise, and for all the vigour with which the initial task was tackled by Dr. Dalton and the National Parks Commission, a situation has developed which threatens to frustrate the whole purpose of the Act unless the question of joint planning is firmly and promptly handled in accordance with the pledges given in Parliament when the Bill was passed. Some disappointment has been expressed in regard to the national members appointed by the Minister to the Joint Boards for the Peak District and Lake District National Parks, on the ground that insufficient use has been made of the services of those known to possess experience, knowledge and vigour in local rural preservation; but that disappointment may not in the event prove justified, and is entirely secondary to that of the financial independence of the Joint Boards.

When, at the committee stage of the Bill, an amendment was moved which would have ensured that the finance committees of county councils whose powers were being transferred to a joint board should have no control over the board, the Minister, then Mr. Silkin, immediately stated that, once an 'order' had been made to set up a joint planning board, there would be no need to go back to the separate authorities for permission to arrange the necessary finance. It would be met entirely by precept issued on the counties by the board. The first schedule of the 1949 Planning Act specifically provides for this, and it was on this undertaking that the amendment was withdrawn. In spite of this pledge, in his 'order' establishing the Lake District Joint Planning Board, Dr. Dalton placed a limit of £7,500 on the annual expenditure of the Board, and made any increase in this figure subject in the first instance to the consent of the three county councils in the areas of which the Park lies. This figure, which is half that originally suggested as probable by the Ministry of Local Government and Planning itself, is the figure at which the county councils offered to do the work with their own officers. The order thus frustrates the freedom of the Board as regards planning, which was expressly promised in the House of Commons, together with financial independence. It is understood that the National Parks Commission has already protested to the Minister that it considers the councils' proposals to be unsatisfactory and that in its opinion the Lake District Joint Board should appoint its own planning officer, who should be wholly in its service. It is, of course, a statutory duty of the commissioners, under the National Parks Act, to advise the Minister "generally and in relation to particular national parks" as to the action needed to be taken. By the terms of the Act, too, the Commission should be consulted about such administrative matters; but this obligation seems to have been disregarded: the arrangements appear to have been concerted entirely between the Ministry and the county councils.

There is also controversy over the Joint Board for the Snowdonia National Park, where the Caernarvon County Council has been pressing for administration, in defiance of the Act, by a joint advisory committee.

This situation demands early attention and action from the new Minister. The present Government is not bound by the pledges of its predecessor when the Bill was debated in Parliament, although the division was not on party lines. The principle at stake, however, is so vital that if the nation cannot afford at present the small sums necessary to secure effectiv national administration of the parks, the better cours would be to repeal the National Parks Act an dissolve the National Parks Commission. That a least would be an honest policy, and would not delud the nation into thinking it was enjoying somethin which can never be achieved under local authorit administration.

There are, of course, immediate considerations t be weighed before taking such drastic action, quit apart from the reproach which future generatior would rightly level at us for the irreparable loss t amenity as well as to scientific interests. As ha been urged before in these columns, our scen heritage represents a spiritual asset, which may b of great value in our struggle for economic recover Access to the countryside and national parks ma yet prove an important factor in sustaining th health and spirit of the people, and the case fo nature reserves rests in part on their contributio to the more effective use of the natural resources o Great Britain through a fuller scientific knowledg of the fauna, flora and ecology.

These considerations must be weighed by th Government, and it is to be hoped that there wi be no hesitancy in dealing with the situation whic Dr. Dalton's dubious administration has encourage Let there be either repeal of the National Parks A with a straightforward statement as to why th nation cannot afford the sums required to administ the parks, or firm administration of the Act i accordance with the terms laid down and the unde takings given in Parliament. County counci cannot be relied on to formulate and pursue national policy—and indeed it is unfair to expe it of them. Their co-operation and local advi are none the less essential, and without them th national parks will not be fully effective. Th devising and implementing of a national polic however, belongs to another sphere, and confusio and frustration are liable to result if the two a mixed.

SCIENCE AND RELIGION

Natural Science and the Spiritual Life

Being the Philosophical Discourse delivered befo the British Association for the Advancement Science at Edinburgh on 12 August 1951. By th Rev. John Baillie. Pp. 44. (London, New York an Toronto: Oxford University Press, 1951.) 5s. ne

THE Philosophical Discourse delivered before th British Association at Edinburgh this year h one distinction which has not always been possess by such compositions—it is really philosophical. deals with a subject which is both relevant to t concerns of the British Association and of fund mental importance—the relation between science a religion. Those who know Dr. J. Baillie's writin will expect to find learning and literary grace happ wedded, and they will not be disappointed. "C two walk together except they be agreed ?" is t text of the discourse; but there is a subsidiary te from the Phædo, in which Socrates recalls his early nterest in natural science and the reasons which led him to abandon these studies. The thesis which Dr. Baillie develops and defends is that there is no inherent conflict between religion and science; but they cannot be brought into a harmonious relation by assigning one field of our experience to science and another to religion. "Nowhere is it possible to draw an iron curtain across the field of our experience and proclaim either the exclusion of science from the one side or its totalitarian right on the other. What we have to do with is rather two diverse ways in which the whole territory of our human experience may be approached and explored."

The thesis is elaborated by a rapid but illuminating survey of later Western thought from the point of view of the two types of causation, 'efficient' and final'. We cannot follow the argument in detail here. No doubt it will raise questions in many readers' minds, as the author intended. Two may be mentioned. It is not quite clear whether Dr. Baillie would draw a distinction between religion and theology and, if so, how he would define it. This is mportant, for the conflicts between religion and science have for the most part been, in fact, between theological doctrines and scientific theories. One can magine, indeed one knows, scientific men who claim to have a religious approach to experience but reject the theological propositions which are presented by Christianity or any other religion for their belief. Dr. Baillie, again, has much which is most interesting to say on the Christian origins of natural science. He holds, with many other eminent philosophers and historians, that but for Christianity there would have been no science. I think we must agree that the Christian world-view did, in fact, prepare the way for the scientific method by its destruction of the ancient cyclic conception of existence and that its doctrine of God had something to do with the evolution of the ideas of the uniformity of Nature and natural aw; but I find it difficult to believe that apart from Christianity the Western mind would never have hit upon the plan of investigating Nature by observation and experiment. After all, many of the presuppositions of natural science are present in Lucretius. But I have Whitehead, Berdayev, Ritchie and Foster, as well as Dr. Baillie against me. Dr. Baillie has written a stimulating pamphlet which deserves to be pondered and discussed.

W. R. MATTHEWS

GLASGOW CHEMISTS

An Eighteenth Century Lectureship in Chemistry
Essays and Bicentenary Addresses relating to the Chemistry Department (1747) of Glasgow University (1451). Edited by Dr. Andrew Kent. (Glasgow University Publications, 82.) Pp. xv+233+19 plates. (Glasgow: Jackson, Son and Co., 1950.) 21*s*. net.

IN 1747 a lectureship in chemistry was instituted in the University of Glasgow and was first held by the famous teacher of medicine, William Cullen, followed by Joseph Black, John Robison, William Irvine, Thomas Charles Hope, Robert Cleghorn and Thomas Thomson. Soon after Thomson's appointment the lectureship was elevated to a regius chair, and this chair, it is stated, was "the earliest (1818) for chemistry, *tout simple*, in the country". The present incumbent, Prof. J. W. Cook, contributes a useful foreword to the book now under notice. In 1919 the Gardiner chair of chemistry was added, which Prof. J. M. Robertson now occupies. Dr. Kent points out that the Chemistry Department at Glasgow "in its first century was conducted single-handed and at times, indeed, only as an adjunct to other duties". A list is given of appointments to all grades of the academic staff of the Department up to the session 1947–48.

The scope of the book can be partly gauged by the subjects of the addresses and essays (and their authors) forming its chief contents: the lectureship at Glasgow (Dr. Kent); William Cullen's history of chemistry (Dr. Kent); Glasgow University in the eighteenth century (Prof. J. D. Mackie); Hermann Boerhaave and Scottish chemistry (Dr. Archibald Clow); William Cullen, M.D., and his times (Dr. Douglas Guthrie); phlogiston, caloric and heat (J. C. Gregory); Joseph Black, M.D.—the teacher and the man (Prof. John Read); Black's influence on chemistry (Dr. John A. Cranston); the industrial development of Scotland in the Cullen–Black period (Alexander Fleck); John Robison, M.A. (Sir Edmund Whittaker); James Watt and Glasgow University (Robert C. Howie); William Irvine, M.D. (Dr. Kent); early scientific links between Scotland and America (Dr. J. A. V. Butler); Thomas Charles Hope, M.D. (Prof. James Kendall); Robert Cleghorn, M.D. (Dr. George Thomson); Thomas Thomson, M.D. (Prof. J. R. Partington); some observations and an anecdote [Black and the teaching of chemistry, and Thomas Thomson] (the late Prof. T. S. Patterson); the chemical laboratory at Glasgow sixty years ago (the late Dr. Robert Broom); and Glasgow chemistry in the twentieth century (Prof. A. R. Todd). A prodigious amount of information is elegantly and most readably set forth. Numerous references to original sources, often extremely recondite, form a unique and invaluable collection.

It is almost inevitable that some controvertible statements have occurred in dealing with so much material. Thus, the unqualified assignment of 1774 as the year of Scheele's independent discovery of oxygen (p. 104) will surprise many. According to Nordenskiöld's researches, Scheele may have prepared oxygen as early as 1771; therefore then, or soon after, he may have observed its properties sufficiently to merit the use of the word discovery. In my opinion it seems impossible on available evidence to decide on any particular year whatsoever. On pp. 101–102 it is stated that Black discovered magnesium oxide, whereas even in his own famous paper some of the previous work of the great Friedrich Hoffmann is cited, including the ignition of what we now call magnesium nitrate, whereby the oxide is formed. Although magnesium compounds had been observed even before the investigations of Hoffmann, it is to him that the first clear and thoroughgoing publication of their characteristics belongs, based largely on his own admirable experiments. He clearly differentiated between magnesium and calcium oxides. But Black's epoch-making contributions to chemistry tower high above the discovery of magnesia. On pp. 157–8 a brief account of the early history of strontium contravenes the evidence assembled by Prof. Partington about this subject (*Ann. Sci.*, 5, 157; 1942. 7, 95; 1951). It was not Hope, but Crawford and Cruickshank, to whom is due the first known isolation of a strontium compound, the (hydrated) chloride. The treatment of the discovery of the oxide also requires considerable revision. In referring to achievements of Black's students, the statement (p. 46) that "Smithson Tennant developed the backward Cambridge school" is misleading, as his contact with Cambridge as a teacher was very brief. Appointed professor of chemistry in May 1813, he apparently delivered only one course of lectures, in April and May 1814. These lectures were probably excellent; but he died the next February on the Continent, where he had been for the preceding five months. As to the backwardness of Cambridge (presumably compared with Glasgow) at the time, this seems open to question, but I am unable to express an opinion based on enough study.

Partly in jest, one might say that the last three of the examples quoted give grounds for suspicion that respectable reverence for local gods has unwittingly influenced investigation and appraisement of their deeds. Be that as it may, every recorder of facts and their interpretations is liable to various psychological influences which he must guard against. This well-known fact should constantly be remembered, perhaps especially earnestly in these times.

It is hoped that the usefulness and charm of this book will be so widely recognized that future editions will be demanded. As well as corrections of textual errors, another desirable improvement would then be possible—in the indexes, where mentions of some persons in the text are not recorded, and those of others often only partially. There is something to be said for no index at all, rather than one having the air and intention of completeness which in fact it is far from achieving. A searcher relying on the latter kind may be denied information to be found, though with unnecessary difficulty, from reading the text.

Altogether, this is an indispensable text-book for students of the Cullen–Thomson period. Its price is moderate for the feast of knowledge and entertainment it affords.

L. F. Gilbert

UNITARY BIOLOGY

Cell and Psyche

The Biology of Purpose. By Edmund W. Sinnott. (John Calvin McNair Lectures.) Pp. ix+121. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1950.) 16s. net.

PROF. E. W. SINNOTT'S thoughtful and stimulating book is based on one forthright, far-reaching thesis. "The position which I wish to defend . . . is briefly this: that biological organization (concerned with organic development and physiological activity) and psychical activity (concerned with behaviour and thus leading to mind) are *fundamentally the same thing*" (p. 48). "It is this organization . . . which, *as experienced by the organism*, I believe to be the simplest manifestation of what in man has become conscious purpose" (p. 53). Sinnott is, of course, not the first to make suggestions of this kind. Somewhat similar attempts to avoid a bifurcation of Nature by refusing to admit the existence of a dualism are found in philosophies as different as those of Whitehead, the *Gestalt* school and Marxism. Sinnott's characteristic contribution is that he approaches the subject as a student of development. His professional biological interests bring him into immediate contact with those processes in which young organism is driven by its own internal constitution towards the realization of a specific end, th adult state—processes which strongly suggest parallel with those carried out by man under th guidance of a conscious purpose. Thus, whereas mos authors who have thought on these lines have been perhaps most interested in the problem of knowing Sinnott is particularly concerned with the problem of will.

It would certainly seem that, if we are ever t transcend the defeatist dualism of the conventiona outlook on biology, Sinnott has indicated the genera direction in which to seek a way of bringing the subjective experience of purpose into relation with materia events. There is no doubt that, particularly durin embryonic development, biological systems do sometimes get into states which result in a tendency fo change to occur in a definite direction. At present the examples of such states about which we know most do not involve the fully differentiated nervou system, but more simple systems in earlier stages o development. There is, however, no reason to den that similar situations of 'competence' might arise i the brain, and it would be to such conditions tha Sinnott would look to find the physical basis o will.

After developing these ideas in the first tw chapters, in the third Sinnott mentions briefly the relevance to some of the classical problems of philosophy. He attempts rather to show that his outloo may lead to a new formulation than to provid ready answers. Thus on p. 89 he writes, "The rea issue in the problem of freedom is again the fundamental character of biological organization, of wha it is that sets up self-regulating mechanisms in a livin thing, and ultimately in the nervous system of man and which thus creates purposes and fulfils them i action". This is hinting, surely, that there may b some close parallel between the 'spontaneous' formation of a purpose (that is, free will) and the sudde arising of a previously non-existent crystal orde when two suitable types of molecular species happe to come together in a liquid—a bizarre thought, bu perhaps not entirely unworthy of turning over in th mind. It is certainly a stimulating book.

C. H. Waddington

QUANTUM THEORY OF MOLECULES

Structure of Molecules and the Chemical Bond

By Y. K. Syrkin and M. E. Dyatkina. Translated an revised by M. A. Partridge and D. O. Jordan. P ix+509. (London: Butterworths Scientific Publications, Ltd., 1950.) 63s.

ALTHOUGH the quantum mechanical treatmen of atomic and molecular structure is now universally accepted, remarkably few monographs on th subject have yet appeared. This book, by Y. K Syrkin and M. E. Dyatkina, has already achieve recognition in its original Russian version, and th appearance of an English translation is therefore a event of some interest. During translation, certai additions and revisions have been made, and th intention evidently has been to provide a comprehensive and authoritative account of the subject f Western readers.

Certainly the field has been covered comprehen-vely, and the text is sprinkled with useful tables nd numerous references. These seem well chosen, lthough they show a certain bias to the Russian terature. Most of the treatment is qualitative, esting on the familiar resonance theory; but the athematical basis of the theory is also discussed in me detail. The style is adequate, and the book is ell produced and well indexed.

Unfortunately the authors have failed to make good se of their material and the book cannot be regarded s a success. In the first place, it seems to lack co-rdination, the chapters giving the impression of nplanned and disconnected essays. Thus most of he treatment of the Periodic Table in Chapter 2 ests on ideas of valency which are not discussed ntil Chapters 3 and 4, and spectroscopic notation s introduced in passing without any explanation. gain, there is a tendency to condense discussions of mdamental principles and enlarge on irrelevant etails; an example is the brief 'explanation' of esonance at the beginning of Chapter 5, followed by a igression on Rumer's theorem and a list of the rty-two canonical structures of naphthalene. Finally, he mathematical parts of the book seem particularly ept; some sections are obscured by vast smoke-creens of unnecessary algebra (the Heitler–London reatment of H_2^+ is a good example), while others uffer from ellipsis and lack of explanation (cf. the udden introduction of the secular equation on . 412).

There are various minor errors and omissions in the ext; for example, diethoxymethylene (p. 113) does ot exist, the bond-lengths quoted for dibenzyl (p. 76) re old and incorrect values, and the statement that oplanarity is essential for resonance (p. 95) is falla-ious. There are some misprints; for example, the mission of two exponents in Table 4, an incorrect esonance energy for chrysene in Table 113, and Mullian (corrected to Mullikan a few lines later) on . 133.

In short, this book cannot be recommended either s an authoritative text or as a suitable introduction o the subject. More experienced readers will find in it much useful factual information. The price seems high.

M. J. S. DEWAR

PHYSICS FOR GENERAL HONOURS STUDENTS

Physics

By S. G. Starling and Dr. A. J. Woodall. Pp. xvi+ 301. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1950.) 42s. net.

THE publication of a comprehensive text-book for students covering the whole subject of physics up to general honours degree standard is an mportant educational event, and in the short time ince it appeared there have already been signs of he cordial reception that this enterprise has deserved. Any volume of this standard planned to supplement ectures and give guidance to students would in these days of large classes and pressure on tutorial and ibrary resources serve a useful purpose and be sure f a welcome. It is all the more gratifying to find hat usefulness has not been submerged in the estricted principle of utility, and that the book can be recommended on its merits alone as an excellent companion for students, which is both sound in content and readable in presentation.

A good deal of elementary work is included, and it is a wise plan to take nothing for granted, for there can be few students who enter on work at this level with a full grasp of all that they are supposed to have mastered earlier; but this is presented in a way that will appeal to the maturing reader, and make him draw on his own resources instead of sending him back to refer to a first-year university text-book. Of the main contents, the electricity and magnetism portions follow the general lines of Mr. S. G. Starling's classic text-book for degree students, and the earlier chapters on the properties of matter again adopt the treatment that he has used successfully in the past, though to a slightly more advanced standard than in his earlier book. The sections on light, particularly the chapters dealing with physical optics, are well done, and the treatment of interference and diffraction is admirable; it is appropriate here to go fairly fully into details, since the elementary teaching at the school or intermediate level seems all so simple and almost complacently rounded off that the student's chief difficulty with more advanced work is to appreciate the physical necessity for a fuller mathematical treatment. The authors have here presented things so skilfully that the transition from what one might call the schoolboy outlook to the more exacting approach of university work comes naturally in the course of the text. The illustrations to this part of the book are helpful, and very well executed. The chapters on heat are perhaps a little below the standard of the rest; this is my opinion, which is based on a feeling that thermodynamics, as the most important of tools and the hardest with which to acquire proficiency, might well have been allotted more space. Other readers may possibly feel that a case could be made for a fuller treatment of this or that particular point; and criticism of this kind is no reflexion on the merit of the book, but rather emphasizes the high quality of what is actually provided, and the discretion and restraint with which the authors have aimed at, and preserved, a very uniform standard throughout the greater part of their work.

There are numerous references to modern developments in optics, electricity and atomic physics, and the principles involved are explained as fully as is desirable at this standard; but experimental details and matters of technique are wisely left for the student to seek elsewhere. This again is very laudable: people at this stage in their careers can stand on their own feet, and use initiative in pursuit of knowledge; but are often all too ready to use a text-book as a crutch if it is comfortably padded.

The first chapter gives a summary of the mathematical equipment required, and at the end of the book there are mathematical tables and a comprehensive list of physical constants. There is a collection of searching examination questions, and also, what is essential in a book of this size, an efficient index. Binding and production are good, and every device by which space may be saved without irritating the reader seems to have been adopted effectively, so that there is really more matter in the book than the respectable total of thirteen hundred pages suggests. At two guineas, in these days, it is very good value for money.

G. R. NOAKES

Inferiority Feelings in the Individual and the Group

By Oliver Brachfeld. Translated from the French by Marjorie Gabain. Pp. 301. (London: Routledge and Kegan Paul, Ltd., 1951.) 25s. net.

THIS book was written in Spanish by a Hungarian, translated into French and re-translated from the French into English. One might have expected from such metamorphoses that the result would be unintelligible; but so carefully has the translator, Marjorie Gabain, done her work that the text reads as if it had been written directly in English. The book is an attempt to show the historical emergence of Adler's ideas in such precursors as Montaigne, Hobbes, Mandeville, Vauvenargues, and so on, then the views of Adler himself, and finally their application to the individual and to society. The author draws on innumerable sources, both medical and literary, and is obviously widely read in most European languages. Most of the exposition of Adlerian principles merely follows the lines laid down by that school; but it is done in an interesting way. In some cases it is superficial and even contradictory; for example, the author is willing to accept the results of questionnaires regarding the superficial causes of inferiority, but he refuses to accept the fact that few musicians are deaf as a refutation of the Adlerian principle that musical ability is the result of over-compensation, as put forward by Elsa Bienenfeld.

The most interesting and original part of his book is the attempt to apply the theories of individual psychology to such problems as industrial disputes. It is long past time when psychologists should have made studies of the deeper causes of strikes and lock-outs, not from the point of view of benefiting either the employers or the employées, but to prevent them and the consequent disruption of society. A knowledge of the deeper causes of industrial warfare may help to prevent international disputes and the wreckage of society. Attempts, such as the author's, to understand the psychology of national feeling may finally give us a deeper knowledge and lead to prevention of war.

This book is a sound exposition of the Adlerian point of view and will interest those who find Adler's work satisfying. It is excellently produced, the paper is good, the print clear, and the binding in brown with gold lettering unobtrusive.

CLIFFORD ALLEN

The Electrical Activity of the Nervous System

A Textbook for Students. By Dr. Mary A. B. Brazier. Pp. x+220. (London: Sir Isaac Pitman and Sons, Ltd., 1951.) 25s.

THIS short text-book gives a useful elementary introduction to the electrophysiology of the central and peripheral nervous system and of the sense organs. Considerable knowledge of anatomy and physiology and some knowledge of elementary physics are required of the reader. The earlier chapters, which deal with the electrical properties and general physiology of peripheral nerve and of the spinal cord, are less detailed and self-contained than are the later ones, in which the peripheral and central sensory apparatus and the spontaneous electrical activity of the brain are described.

In these later chapters, the book ranges rather more widely and goes a little more deeply into its subject-matter than do the relevant sections of the standard texts on physiology. Medical students wil find in it interesting supplementary reading. Thos embarking on advanced courses in physiology wil not need it beyond the early stages of their work i electrophysiology, but they will find the bibliographies useful. The book will be specially valuabl to those physicists who are nowadays being attracte into the field of applied electrophysiology. Parts o it would interest general biological and scientifi readers.

The writing is admirably clear, the presentatio that of a gifted teacher and the many illustration have been wisely chosen.

The Physics of High Pressure

By Prof. P. W. Bridgman. (International Text-Book of Exact Science.) New impression, with Supplement. Pp. viii+445. (London: G. Bell and Sons Ltd., 1949.) 35s. net.

THE main achievements of the past twenty year in the high-pressure field are described in supplement of some forty pages, which is the chie addition to this new impression of Prof. P. W. Bridgman's standard work. Although this method of revision was probably dictated by the photographic process used, no happier way could have been chosen; for the story of the author's own monumental researches is continued beyond the range of pressures reached in the work of the original volume, up to 100,000 kgm./cm.^{2} in many cases, and this is the natural sequence to adopt. A number of new problems, such as the behaviour of metals under shear and plastic deformation at high pressure, are discussed as well as extensions of earlier investigations.

The only alteration in the body of the earlier text is in the section on the compressibility of the alkal metals. In 1931 it had seemed worth while to look for indications of the breakdown of atomic structure under the pressures then attainable. Redetermination of the values, and their extension to the highest pressure range, still fail to reveal any premonition of such breakdown, though in the case of cæsium two interesting discontinuities in the pressure–volume curve are recorded.

Apart from its uncontested authority as the work of reference on this subject, this is a book which the physicist with less-specialist intent can read with profit. It is a story of difficulties sought out and hunted down, written in a style which reveals the author as one of the calmest and most equable of experimenters. His comments and discussion are rich in scientific wisdom, and it is good to see the book once again in print.

Scientific Survey of South-Eastern Scotland

Prepared for the Meeting held in Edinburgh, 8th to 15th August 1951. Pp. 208. (Edinburgh: British Association Local Executive Committee, The University, 1951.) 15s.

THIS book was prepared in connexion with the meeting at Edinburgh this year of the British Association for the Advancement of Science, and, on the lines of surveys for other years of the locality around previous meeting-places of the Association, it gives a comprehensive but succinct account of the history, social conditions and economy of south-east Scotland as well as its scientific features, natural and otherwise. The area covered is made up of the counties of Fife, Kinross, West Lothian, Midlothian, East Lothian, Peebles, Berwick, Selkirk and Roxburgh

—that is, roughly speaking, all the land from the Cheviot Hills to the Firth of Tay lying on either side of the Firth of Forth. The book is divided into twenty-one review articles, each by a local authority and dealng respectively with the following topics: south-eastern Scotland—the region and its parts; weather and climate; prehistoric settlement; the Roman period; medieval times; 1500–1950; growth of Edinburgh, 1128–1800; growth of Edinburgh, 1800–1950; public health; influence of man on plant and animal ife; agriculture; mining; manufacturing industries; changes in rural life and landscape, 1500–1950; population; transport; education; University and colleges of Edinburgh; the outlook; geology; esearch institutions. To complete the work a Bartholomew quarter-inch coloured topographical map is included, tucked into a flap on the inside of the back cover.

In the space of a short note it would be invidious to select any particular item for detailed comment, but perhaps it might not be inappropriate to say that, since paper-making and printing and book-binding are mentioned as among the principal industries of Edinburgh, one could expect that the production of this book would be of a high standard —and one's expectations are fulfilled. As befits the capital city of the northern half of the Union (and there are some, Sassenachs included, who would describe it as the fairest city of the Union) a good proportion of the space is devoted to Edinburgh itself; but a capital city is not the be-all and end-all of a country, and it can be fairly said that south-east Scotland as a whole has received its due share.

While the appeal of this type of survey is necessarily limited to those with ties to the immediate locality in question, nevertheless the members of the British Association who conserve these annual volumes thereby collect an authoritative collection of material pertaining to the principal centres of Great Britain, and this volume is second to none in this series.

Introduction to the Patenting of Inventions

By Cecil Hollins. Pp. 99. (London: Ernest Benn, Ltd., 1951.) 4*s*. 6*d*. net.

MR. CECIL HOLLINS and his publishers are to be congratulated on producing in ninety-nine pages and for 4*s*. 6*d*. such a concise and straightforward account of the essentials of that complicated and important field of law—British patent law. Mr. Hollins is exceptionally well equipped for producing such a book. For many years he was head of the Patent Department of the Imperial Chemical Industries, Ltd., and he has also had a wide experience on patent and related matters in Great Britain and abroad. He is therefore fully aware of the needs of scientific and technical persons in relation to the important questions of patents, and this book should make a great appeal to inventors and persons engaged in research generally and to members of the staffs of industrial firms.

In January 1950 the Consolidated Patent Act, 1949, came into force and made many important changes in patent law. Most of these amendments had been recommended by the departmental committee on patents presided over by Sir Kenneth Swan. Mr. Collins's book deals briefly with all the provisions of this Act. Chapters 1 and 2 deal with questions likely to arise in the course of prosecuting patent applications, and Chapter 3 is concerned with questions after a patent is granted. In Chapter 4 he indicates briefly the grounds upon which a patent may be attacked for invalidity.

The book is well set out, with the main headings printed in heavy type, and marginal references to the sections of the Act are included in the text. For a small book of this kind, the index is exceptionally good, and an attractive feature is that this index refers both to the pages of the book and to the sections of the Act. It is therefore a complete index to the Act, irrespective of the contents of the book. There are references to some important court cases, but the book has the advantage of not being cluttered up with references to many cases which the new Patent Act has put out of date. R. G. LLOYD

Australian Fisheries

A Handbook prepared for the Second Meeting of the Indo-Pacific Council, Sydney, April 1950. Edited by I. G. MacInnes. Pp. 103+6 plates. (Sydney: Commonwealth Fisheries Office, 1950.) n.p.

THIS handbook gives a balanced and informative picture of a young and vigorous fishing industry expanding in spite of the handicap of a general low level of productivity in the surrounding seas. The freshwater fisheries of Australia are of little importance; but the estuarine fisheries are very important, so much so that it is a pity that statistics for these fisheries are not given. The deep-sea trawling and seining fisheries contribute 16 million out of an estimated total production of some 91 million pounds of fish in 1948–49; it is the distribution of the balance which would be so informative, and one has to search through the text for such statistical data as are given.

The lack of statistical tables, however, is the only criticism in a most useful booklet. The fine work being done by the research staff is summarized; in more than one instance this research has led directly to new fishing industries.

The distribution of the existing fisheries is shown, and explained in terms of produce and markets. The expansion of canning and freezing may, however, open up fisheries in sparsely populated areas, as has already happened in the case of Tasmania. Six useful plates illustrate the principal Australian fishes of commercial importance. C. F. H.

Journal of the Institute of Metals

Editor: Lieut.-Colonel S. C. Guillan; Assistant Editor, Major W. G. Askew. Vol. 75, 1948–49. Pp. lii+1230+138 plates. (London: Institute of Metals, 1949.) 60*s*.

THE Institute of Metals attempts the difficult task of providing a society to serve the interests of those concerned with the industrial side of non-ferrous metallurgy, and of purely scientific workers. The present volume shows how admirably this dual function is fulfilled on the publication side. It contains fifty-four papers covering such a wide range that any metallurgical reader will find much of interest. The standard of printing and illustration is high, but the volume of 1,230 pages is far too bulky and should have been split into two parts or separate volumes; the bound copy sent for review will rapidly become detached from its cover in the course of normal laboratory use. The papers include six contributions to a symposium on metallurgical aspects of non-ferrous metal melting and casting of ingots for working, and apart from this the wide range of subjects is remarkable. W. HUME-ROTHERY

INSECT PHYSIOLOGY AND APPLIED ENTOMOLOGY

A MEETING of the Association of Applied Biologists, held in the rooms of the Royal Entomological Society of London on October 12, was devoted to "Insect Physiology in Relation to Applied Biology". Dr. V. B. Wigglesworth was in the chair.

In opening the discussion, Dr. Wigglesworth claimed that insect physiology makes no direct contribution to applied entomology. The control of insect pests by biological methods is based upon ecology; but a proper understanding of the ecology of an insect is impossible without a knowledge of its physiology. The practical value of this knowledge lies in the new ideas that it gives to the applied entomologist. Similarly, all the greatest discoveries in the use of insecticides have been made empirically. But the subsequent study of the diverse physiological mechanisms involved in insecticidal action has served to codify our knowledge, to put it on a rational basis and to point the way to further advances.

The study of insecticidal action may be pursued at three levels: the uptake of insecticides from the environment, their passage through the protective coverings of the insect or its egg, and the intervention of insecticidal poisons in metabolism. Dr. W. A. L. David discussed the physiological and anatomical factors involved in the accumulation of contact insecticides. The movement of the insect plays a most important part; and, as Dr. E. A. Parkin pointed out later in the discussion, the insecticide may itself influence the insect's movement and so the quantity of poison it acquires. Insects walking on a treated surface will pick up increased amounts of poison. The fine droplets that compose insecticidal mists will strike the insect only if they have sufficient momentum or if the insect itself is moving rapidly enough. They are, indeed, effective as a rule only if the insect is in flight, and, since the wings of flies or mosquitoes commonly move at least ten times as fast as the body, by far the greater number of droplets are taken up by the beating wings. Many different factors have to be considered in the accumulation of insecticidal dusts by insects. Some dusts are physically bulky, others dense; and the appearance of the treated insect may give a totally misleading impression of the weight of dust accumulated. In the case of rough or hairy insects, large amounts of the dust collected may be quite out of contact with the effective sites of entry; and with a single species of insect the same amount of the active principle accumulating on the body may be more effective when associated with one carrier than with another, because the shape of the dust particle has an important influence in ensuring contact with the vulnerable areas.

Dr. J. W. L. Beament pointed out that recently acquired knowledge of the structure of the cuticle and egg-shell of insects goes some way to explain the variable toxicity of contact poisons. In both the cuticle and the egg-shell a thin layer of wax forms the most important barrier; an insecticide must dissolve in wax and have a suitable partition coefficient between oil and water. Local differences in the structure of the membranes demand detailed study. In the egg of Heteroptera, for example, the general surface is totally impermeable to the most potent poisons. But around the rim of the cap are respiratory ducts containing an air-filled, spongy substance leading to a thin layer of the same air-filled material lining the shell. Insecticides with suitable wetting properties will readily fill layers of this type, which are of common occurrence in insect eggs, and they are then separated from the contents of the egg only by the thin wax layer. Some eggs deposit a further layer of impermeable material inside the wax. The formation of this layer may be correlated with a great increase in the resistance of the egg to insecticides when it reaches a certain age. It may become susceptible again in the late stages of development when this inner membrane is dissolved; or the embryo may be poisoned by the quantities of insecticide that have been held in this protective membrane and liberated during its solution. Clearly the age of eggs must be most carefully controlled in making ovicidal tests.

Dr. C. Potter described a number of researches by himself and his colleagues, Dr. K. A. Lord and Dr. A. H. McIntosh, which served to illustrate some of the physical and biochemical factors concerned in insecticidal action. The size of particles of an insecticide applied externally may greatly influence the toxic action. Small particles of rotenone are several hundred times more toxic than layer particles. With DDT the difference is less evident—perhaps because it is so much more soluble in the lipoid layer of the cuticle that its rate of entry is not greatly influenced by being in finely particulate form. The same correlation between the effect of particle size on toxicity, on one hand, and lipoid solubility, on the other, is seen when the poisons are injected into the blood stream. Temperature may influence the toxic action of insecticides in several quite different ways. Pyrethrins, DDT and some other poisons are much more toxic if the insects are kept at a low temperature after spraying. This is mainly an effect on metabolism. But at high temperatures insects move more actively; they may therefore pick up more of the insecticide from the environment and thus show an increased mortality at higher temperatures. Moreover, at low temperatures the more rapid solubility of small particles is accentuated so that their relative toxicity is even greater. The action of insecticides in metabolism was illustrated with reference to the organo-phosphorus compounds. These are powerful inhibitors of choline-esterase, and when an analogous series of organo-phosphorus insecticides is examined there is a partial correlation between choline-esterase inhibition and toxicity. But there are other esterases present in insects which do not hydrolyse acetylcholine, and it has been found that these also are inhibited by the organo-phosphorus insecticides; and it may well be that this effect is involved in their insecticidal action—for example, when they kill insect eggs at an early stage of development. A knowledge of the differences between the esterase systems of insects and mammals might serve as a basis for selecting chemicals toxic to insects but relatively non-toxic to man.

The interrelations between physiology, ecology and cultural control were illustrated and discussed with reference to the sheep tick *Ixodes ricinus*, an important carrier of a number of serious diseases in sheep on hill farms. Dr. A. Milne described the general features in the ecology of this tick. It is widely spread throughout the hill sheep-farming areas of Great Britain, but occurs only in those localities where the pastures are rough, with a thick layer or 'mat' of dead and dying vegetation at the base of the herbage. The humidity in this mat is always about 100 per cent, and it appears to be this high humidity which is the limiting factor in the distribution of the tick. This is not surprising when it is realized that the sheep tick is not resistant to desiccation, and yet during its life-cycle of two to three years it spends only about six weeks in feeding on its host. For the rest of its life it is lying inactive in the moist mat or is at the tips of the grass stems waiting for a passing host. In most of the country there is only one period, in the late spring and early summer, during which the ticks are active in this way. But there are some localities, notably in the west of England, where there is a second peak of activity in the autumn. (An apparent peak in the summer which has been described in Wales is spurious and has been wrongly inferred from the gradual rise in the numbers of ticks upon stock introduced to infested pastures.) Pasture improvement, with the elimination of the humid 'mat', will effectively eradicate the sheep tick—though this is seldom economically practicable on the hill farms.

Dr. J. Allan Campbell described his detailed studies of the developmental cycle of the sheep tick in Nature. The temperature in the natural environment ranges between -2° C. and $+15^\circ$ C. At these temperatures development and egg-laying proceed at much slower rates than has been inferred from studies in the laboratory. In the normal cycle the tick at each stage of its development feeds in the spring or early summer, moults or oviposits during the summer, and overwinters in the unfed state. But there is a second cycle in which the ticks feed in the autumn, pass the winter in the egg or in the engorged state, and hatch or moult in the spring. It is these two populations, between which there seems to be little interchange, which are responsible for the two peaks of activity in the spring and in the autumn. The threshold temperature for development of the egg is 7° C.; but the eggs laid by the ticks of the autumn feeding cycle will not develop, even at 10–20° C., until they have been exposed to severe cold for a good many weeks.

The physiology of the sheep tick, as described by Dr. A. D. Lees, goes far towards explaining the observations made on its ecology. When compared with a series of other ticks, *Ixodes ricinus* has a cuticular wax of very poor waterproofing powers, and it is this which limits its distribution. The closely related dog tick *Ixodes canisuga*, which has a cuticular wax of higher melting point, is alone able to survive in the kennels of the sheep dogs, although both species are picked up by them. So long as *Ixodes* remains in a nearly saturated atmosphere, it can absorb water vapour actively through its cuticle and maintain its water content. When it becomes active in the spring, the unfed tick shows a negative response to gravity and an avoidance of high humidity which lead it to the tips of the grasses, where its sensitive responses to vibration, to passing shadows and to eddies of warm air and smell enable it to cling to a passing host. The unfed tick at each stage of its life-cycle can remain latent in the humid mat for many months. The length of time it can resist starvation is determined by its reserves of fat carried over from the previous stage. After becoming active and resting for some time at the tips of the grasses, it loses moisture and it then returns to the mat to restore its water content by the active uptake of water vapour. This form of activity is necessary if the tick is to secure a meal to enable it to grow or reproduce. But it soon exhausts the limited reserves of fat, and the active tick dies of starvation far sooner than the more sluggish individual which remains dormant at the base of the vegetation.

In closing the discussion, Dr. Wigglesworth said that the sheep tick problem was chosen because it illustrates particularly well the way in which a knowledge of the detailed physiology of a pest enables the applied biologist to think clearly and rationally about it and to see his problems in a new light. That is part of the debt of applied entomology to insect physiology. But there is a debt of perhaps even greater magnitude in the other direction. Many of the most important discoveries in insect physiology, and indeed in biology in general, have resulted from the intellectual stimulus of contact with some practical problem.

BUILDING RESEARCH CONGRESS, 1951

THE Building Research Congress held in London during September 11–20 was the outcome of co-operation between some two-dozen professional institutions and trade federations interested in building and civil engineering construction, the Department of Scientific and Industrial Research and the Ministry of Works. As the first of its kind ever to be held, it aroused much interest both in Great Britain and overseas, and among its 1,400 members were representatives of more than fifty countries; of the eighty-eight papers presented forty-five were by authors from outside Great Britain. The enthusiasm with which the Congress was greeted was a clear indication of the need for such a conference, and the large attendance from abroad was a tribute to the regard in which the pioneer work of Great Britain in this field is held. The Congress, the organization of which was largely undertaken by the Building Research Station of the Department of Scientific and Industrial Research, met under the presidency of Lord Samuel.

The opening session, held at the Institution of Civil Engineers on the morning of September 11, was the occasion of the first of Lord Samuel's thought-provoking contributions. He directed attention to the effect environment—man-made as well as natural—has had on individuals and pointed out the effect that building research could therefore have on individual and national life. Dr. F. M. Lea, director of building research in the Department of Scientific and Industrial Research, traced the growth of organized building research and made a plea for still closer co-operation of industry in the application of its results. In the afternoon members were the guests of the Government at a reception at Lancaster House, and later, under the auspices of the Parliamentary and Scientific Committee, visited the new House of Commons Chamber and other parts of the Palace of Westminster.

For the technical sessions, the Congress was organized in three divisions, dealing with the engineering and constructional problems, with building materials, and with the factors affecting the use of buildings. For most of the period of the Congress there were thus five concurrent sessions; the papers, all of which had been specifically invited, had been circulated before the Congress and were therefore only briefly introduced, so that most of the time was available for discussions, which were at all times lively.

The first two sessions in Division 1 were devoted to papers dealing with the influence of mechanization and prefabrication on techniques and cost of building. After a general review had been given by R. Fitzmaurice (Great Britain), there were papers from Holland, the United States and France, on the latest developments in the building of dwellings in these countries. It was apparent that there is still a good deal of work in progress on non-traditional construction. Research into the use of mechanical aids in building operations was covered in a paper dealing with work in Great Britain, and it was pointed out that the full application of aids of this sort has yet to be effected. The last paper in this group was from Switzerland and dealt with the changes which new building methods bring into design and drawing-office procedure. Perhaps the main feature brought out in the discussion of this group of papers was the slow effect innovations have on the structure and techniques of so traditional an industry.

Three sessions were then devoted to the influence of modern research on structural design, in which a general review paper was given by Prof. G. Wastlund (Sweden). A group of four papers dealt with research on the use of concrete in structures, and considerable interest was aroused particularly in the two papers in this group which dealt with pre-stressed concrete and the design and use of thin concrete shells. A further four papers dealt with research into the use of steel in structures; and these papers covered such points as the way in which research has been helping the designer, research on structural steelwork particularly with reference to the behaviour of structures beyond the elastic range, and the application of welding in steel structures. A third session in this group was devoted to timber and light alloys; in this session there was a paper dealing with the modern development of the use of glued laminated timber as a structural material.

The final two sessions in Division 1 were concerned with the influence of modern soil studies on the design and construction of foundations, and it was fitting that the introductory paper should have been written by Prof. K. Terzaghi (United States). The other papers presented were drawn from the United States, Great Britain, Canada and Holland.

The proceedings of Division 2 opened with an introductory paper by Dr. T. W. Parker, deputy director of building research, Department of Scientific and Industrial Research, on general trends in research on building materials, in which reference was made to the importance of pursuing an adequate measure of fundamental research, despite the pressing demands of day-to-day technical problems, and to the need for the co-ordination of information on materials so that each may be used to the best advantage to meet the overall functional requirements of the building. The remainder of the proceedings were concerned with papers from Britain, Canada, Australia, South Africa, the United States, France, Holland and Germany, on varied aspects of research on the production, properties or utilization of the main building materials.

Four papers on the weathering and durability of building materials generally and another on the durability of concrete in engineering structures demonstrated the complexity of a subject that covered the whole range of building materials under temperate, tropical and sub-arctic conditions, and revealed much common ground of observation and experience.

Papers on burnt-clay products described developments in manufacturing processes induced in some measure by the need for economy in the use of both fuel and labour, and showed evidence of the growing recognition by the industry of the part that new fundamental knowledge of the nature of clay can play in guiding technical control of the operations. A survey was presented of the work that has been done, mainly in Great Britain, on the structural performance of burnt-clay products in respect of strength, resistance to rain penetration, fire resistance, and other functional requirements—investigations that provide a sound basis for framing codes of practice and building by-laws.

Contributions from the United States, Britain and France on the quality control of concrete on building sites showed that substantial advantages can be gained by the adoption of an organized system of control. Concrete of the quality specified in a contract can be secured with a reduced consumption of cement. Appropriate change in the conventional form of specification would provide an incentive to take economic advantage of the use of quality-control methods.

The economic and functional merits of light-weight concretes were discussed, and a review was presented on the effects of curing concrete at elevated temperature, each with comments on the directions in which there is still scope for fundamental and technical investigation.

Two papers dealt with the utilization of building stone with particular reference to means for reducing costs. One referred to the adoption of a restricted range of standard sizes of block stone in the French Standard *B*10-001 and described the construction and performance of the machines that have been developed in France for winning the stone from the quarry face and for its subsequent preparation. The other paper, based on a recent survey, set out the present differences in the cost of building houses in stone and in brick in the more important stone-producing districts of England and Scotland, and suggested ways in which the cost of building houses in stone might be reduced.

A contribution on the burning and hydration of lime described physicochemical studies that have been undertaken in South Africa with the object of explaining and eliminating building defects attributed to unsoundness in certain magnesium limes used there. Other papers dealt with the production, properties and uses of calcium sulphate plasters, with paint application, and with developments in limewash and cement paints.

The proceedings of Division 2 concluded with the presentation of three papers on timber technology. One, on the resistance to wear of timber flooring, described the development of testing equipment to reproduce qualitatively and quantitatively the wear effects observed in service; another described investigations on the use of plywood as a building material; and the third, investigations on the durability and preservation of timber.

Division 3 concerned light, heat and sound in buildings, and design research on three types of buildings—hospitals, factories and schools. Papers had been invited from authors in Great Britain, United States, Sweden, Holland, Germany, Austria, South Africa, Australia, Switzerland and France.

In the group of papers on lighting research and its application to building problems, the four main aspects of the problem were each treated in turn. First there was a group of papers dealing with the brightness pattern of the work (meaning the particular object of attention) and its surroundings. Then came a group of papers dealing with sources of artificial light, where the difficulty is to get desired levels of lighting on the work and elsewhere without these sources sending too much light directly into the observer's eyes. The same sort of problem was stressed in the group of papers on the use of daylight, where the window is the source of light. The final group of papers was on the use of colour, by which one factor in brightness is controlled. Papers in this group on lighting made their contributions through the study of principles, of measurement and of subjective investigation, all being applied to the buildings themselves.

In heating, the range of the subject-matter discussed was wide both in methods and geography. There were papers on laboratory and analogue studies, on full-scale experiments, and on the problems presented by the range of climates from temperate to tropical. The effect of building design, and especially of thermal capacity, was found as an influence in most of the papers and discussions, especially in relation to the problems of non-steady heating. These same factors appeared also in the consideration of tropical buildings where thermal capacity is one of the main design factors by which tolerable conditions can be obtained when expensive cooling equipment cannot be used. In the session devoted to the design of heating plant, an interesting recent technique reported was the use of high-pressure hot-water systems using temperatures as high as 350° F. (176·7° C.) with consequent savings in size and cost of heating services.

The group of papers on sound were centred round the topical acoustical problems associated with auditoria and broadcasting studios. Once again, the range of matter discussed was wide, and extended from the contribution which recent theoretical developments in acoustics may be able to make to design as compared with older geometrical and statistical methods, to the consideration of the very large halls which are a feature of United States auditoria and which seat upwards of five thousand people. The particular problems of broadcasting studios were discussed in papers from Great Britain and Switzerland, as were open-air auditoria, general-purpose halls and halls designed specifically for musical purposes.

Towards the end of the Congress three sessions in Division 3 were devoted to the study of three particular types of building. One session was devoted each to hospitals, factories and schools. This application of building research is a recent development, and it is perhaps surprising to find the strict way in which experimental techniques can be, and are being, used in architectural design research. This was most strikingly demonstrated in the hospital section, where detailed observations of the use and administration of wards have led to a new thesis in planning which is now to be the subject of full-scale experiment. The schools section revealed an equally interesting innovation in the use of large-scale industrial development methods for the production of high-quality schools of various types. The section on factories was notable for the stress laid on the contribution the architect can make not only to the appearance of the building itself, but also to the detailed planning and arrangement of its interior in terms of the work to be done inside the building.

It is appropriate that the closing meetings, on September 20, should have taken place in the Royal Festival Hall, which is itself an outstanding contemporary example of the application of building research. No formal summing-up of the Congress was attempted; but at the morning session a number of members from overseas gave their impressions of the effect the Congress might have on the problems of their countries. Several of those who spoke took the opportunity of suggesting that smaller and more specialized conferences might be arranged in the future and then followed by another comprehensive congress after a period of several years. In the afternoon, Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, gave an address in which he directed attention to the urgent need for the fuller application of the results of the work of men of science in this field.

LOCALIZATION OF GUSTATORY AND OLFACTORY ENZYMES IN THE RABBIT, AND THE PROBLEMS OF TASTE AND SMELL

By A. F. BARADI and Dr. G. H. BOURNE

Department of Histology, London Hospital Medical College, E.1

IT has been shown[1] that alkaline glycerophosphatase is localized in the gustatory regions of the tongue in a number of mammals (bat, rabbit and man) and in the olfactory mucosa of the rabbit. Since then, Baradi and Bourne[2] have shown that a simple esterase is present in the taste buds and epithelium of the papilla foliata of the rabbit, and that the histochemical reaction for this enzyme was inhibited by the addition of quinine to the substrate mixture and the glycerophosphatase reaction by vanillin.

In addition to these two enzymes, we have found that enzymes are present in the papilla foliata and the olfactory mucosa of the rabbit which split various substrates, such as hexose diphosphate, adenosine triphosphate, muscle adenylic acid (5-nucleotidase, Reis[3]), yeast adenylic acid (3-nucleotidase), nucleic acid (probably ribonuclease), long-chain fatty acids (lipase), alpha-glycerophosphate at pH 3–5 (acid phosphatase). The distribution of these enzymes in the papilla foliata is shown in Fig. 1. In general, one can say that all the enzymes are located in the epithelium lining the folds between the papillæ, although some are present in addition in the neighbouring epithelium. Acid phosphatase is present in only small amounts at the bases of the papillæ; ribonuclease is present only in the epithelium immediately overlying the taste buds; esterase and acid phosphatase are present in taste buds and in Ebner's glands; and the enzymes which split yeast and muscle adenylic acid appear to be present in all nuclei in the preparations, as well as in the cytoplasm of superficial epithelial cells.

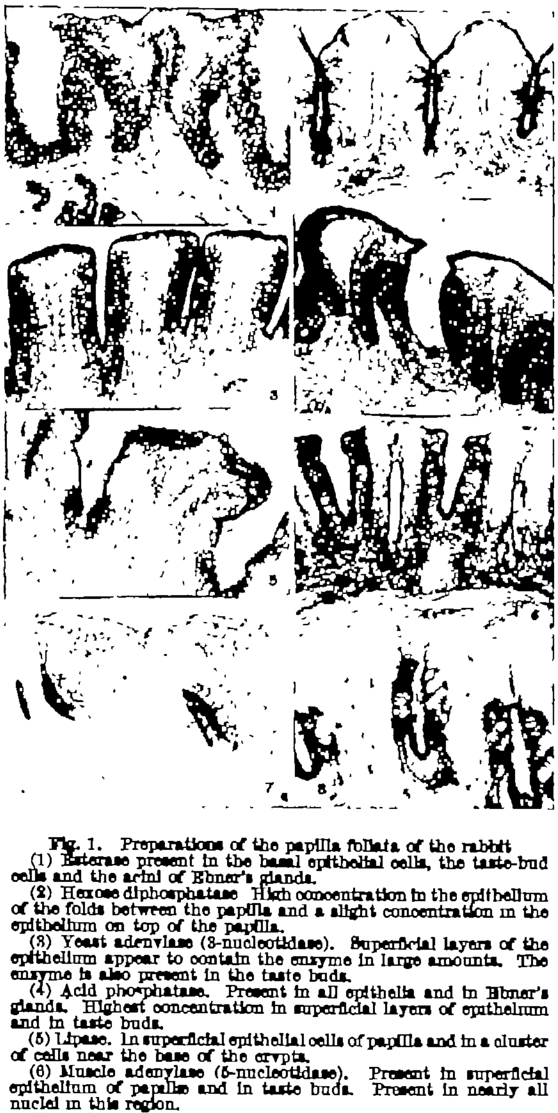

Fig. 1. Preparations of the papilla foliata of the rabbit

(1) Esterase present in the basal epithelial cells, the taste-bud cells and the acini of Ebner's glands.

(2) Hexose diphosphatase High concentration in the epithelium of the folds between the papilla and a slight concentration in the epithelium on top of the papilla.

(3) Yeast adenylase (3-nucleotidase). Superficial layers of the epithelium appear to contain the enzyme in large amounts. The enzyme is also present in the taste buds.

(4) Acid phosphatase. Present in all epithelia and in Ebner's glands. Highest concentration in superficial layers of epithelium and in taste buds.

(5) Lipase. In superficial epithelial cells of papilla and in a cluster of cells near the base of the crypts.

(6) Muscle adenylase (5-nucleotidase). Present in superficial epithelium of papillæ and in taste buds. Present in nearly all nuclei in this region.

(7) Nuclease (probably ribonuclease). Present only in epithelium immediately on top of taste buds.

(8) Effect of adding quinine to ribonuclease substrate mixture in which slide was incubated. All epithelium between papillæ shows high concentration. Enzyme also now present in taste-bud cells.

The distribution of enzymes in the nasal mucosa is shown in Fig. 2. All the phosphate-splitting enzymes are concentrated entirely in three or four basal cells in the olfactory epithelium. As centres of enzyme activity these cells appear comparable with the stratified epithelial cells which line the folds in the papilla foliata. The ducts of Bowman's glands are positive for alkaline glycerophosphatase but the glands are negative. However, they are positive for lipase and esterase. Lipase is only present in this site; but esterase is present in all the cells of the olfactory epithelium as well.

The localization of these enzymes in and around the gustatory and olfactory organs in the rabbit suggests that they may be associated in some way with the mechanism of smell and taste.

It has been suggested by Kistiakovsky[4] that the mechanism of smell could be explained by the existence in the olfactory mucosa of four enzyme groups (one for each of the theoretical basic smells), and that odoriferous substances are distinguished by their differential inhibition of particular enzyme groups. The same explanation might be used to account for a mechanism capable of distinguishing between substances of different taste.

At the time Kistiakovsky's suggestion appeared, we had already tried out the *in vitro* effect on the gustatory enzymes of a number of substances with a well-defined taste. These had been added to the substrate solutions used for localizing the enzymes. Complete details will be published elsewhere, but we refer here to a few of the more outstanding results. Vanillin (0·05 per cent) inhibited glycerophosphatase activity but had no effect on any other reactions. Tea infusion inhibited esterase and ribonuclease reactions. Sucrose had no effect and saccharine inhibited esterase. Quinine inhibited the glycerophosphatase, the 5-nucleotidase and the esterase reactions and greatly *increased* the ribonuclease reaction. Some inhibition of the ribonuclease, 5-nucleotidase and 3-nucleotidase (yeast adenylic acid) reaction was obtained by adding enough sodium chloride to the substrate mixture to bring its concentration to twice that of normal saline. Capsicum, aniseed, peppermint and coffee also caused differential inhibition of the various enzyme reactions.

The accentuation of the ribonuclease reaction by quinine suggests that the enzyme was in these sites

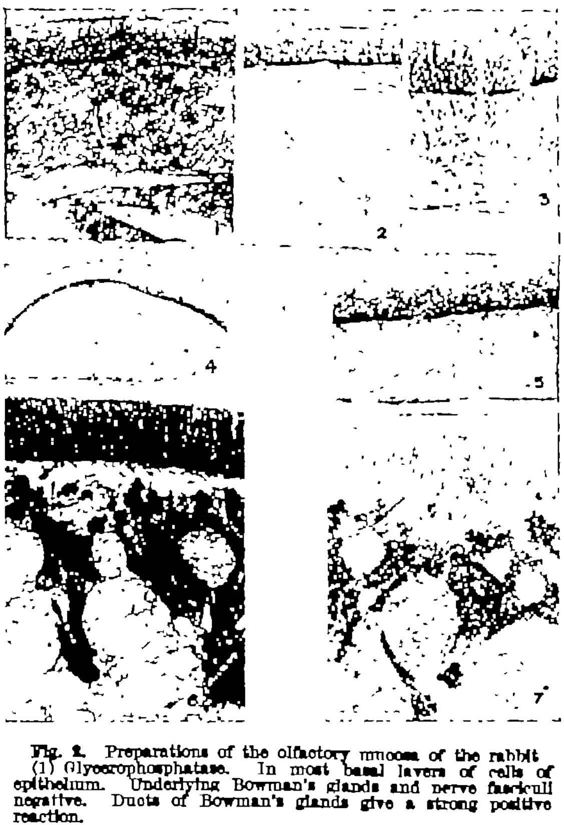

Fig. 2. Preparations of the olfactory mucosa of the rabbit

(1) Glycerophosphatase. In most basal layers of cells of epithelium. Underlying Bowman's glands and nerve fasciculi negative. Ducts of Bowman's glands give a strong positive reaction.

(2) Hexose diphosphatase. In most basal cells of epithelium only.

(3) Adenosine triphosphatase. Present only in most basal cells of epithelium.

(4) 5-Nucleotidase. Principally in most basal layer of epithelial cells. All nuclei are positive. The enzyme also present on surface of epithelium.

(5) 3-Nucleotidase. Principally in basal layer of cells of epithelium. More superficial cells of basal cells also positive.

(6) Esterase. All basal cells of epithelium intensely positive. Olfactory cells also positive. Bowman's glands intensely positive. Nerve fasciculi negative.

(7) Lipase. Only Bowman's glands positive.

before, but at too low a concentration to give a positive result. The amount of quinine used (0·5 per cent) would have been sufficient to combine with all the substrate present and may have facilitated its splitting by low concentrations of the enzyme. It seems probable that all these substances may exert their effect by combining with the substrate. The possibility of some interference with a co-enzyme must, however, also be considered. It is also of interest that the *dl*-isomer of tryptophane, which is sweet, inhibits the glycerophosphatase reaction, and the *l*-isomer, which is bitter, has only a slight inhibitory effect.

A number of technical criticisms may be made of this work, and if they were correct they may to some extent invalidate it. These are: (1) Is there a non-specific attraction by the apparent sites of enzyme activity for some of the reaction products (for example, calcium phosphate)? (2) The enzyme may be present in a particular site and give no reaction[3]; this is supported by the way quinine causes a positive ribonuclease reaction in otherwise negative sites. (3) Are we demonstrating one phosphate-splitting enzyme or a number of such enzymes? (4) Are the inhibitions of activity true interference with enzyme substrate reaction, or do they simply represent interference with the histochemical reaction, for example, prevention of deposition of reaction product?

If (1) were correct, all phosphate-splitting enzymes would have an identical distribution. They do not. Also, at the suggestion of Prof. J. Danielli, calcium phosphate was precipitated by adding hydrogen peroxide to the incubating medium over a section in which enzyme activity had been destroyed. There was no particular affinity on the part of the sites of enzyme activity for the calcium phosphate. The second criticism may be correct, but we claim only that positive results indicate the presence of enzyme and we do not deny that it may be present in apparently negative sites. In fact, our results indicate that it may be present in such sites. In the case of (3), it may be that glycerophosphatase, a known non-specific enzyme, may contribute to some extent to the results obtained with other substrates; but different distribution, together with differential inhibition (apart from other independent evidence), strongly suggest that we are dealing with a series of different, though probably closely related, enzymes. If the inhibitions represent only interference with the histochemical test (4), then, for example, any substance which inhibits one phosphate splitting enzyme will inhibit them all. This is not the case, and, in fact, one inhibitory substance (quinine) actually accelerates the action of another phosphate-splitting enzyme. Further discussion of this problem will be given in subsequent publications, but at the moment we believe that these inhibitions represent true interference with enzyme substrate reaction, even allowing for the well-known variability of histochemical preparations.

If we assume, therefore, in the absence so far of any contradictory evidence, that these enzymes are localized in the sites described, and that their action is inhibited or accelerated by various substances with pronounced taste, we are impelled to ask in what way such a mechanism could explain any of the phenomena of taste.

Generally speaking, the enzymes we have studied are localized in six main sites. Furthermore, there is an abundant nerve supply[6,7] to the epithelium of the papillæ as well as to the taste buds.

Taking these facts into consideration, we suggest the following tentative hypothesis to explain their relation to the mechanism of taste. The chemical reaction involved in the breakdown of substrate by enzyme presumably gives rise to ionic changes which would induce currents in nearby nerve fibres. We can then conceive of a tasting substance coming into contact with superficial enzyme sites. It would inhibit the activity of an enzyme in one site, accelerate the activity of an enzyme in another site and have no effect on enzymes in other sites and so on. It would therefore alter the pattern of nerve impulses reaching the brain, and each substance would produce its own individual pattern. Since there are six main sites of enzyme activity, each of which can be accelerated, inhibited or left unaffected, we have a mechanism for distinguishing between 2,160 tasting substances. This hypothesis therefore makes the conception of four basic tastes unnecessary. It also suggests that the taste buds are not the sole organs of taste, but that they are only reference or focusing points to which the brain can relate impulses coming from other sites; in other words, they give precision to taste.

This hypothesis also serves to explain why substances of widely differing chemical nature can have a similar taste. The distribution of the enzymes overlaps at the various sites; therefore inhibition of *different* enzymes at the *same* sites by *different* substances will produce the same pattern of nerve impulses, which will be interpreted by the brain as the same taste.

The same hypothesis can probably be used to explain the sense of smell. Most of the gustatory enzymes have also been found in the olfactory mucosa (and are inhibited in the same way). Here again we feel that the sense of smell may not be the sole property of the so-called olfactory cells but that these cells may act only as reference points with relation to the rest of the olfactory mucosa and that, in fact, they may function in the same way as the taste buds in the tongue.

There are almost certainly very many more enzymes in the gustatory and olfactory regions, but we are limited in this work to those which can be localized histochemically. There are still some, for which histochemical tests exist, which we have not yet tried. Nor have we yet taken into account the significance of the distribution of certain enzymes in Ebner's and Bowman's glands.

This conception of taste and smell can, of course, be only of a provisional nature and it may, in the light of future work, be subject to substantial alteration. Nevertheless, we find it useful at the present moment as a working hypothesis.

The phosphate-splitting enzymes were demonstrated by the technique described by Gomori[8], the lipase also by a Gomori method[9] and the simple esterase by Gomori's unpublished modification of the Nachlas–Seligman method[10].

We are indebted to W. J. Bush and Co., Ltd., for a supply of essential oils and essences used in this work.

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ANNIVERSARY OF TRANS-ATLANTIC RADIO

By Dr. R. L. SMITH-ROSE

On December 12, Marconi's Wireless Telegraph Co., Ltd., is celebrating the fiftieth anniversary of the first demonstration that electromagnetic waves could be transmitted across the Atlantic Ocean, over a distance of 2,200 miles. Following Marconi's early experiments in Great Britain, wireless telegraphy was developing very rapidly at the turn of the century for short-distance communication; particularly between ships and shore. Early in 1900, Marconi applied for a British patent describing appliances for conducting what was termed 'syntonic telegraphy', in which for the first time provision was made for adjusting the transmitting and receiving apparatus to operate on the same frequency or wave-length. The investigations on what we now understand as 'tuning' the equipment were essential steps in the development of long-distance trans-oceanic wireless telegraphy; and a year later, in January 1901, communication was established between St. Catherine's, Isle of Wight, and the Lizard, Cornwall, a distance of two hundred miles. Prior to this achievement, however, Marconi had already decided to make a serious attempt to send electric waves across the Atlantic; and he had enlisted the services of John Ambrose Fleming to assist in the design and installation of a high-power spark transmitting station at Poldhu in Cornwall. The project was not without its difficulties; and, viewed from the vantage point of fifty years later, the detailed technical history is of some interest and will be found recorded in Fleming's book on "The Principles of Electric Wave Telegraphy and Telephony", the first and second editions of which were published in 1906 and 1910, respectively. Reference may also be made to a "Handbook on Radio Communication", published by the Science Museum (see *Nature*, 135, 326; 1935), and to the fact that this Museum has in its collections some of the items used in these experiments.

Fleming was responsible for specifying the electrical engineering plant to be used (having an output of 25 kW.) and for designing special portions of the apparatus for generating and controlling the, for that time, powerful radiation of electric waves it was desired to create and use. At the same time, Marconi decided on the nature of the aerial system to be erected, which originally comprised a ring of twenty masts, 200 ft. high, arranged in a circle of 200 ft. in diameter, and supporting aerial wires grouped in the form of an inverted cone.

In the early months of 1901, experiments began with the view of completing the arrangements, and numerous telegraphic tests were carried out between Poldhu and Crookhaven in the south of Ireland, and Niton in the Isle of Wight. There were various set-backs, not least of which was the wrecking of the aerial system at Poldhu by a storm on September 18, 1901. The Marconi Company, however, quickly erected two wooden masts 160 ft. high and 200 ft. apart and carrying a fan-shaped aerial of 50 wires. Within two months, sufficient progress had been made to enable Marconi to contemplate making an experiment across the Atlantic; and he left England on November 27, with his two assistants, G. S. Kemp and P. W. Paget, arriving at St. Johns, Newfoundland, on December 5.

Here again, there were difficulties associated with rough weather. The receiving station was located in a government building at Signal Hill, Newfoundland, and the aerial was supported in the first place by a balloon. This was, however, lost on its first ascent, and was replaced by a large kite carrying an aerial wire which was successfully flown to a height of 400 ft. The rise and fall of the kite in the wind caused variations in the capacity of the aerial, and this precluded the use of any of the syntonic receiving apparatus which was then available. The apparatus actually used was simply a self-restoring coherer in series with the aerial and a telephone earpiece.

By prior arrangement, confirmed by cable, a daily programme of transmissions which consisted in sending the letter *s* (three successive dots in the Morse code) began on Wednesday, December 11. These signals were received and recognized on the following day, December 12, at 12.30, 1.10 and 2.20 p.m., and again at 1.38 p.m. on Friday, December 13. In this way, the fact was established that, contrary to the expectations and predictions of some theoretical workers, these electromagnetic waves could be transmitted and successfully detected around a considerable fraction of the curved surface of the earth.

The achievement created an immense sensation in every part of the civilized world, although, of course, there was much to be learned concerning the laws of propagation of radio waves and the influence of the ionosphere as we know it to-day, before communication sufficiently reliable for the transmission of coherent messages could be attained. This accomplishment was the starting point of the past fifty years of development leading to the vast and complex network of communications, broadcasting and navigation services in use to-day.

In December 1902, the Poldhu station began the first trans-Atlantic wireless telegraph service; and with various modifications from time to time this service continued until June 10, 1922, when Poldhu was finally closed for public transmissions. After that the station was used by C. S. Franklin in his experimental work with Marconi on directional short-wave transmission. Poldhu was dismantled in 1933; to-day a memorial column of granite marks the site, and inscriptions on three of the four plaques on its sides summarize the achievements described above. The fourth plaque records that "The site of this column and some six acres of land on the edge of these cliffs together with the cliffs and the foreshore beneath them were given to the National Trust in 1937 by the Marconi Company to commemorate the pioneer work done at the Poldhu wireless station between 1900 and 1933 by its research experts and radio engineers".

In concluding this article, reference may be made to another milestone in the development of radio communication across the Atlantic. This occurred twenty years later almost to the day, when, on December 9, 1921, signals were successfully received in Great Britain from twenty-seven amateur transmitting stations in America operating on wave-lengths between 200 m. and 375 m., some using spark and some continuous-wave equipment. These wave-lengths may be compared with that of about 1,800 m. used at Poldhu, and may be regarded as an intermediate step in the development of the short waves (10–100 m.) which are now used for the bulk of the world's long-distance radio-communication and broadcasting services.

OBITUARIES

Mr. William E. Heath

THE sudden death on October 25 of Mr. William E. Heath, reader in agricultural economics and vice-dean of the Faculty of Agriculture and Horticulture of the University of Nottingham, was a heavy loss to agricultural economists in the United Kingdom. Although only forty-five years of age, he was recognized as one of the leading members of his profession.

As head (until 1947) of the Farm Economics Branch of the Department of Agriculture for Scotland, one of his main tasks was the direction of a pioneer study of the problems of marginal agricultural production. At Nottingham, his main preoccupation was the extension of the teaching and research of his Department and the development of standard measures of economic efficiency capable of application by advisory officers and by farmers. Agricultural economists should, in his view, supply the farming community with yardsticks and guide posts which would enable better use to be made of farm resources and assist advisory officers to understand the economic implications of the technical advice they give to farmers. It was also his ambition to build up a good library of agricultural economics literature, and he had recently completed exchange arrangements with every institution in the English-speaking world with an agricultural economics department.

Heath was particularly interested in problems of agricultural policy and of the most efficient utilization of those national resources devoted to agricultural production. He was regarded as one of the best informed and most inspired workers in this important field. He had recently returned from a six months visit to the United States, and as he was a member of the Council of the International Conference of Agricultural Economists his loss will be felt by many outside Great Britain.

Although lamed in youth by an attack of infantile paralysis, he bore his affliction with a courage which compelled the admiration of all who came into contact with him. He took a particular interest in the work of local young farmers' clubs, but he will perhaps be best remembered by many of his younger colleagues for the sound guidance and genuine encouragement he gave them at the start of their careers.

R. BENNETT JONES

Mr. P. A. Curry

PHILIP ARTHUR CURRY, lately deputy director-general of the Physical Department of the Ministry of Public Works, Egypt, died suddenly at Littlehampton at the age of sixty-seven. After his education at Darlington Grammar School and Trinity College, Cambridge, he joined the Egyptian Survey in 1905. During the First World War he served with the Survey Company in Egypt and Palestine and afterwards became deputy director-general of the Physical Department of the Ministry of Public Works, Egypt, from which he retired in 1939. Concurrently with this he was, first, director of the Weights and Measures Service which he started and organized, and afterwards director of Helwan Observatory. He was an excellent administrator, a very good observer and skilful with instruments. Among a large amount of very useful work were the first determinations of gravity in Egypt and the Sudan, the results of which and other work are recorded in scientific papers. He was a good friend and valued colleague, and his death will be regretted by many, both Egyptian and British. He leaves a widow, two sons and two daughters.

H. E. HURST

NEWS and VIEWS

Zoology at Birmingham : Prof. O. E. Lowenstein

DR. O. E. LOWENSTEIN, whose appointment as Mason professor of zoology in the University of Birmingham in succession to Prof. P. B. Medawar has recently been announced, was born and educated in Munich. He became assistant to Prof. von Frisch ; but when the Nazi party came to power he left Germany in 1933. Through the good offices of the Academic Assistance Council and of Prof. H. Munro Fox, he was able to resume research in the University of Birmingham, where he remained, taking the degree of Ph.D., until 1937, when he went as assistant lecturer to Exeter. In the following year he moved to Glasgow, becoming eventually senior lecturer in zoology. He combines to an unusual degree the technical skill and intense research interests of the specialist with the broad knowledge of the teacher. A most distinguished worker in electrophysiology, he has made notable use of the oscillograph to investigate the function of the vertebrate labyrinth. Initial studies, largely in collaboration with the late Dr. A. Sand, on the semicircular canals in fishes, have been followed by analysis of the gravity and vibration responses of the more delicate otolith organs. He is responsible for major advances in knowledge of the distribution of functions within this most complex receptor. The width of Dr. Lowenstein's interests are revealed by his complete revision of the volume on invertebrates in Parker and Haswell's "Text-book of Zoology". No one has lectured more widely on zoological topics to university students, and he has given courses on biology and human affairs to arts students and to adult education classes. He is equally happy as research worker and as teacher, and in both capacities he will find full scope for his great abilities in the further development of the Department of Zoology at Birmingham.

Melvil Dewey (1851–1931)

SCIENTIFIC libraries throughout the world to-day use the Dewey decimal system of classification or one of its modifications. Its originator, Melvil Dewey, was born at Adams Center, New York, a century ago, on December 10, 1851. In his youth he already displayed an enthusiasm for classification and systematization. At the age of twenty-three he graduated at Amherst College, where as acting librarian he first proposed his decimal system of classification for cataloguing and arranging books and pamphlets in a library. In 1876 he helped to found the American Library Association, serving as its secretary from 1876 until 1890 and as editor of *The Library Journal* during 1876–80. Appointed librarian of Columbia

College in 1883, he established the School of Library Economy, the first institution in the United States for the training of librarians. His welcoming of women pupils met with much disapproval, as did his questionnaire concerning their height, weight, and colour of hair and eyes, and his request for a photograph. From 1889 until 1906 he was director of the New York State Library, and he inaugurated a system of travelling libraries and picture collections. A man of boundless enthusiasm and energy, Dewey promoted the use of the metric system and was keenly interested in spelling reform. In his long and useful life this great library pioneer succeeded in making many friends and also many enemies. He died in Florida on December 26, 1931.

The Coal Industry of Great Britain

THE study of the coal industry carried out by the Acton Society Trust and published under the title "The Extent of Centralization" merits the attention of a wider field than those directly connected with the industry, for it may be said that the economy of Great Britain as a whole hinges upon coal, the most important of its natural resources. Apart from the discussion of the position of the technical specialists and the use made of them—a problem which is particularly acute in the coal industry, for reasons indicated in this study, and which is the main source of complaints of over-centralization made by men within the coal industry—the report is important as providing strong evidence against the desirability of rapid and sweeping changes by legislation or otherwise. It points out that improvements are most likely to be achieved gradually; the problems are essentially those of human relations, and what is required appears to be a series of small practical improvements which in the aggregate will eventually change the whole atmosphere of the industry. The inquiry gives a clear picture of the organization of the industry and of the system of technical and functional control in use. It indicates the impossibility of carrying out a large programme of re-equipment and redevelopment on a national scale with the fullest economy without some interference with the free judgment and initiative of local government. Arrangements for achieving these ends are largely responsible for the sense of frustration which exists at several levels of the industry and for many complaints of over-centralization. Some research may well be required in order that all such problems may be solved; and the difficult one of the status of the colliery manager, the wider implications of which are discussed elsewhere, will only be fully solved when by a process of education a more highly trained type of manager, alert enough to seek and use the best technical advice available, is readily obtainable.

Antiquity of the Australian Aborigines

AT the Brisbane meeting of the Australian and New Zealand Association for the Advancement of Science, Mr. Edmund D. Gill, palæontologist in the National Museum of Victoria, gave an address on new evidence for the antiquity of man in Australia. He pointed out that Sir Richard Owen described the extinct marsupial *Thylacoleo* from bones collected by an early settler, William Adeney, from the shore of Lake Colongulac (=Timboon), Western Victoria, beside which he lived. For more than a century this has been the classic locality in Victoria for extinct giant marsupials, *Diprotodon*, *Procoptodon*, etc., being also described from here by Owen, McCoy and others. However, it has not been known previously from what bed these fossils came, but recently this was discovered and fossils collected therefrom. A dingo jaw and a carved bone (the Colongulac Bone of earlier authors), evidences of human occupation, were also collected by Adeney, and are in the National Museum, Melbourne. The fossils from this bed are remanié, being derived from a still earlier bed. An unusual matrix and the type of preservation made it easy to recognize that the collections in the Museum from Lake Colongulac came from this horizon. Since the extinct marsupial fossils were embedded, the local volcanoes have laid down an ash-spread, and a lake has cut back the resultant tuff for a great distance so as to form cliffs in it. After that came a comparatively arid period when the lake dried up, and dunes of loess more than 50 ft. high were built from the desiccated lake floor. In this loess a fossil aborigine was found. Since the dune-building phase, there has been a pluvial period when the lake returned, cutting cliffs 25–30 ft. high in the loess; also a high-level alluvium (now incised) was deposited in the valleys of creeks entering Lake Colongulac (consequent type). The loess is considered to belong to the Mid-Holocene Arid Period and the tuff to early Holocene. The cycles of sedimentation and erosion affecting the fossil bones thus carry back into the Pleistocene. Hence there is evidence for Late Pleistocene and Middle Holocene human occupation of this area.

British Bulletin of Spectroscopy

A NEW venture in the literature of spectroscopy started this September with the first number of the *British Bulletin of Spectroscopy*. It is in the form of a four-page news sheet with notices of forthcoming events, reports of various meetings in Britain and overseas, and notes and comments on recent publications and on new experimental techniques, including a summary of recent progress on applied spectroscopy at the British Iron and Steel Research Association. The *Bulletin* is in two sections: emission spectroscopy, edited by K. Dixon and W. Ramsden; and molecular spectroscopy, edited by G. H. Beavan and W. C. Price. It has been published with the co-operation of the Industrial Spectroscopy Group of the Institute of Physics, the Photoelectric Spectroscopy Group, the Infra-Red Discussion Group and the Physical Methods Group of the Society of Public Analysts and Other Analytical Chemists. It is hoped that the *Bulletin* will mark a step towards closer co-ordination of the several spectroscopic groups in Great Britain. In the foreword, by S. D. Steele, the need is stressed for some publication to cover the many small developments in experimental technique which often fail to find their way into the major scientific journals. It is also hoped that the *Bulletin* may become a useful medium for expressing views by correspondence, which will be welcomed. It is published independently and is available to all interested at 5s. a year, post free, from the honorary treasurer, W. H. Storey, Unicam Instruments (Cambridge), Ltd., Arbury Road, Cambridge.

The Fair Isle Bird Observatory

THE second annual report of the Fair Isle Bird Observatory Trust is, like the first, a record of sound work well done. During 1950 active field-work was carried out for a period of twenty-eight weeks, the work of trapping and bird-ringing being continued by the Warden during the rest of the year. Among the field-workers were students from schools and universities, some of these making a return visit to continue observations begun in the previous year. In addition to migration news, the report contains sections on selected species, trapping and bird-ringing and ectoparasites. There is also an interesting account of the recorded breeding habits of the arctic skua, great skua, grey wagtail, lapwing and fulmar. Among other items in the report are some notes in field taxonomy, special studies of the wheatear and redwing, and a statistical account of wheatear weights. The report may be obtained from the Honorary Secretary of the Trust, 35 George Street, Edinburgh 2.

Imperial Forestry Institute, Oxford : Annual Report for 1949–50

The twenty-sixth annual report of the Imperial Forestry Institute covers the year 1949–50 (pp. 27; Oxford: the Institute, 1951). The number of students attending the Institute during the year was fifty-nine, thirty-nine being undergraduates. The record number of thirty took the final honours 'school', three obtaining first-class, seven second-class, fourteen third-class and four fourth-class honours. A new departure was initiated in the previous year of sending selected subordinate service officers from the Colonies for a special course, the satisfactory completion of which may lead to promotion. This scheme has been continued, two Nigerian forest assistants and one European forester from Uganda going to Oxford. They completed the courses creditably, and the step taken is undoubtedly a wise one, since the best forest-workers below the officer grade should, if afforded the opportunity, make efficient gazetted officers. One of the successful candidates in the above-mentioned Oxford honours 'school' was a member of the Malayan subordinate forest service, and will be the first Malayan to obtain a forestry degree and promotion to the higher service. The report is full of information; details of the Institute, the practical courses and the research work undertaken by the staff are given. It has one disadvantage: it is difficult to distinguish between Oxford undergraduates taking forestry and the officers from the Colonies taking refresher courses and so forth, particularly as regards the respective courses they are following and especially the practical courses.

Glossary of Terms used in the British Plastics Industry

A recent pamphlet, "Glossary of Terms used in the Plastics Industry" (British Standard 1755 : 1951. Pp. 59; London: British Standards Institution, 1951; 6s. net.), was compiled by the British Plastics Federation and is one of the documents being prepared by the British Standards Institution to cover glossaries of terms used in various industries. It is hoped that the Standard will be of considerable use to members of the plastics industry and will serve as a basis for discussions on an international glossary for plastic materials. The terms are grouped in sections to cover: chemistry; industrial applications; constituents; properties, including thermal, electrical and mechanical; moulding processes and other manufacturing processes such as casting, extrusion, welding and finishing. The terms listed in the sections are fully defined. An alphabetical index is a useful addition.

"Elastic Constants of Alkali Halide Crystals"

The following note added in proof to the communication by Sir K. S. Krishnan and Dr. S. K. Roy published in *Nature* of November 17, p. 869, was received too late for incorporation:

The corresponding table for the elastic constants of cæsium chloride, expressed in terms of $e^2/(16d^4)$, where d is the Cs–Cl distance in the crystal, is:

	11	12	44
s	$6\alpha' - 18\chi'$	$-15\alpha' + 9\chi'$	$-3\alpha' + 9\chi'$
ρ	$2\alpha'(\delta - 2)$	$2\alpha'(\delta + 4)$	$2\alpha'(\delta - 2)$
c	$2\alpha'(\delta + 1) - 18\chi'$	$\alpha'(2\delta - 7) + 9\chi'$	$\alpha'(2\delta - 7) + 9\chi'$

α' and χ' are defined in the same manner as α and χ respectively, except that ξ, η, ζ do not now take all integral values, but are restricted to where they are all three odd, and all three even; $\alpha' = 1{\cdot}018$ and $\chi' = -1{\cdot}08$.

Colonial Service : Recent Appointments

The following appointments have recently been made in the Colonial Service: C. W. Lynn (senior agricultural officer, Gold Coast), assistant director of agriculture, Gold Coast; A. Jackson (senior chemist, Federation of Malaya), chief chemist, Federation of Malaya; R. J. Dewar (assistant conservator of forests, Nigeria), assistant conservator of forests, Nyasaland; S. A. Child (dairy and poultry officer, Northern Rhodesia), livestock officer, Tanganyika; St. G. C. Cooper (agricultural superintendent, British Guiana), agricultural superintendent, Dominica, Windward Islands; D. J. Bettson, agricultural officer, Gold Coast; L. A. Heapy, agricultural officer, Nigeria; J. L. B. Hitchcock, probationer in agriculture, Federation of Malaya; T. E. T. Trought, entomologist, Uganda; T. G. Allan, assistant conservator of forests, Fiji; F. S. Wilson, assistant conservator of forests, Tanganyika; J. L. M. Lambert, geologist (petrologist), Tanganyika; J. Robinson, senior scientific officer (chemist), Colonial Insecticides Research Unit, Tanganyika; Miss K. F. Salmond scientific officer (entomologist), Bulk Stored Grain Infestation Research, Nyasaland; W. A. Sands, scientific officer, Termite Research Unit, East Africa High Commission; B. Steele, scientific officer (botanist), Tsetse Fly Survey, Nyasaland; B. R. Thompson, veterinary officer, Northern Rhodesia; D. C. P. Evans, agricultural officer, Gold Coast; W. P. Jaffe, livestock officer, Veterinary Department, Tanganyika; M. Z. Snihur, meteorological officer, Northern Rhodesia; D. Stephens, specialist in chemistry, Agricultural Department, Gold Coast; K. A. Watson, agricultural superintendent, Nigeria.

Ramsay Memorial Fellowships for Chemical Research

The Ramsay Memorial fellowships for chemical research for 1951–52 have been awarded as follows: L. E. Lyons, a British fellowship of £500 a year at University College, London; James Jack, a Glasgow fellowship of £500 at the University of Cambridge; Dr. K. O. G. Kutschke, a Canadian fellowship at the University of Leeds; Dr. Serafin Novoa, a Spanish fellowship at the Agricultural Department, University of Oxford; Dr. Garcia de la Banda, a Spanish fellowship at the University of Bristol; Dr. Margaret D. Cameron, a United States fellowship at the University of Leeds. These awards involve the re-establishment, with the co-operation of the Fulbright

Commission, of the United States fellowship which has been in abeyance since 1928; they also include a second Spanish Ramsay fellowship. In addition, the British Ramsay fellowship, held by Dr. E. Gelles, has been renewed for a further year, and an extension of four months has been granted to H. Mendel (Netherlands) at the University of Oxford.

The Nature Conservancy: Awards for 1951

The Nature Conservancy has announced the following awards of research studentships for post-graduate training in ecology, tenable for periods of up to three years at the universities named. *Botany*: Miss B. Blanchard (Liverpool); D. H. Dalby, Miss J. M. Laptain (University College, London); M. C. F. Proctor (Queens' College, Cambridge); R. G. West (Clare College, Cambridge); D. A. Robertson (King's College, Newcastle upon Tyne). *Palæontology*: R. E. H. Reid (University College, London). *Zoology*: R. D. Hughes (Imperial College of Science and Technology, London); J. D. Lockie (Balliol College, Oxford); A. W. G. Manning (Merton College, Oxford); D. J. Morris (Magdalen College, Oxford); H. Roberts (University College, Southampton); I. W. B. Thornton (Leeds).

Christmas Lectures for Juveniles (London)

A number of lectures for juvenile audiences, to be held in London during the Christmas holidays, are being arranged by various organizations. At the Royal Institution (21 Albemarle Street, W.1), the Christmas Lectures "to a juvenile auditory" will be given by Prof. James Gray on "How Animals Move" at 3 p.m. on December 27 and 29, 1951, and January 1, 3, 5 and 8, 1952; the fee for these lectures is: juveniles £1, adults £2. The Institution of Civil Engineers (Great George Street, S.W.1) is holding three lectures, for boys 13–17 years of age, on "Exploring for Oil", "Transporting Oil in Peace and War (Pluto)", and "Working of an Oil Refinery", to be given at 3 p.m. on December 28 and 31, 1951, and January 2, 1952, respectively. The Royal Geographical Society (1 Kensington Gore, S.W.7) is arranging a lecture, "Jumbos and Jungles", and a sound film, "Scott's Last Expedition", to be given at 2.30 p.m. on December 28 and 31, respectively, for which application should be made before December 14. At the Institution of Electrical Engineers (Savoy Place, W.C.2) the sixth Christmas lecture of the Institution will be given twice, at 3 p.m. on January 3 and 4, 1952, the subject being "Electricity in Civil Aviation". The Royal Photographic Society (16 Princes Gate, S.W.7) is holding three lectures at 3 p.m. on December 31, 1951, and January 1 and 2, 1952, on "How a Lens Forms an Image", "Three-Dimensional Films", and "The Miracle of the Photographic Emulsion", respectively. In addition, the London County Council is holding twelve lectures on various subjects which will be given in different parts of London between December 31, 1951, and January 4, 1952; applications should be made through the pupil's school.

Scientific Advisers for Civil Defence

The Home Secretary has announced that the following men of science have been appointed, in a voluntary capacity, to advise on civil defence in the regions indicated: *South Western Region* (*Bristol*): senior scientific adviser, Prof. W. E. Garner; scientific advisers, Prof. S. H. Piper and Prof. F. H. Newman. *Midland Region* (*Birmingham*): senior scientific adviser, Prof. H. W. Melville; scientific advisers, Prof. P. B. Moon and Prof. J. R. Squire. *London Region*: senior scientific adviser, Sir Charles Ellis; scientific advisers, Prof. W. V. Mayneord and Dr. H. N. Rydon. *North Midland Region* (*Nottingham*): senior scientific adviser, Prof. L. F. Bates; scientific advisers, Prof. L. Hunter and Dr. D. O. Jordan. *Northern Region* (*Newcastle upon Tyne*): senior scientific adviser, Prof. W. E. Curtis; scientific adviser, Prof. G. R. Clemo. *North Eastern Region* (*Leeds*): senior scientific adviser, Prof. F. W. Spiers; scientific advisers, Prof. W. Bradley and Prof. W. Sucksmith.

Announcements

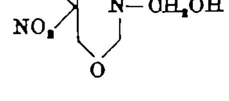
Sir David Brunt, professor of meteorology in the Imperial College of Science and Technology, University of London, has been appointed to the Board of Directors of the Fulmer Research Institute, Stoke Poges, Bucks. The Institute was founded in 1946 on the initiative of Colonel W. C. Devereux, chairman, and opened officially by Sir Stafford Cripps, then President of the Board of Trade, to carry out sponsored research, the results arising therefrom (including patents) belonging solely to the sponsors.

Dr. D. J. E. Ingram, of New College, Oxford, has been appointed research fellow in the Department of Electronics, University College, Southampton, with effect from January 1, 1952. He will be mainly concerned with the work on microwave spectroscopy which is being carried out at the College.

The conference this year of the Universities of Great Britain and Northern Ireland, convened by the Committee of Vice-Chancellors and Principals, will be held in the William Beveridge Hall, University Senate House, London, W.C.2, during December 14–15. There will be three sessions, as follows: "The Procedure for the Selection of Students for Admission to the Universities", "Universities and the Fine Arts" and "Student Health". The conference is only open to delegations appointed by the universities and to specially invited guests. Further details can be obtained from the secretary, Dr. J. F. Foster, at 5 Gordon Square, London, W.C.1.

An account is given on p. 975 in this issue of the Building Research Congress, 1951, which took place in London during September 11–20. The papers presented at the Congress have been printed in three paper-covered books, one dealing with each Division of the Congress. Copies of these books are now available, price 22*s*. 6*d*. each, or 60*s*. for the set of three, from the Organizing Secretary, Building Research Congress, 1951, Building Research Station, Garston, Watford, Herts. The price is reduced in the case of members of bodies which participated in the Congress.

Erratum. In the communication by Prof. T. Urbański entitled "New Derivatives of Nitroparaffins and Antitubercular and Antirickettsial Properties" in *Nature* of September 29, p. 562, formula (III) was incorrectly written; it should be:



DEGRADATION OF DEOXYRIBONUCLEIC ACID BY A 'NITROGEN MUSTARD'

By Dr. J. A. V. BUTLER, L. GILBERT, D. W. F. JAMES and W. C. J. ROSS
Chester Beatty Research Institute, Royal Cancer Hospital, London

IT has been shown[1] that, when treated with certain compounds of the 'mustard' type, deoxyribonucleic acid is degraded, the molecular weight as determined by measurements of sedimentation and diffusion falling from an apparent value of c. 10^6 to values between 10^4 and 10^5. The significance of this has been doubtful owing to uncertainty as to the structure of the nucleic acid and whether the molecular weight represents an aggregate or a single polymeric molecule. If the former, the low values obtained after the treatment might be due to its dissociation into the component units, when modified by the reaction. This possibility was supported by observations given in a previous communication[2]. However, new facts have been observed which are difficult to account for on this hypothesis, and support fairly directly the idea that the degradation is due in part to the breakage during reaction of the polymeric nucleic acid chain into smaller units.

The values determined of the molecular weight of the degraded nucleic acid have varied very widely, and in experiments made to ascertain the causes of the variation we made measurements of the sedimentation constant at intervals during the reaction with $CH_3—N(CH_2.CH_2.Cl)_2$ (I) and afterwards. It was found that when the reaction medium was $N/10$ sodium bicarbonate (pH 8·6) the sedimentation constant continued to decrease (see table) for a considerable time after the reagent has lost its reactivity and eventually reached a value of s_0 = c. 3. In a phosphate buffer (pH 7) the change was less extensive; but a decrease continued for several days. It appears from this that the decrease in molecular size of the nucleic acid continues after the reagent has been completely hydrolysed. The effect of pH suggests slow hydrolysis of the original reaction product, giving rise to comparatively small fragments of the original nucleotide chain. The final molecular weight observed in one case has been as low as 17,000. This very slow breakdown may, of course, have nothing to do with the original effect of the nitrogen 'mustard' which causes the loss of the viscosity.

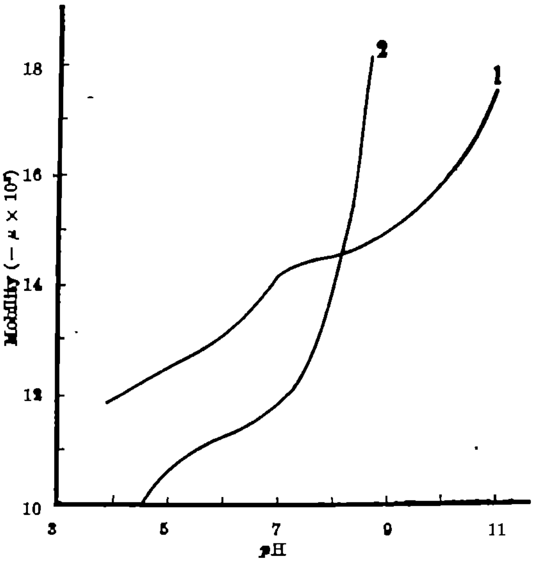
Sedimentation Constants (extrapolated to zero concentration) of Deoxyribonucleic Acid after Treatment with 'Nitrogen Mustard' (I)

In 0·1 *N* sodium bicarbonate	s_0	In phosphate buffer (0·1 *M*) pH 7·0	s
Original nucleic acid	15·8	Original nucleic acid	12·3
5 days after adding (I)	7·5	4 days after adding (I)	10·7
7 " " " (I)	6·1	6 " " " (I)	10·0
18 " " " (I)	4·6	7 " " " (I)	9·3
18 " " " (I) and freeze drying	2·2	14 " " " (I)	5·4

Information about the initial action has been obtained from the electrophoretic mobilities of nucleic acid as determined in the electrophoresis apparatus at intervals after the start of the reaction in a phosphate buffer at pH 7, and in each case giving the solution 6 hr. dialysis against the buffer with constant stirring to remove the dialysable hydrolysis products. No significant change of the electrophoretic mobility was found to accompany the loss of viscosity or to occur afterwards. The accompanying graph shows the electrophoretic mobilities of a nucleic acid treated with 'nitrogen mustard' over a range of pH's. The values of the mobility are not greatly different from those of nucleic acid.

This preparation contains about one 'mustard' residue per tetranucleotide[3], and it was expected that the mobility would be appreciably reduced owing to the partial neutralization of the charge of the nucleate ion. The *effective* charge for unit mass given by $ne/M = \mu(1 - V\rho)/s$, where μ is the electrophoretic mobility and s is the sedimentation constant, is in general not reduced by the reaction and may under some conditions be increased. This *effective charge* is not, however, easily related to the total charge of colloidal anions, and in the case of *nucleates* it has been shown that the migrating particle contains many gegenions[4]. It would appear, therefore, that the partial neutralization of the charge of the nucleate ion is partly compensated by a decrease in the number of gegenions carried along; that is, those mustard 'residues' which react with the phosphate groups are effectively taking the place of gegenions, so that the effective charge is not decreased. It may, in fact, be increased by this process, because the forces holding the gegenions are the electrostatic attractions of the charged phosphate backbone, and the neutralization at intervals of these phosphate groups by mustard residues will diminish the concentration of charge density on the anion as a whole and so decrease the relative number of gegenions held to the remainder.

If this picture is correct, it is difficult to account for the complete loss of viscosity as a consequence of the *partial* neutralization of the charge by the mustard residues. The partial neutralization of colloidal polymeric ions which form statistical coils, as shown by the theoretical considerations of Kühn[5]



Mobilities of thymonucleic acid: (1) untreated (data of Creeth, Jordan and Gulland (ref. 4)) and (2) after treatment with compound (I) (descending limb of U-tube) and the experimental results of Fuoss[6] and others, produces a decrease of viscosity; but a nearly complete neutralization of the charge would be required on this basis to give rise to such low viscosities as are observed with 'mustard'-treated nucleic acid. The electrophoretic experiments show that a complete neutralization has not occurred. We conclude, therefore, that these very low viscosities are produced in part at any rate by some other factor. The very low molecular weights observed with the final product suggest that some breakage of the nucleotide chains occurs in the reaction. It is at present uncertain what the molecular weight is immediately after the completion of the reaction, and experiments on this point are being made. A small number of breaks and the consequent reduction of molecular weight of the particles would have a great effect on the viscosity. If the original nucleic acid consists of rod-shaped particles of molecular weight of the order of 10^6, only a few breaks would be required to reduce the viscosity considerably, although other effects of the partial neutralization would also occur.

With regard to the mechanism of such a process, a possibility which is being explored by one of us (W. C. J. R.) is that the tri-substituted phosphate esters produced by reaction with mustard residues of the doubly esterified phosphate groups of nucleic acid are unstable. It has been shown that tri-alkyl phosphates are often less stable than the corresponding di-esters[7], and that the ease of hydrolysis depends to some extent on the nature of the alcohol component. It may therefore happen that the attachment of a 'mustard' residue to the di-esterified phosphate groups present in nucleic acid may result in a preferential hydrolysis of one of the phosphate-sugar links. Experiments are being made on the relative stabilities of di- and tri-phosphate esters derived from radiomimetic compounds to test this hypothesis.

This investigation has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service. [Aug. 15.

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[1] Conway, Gilbert and Butler, *J. Chem. Soc.*, 3, 421 (1950).

[2] Butler and James, *Nature*, 167, 844 (1951).

[3] Press, H. M., and Butler, J. A. V. (unpublished).

[4] Creeth, Jordan and Gulland, *J. Chem. Soc.*, 1406 (1949).

[5] Kühn, Künzle and Katschalsky, *Helv. Chem. Acta*, 31, 1994 (1948).

[6] e.g., Fuoss and Maclay, *J. Polymer Sci.*, 6, 305 (1951).

[7] Bailly and Gaumé, *Bull. Soc. Chim.*, 3, 1397 (1936). Plimmer and Burch, *J. Chem. Soc.*, 279 (1929). cf. Koefed and Tensen, *Acta Scand. Chem.*, 5, 23 (1951).

PEOPLE AT WORK

THE sixth Present Question Conference was held at Lady Margaret Hall, Oxford, during April 1950. The theme discussed was "People at Work" and brought together individuals from industry and many other walks of life. A report of the addresses and discussion on this extended form of joint consultation in industry has been published in three successive issues of the journal *Question*, the last of which has recently appeared.

The first paper was given by John A. Mack, Stevenson lecturer in citizenship in the University of Glasgow, who discussed the reasons why work has become separated from the rest of life. In primitive societies there is no separate word for work and it is accepted as part of the pattern of living. In industrial communities it is something for which incentives are required, an unnatural condition in a more primitive society; human beings in industry are revolting against a system devised exclusively in response to economic and technical requirements. Originally Mack believed that the root of industrial trouble was in the workers' resentment of arbitrary authority. Investigations in many types of firms have convinced him that this is not so. In one factory where production processes are constantly being changed there is considerable stress, not because of the monotony of mass production, but because of the too frequent absence of monotony; strain is the result of the never-ending sequence of minor changes in machines and operations which results from the continuous ingenuity of technical rearrangement. In this factory there would be little point in changing the inter-personal and inter-group relations unless machine processes are reconstituted so that personal strain is eliminated; the machine must be made to fit the man and not man the machine.

This factory example demonstrates the more general conflict between organization and personal integrity in our industrial society. Modern industrial society is activated by two dynamic aspirations. One is to develop the earth's material resources so as to liberate mankind from the curse of poverty. The other is to develop the spiritual resources of the human world by the liberation of personality from the inhibitions of class, and caste, and male domination—from domination and oppression of any kind. The first is partly realized in an economic and industrial system of great ingenuity and power. The second is also realized in part. But the cost of progress has brought the evil of the disruption of what may be called a natural community. Fortunately, people are becoming aware of what is happening and human situations are arising which work against disruption.

In the second address Dr. J. H. Oldham considered the theme of industry and modern society. To-day, it is recognized that our technical, industrial society is involved in a fundamental crisis. The values in which men have believed and lived by for two thousand years have, for an increasing number of people, lost their authority and power of appeal. Industry, too, is involved in a crisis, and has to face the question whether an industrial society can produce and nourish the human qualities which are needed for maintaining society in a state of health. No technical advances, no improvements in organization, not even greater justice in the distribution of the proceeds of industry, will avail anything if the human material on which, in the last resort, everything depends, is inferior in quality. The crisis in which society and industry are alike involved to-day is fundamentally a crisis of men. Industry cannot solve its own problem unless the other forces in society are working in the right direction and lend it support; society cannot solve its crucial problem unless industry plays its part in that solution.

The fundamental cause of the crisis both in society and industry lies in the belief that the whole of life can be mastered by human understanding and that everything is calculable. Man's triumph over Nature has become his enslavement—the enslavement of man to apparatus, technics, mechanization, organization, the division of labour and centralization. In industry this has been carried to its furthest limits, and economic and technical considerations have ruled out the consideration of man as a human and social being. With Prof. Rosenstock-Huessy, Oldham agrees that the working of the shift system and payment by the hour are both practices which sever man's work from his personal life. The fundamental problem is to find a place for man in an industrial and economic order inescapably subject to technical requirements and natural laws. Man must be helped to gain his self-respect and his sense of relationship, and industry has an indispensable part to play in this re-creation. Happily there is increasing evidence that industry is becoming aware of its human responsibilities and in some ways is already beginning to work out a type of society which is neither individualistic nor collectivist but social, and in which it is accepted that human values are more important than the technical.

Sir Wilfrid Garrett considered the role of work as education, and at first discussed the effects of his first job in industry on a boy who has recently left school. According to Sir Wilfrid the boy finds himself in an environment where he is required to serve a purpose irrespective of what he feels he wants. To help the boy in his confusion industry has to break up its often vague largeness into manageable parts which can be grasped by the individual; the production managers have to realize that they are dealing with human beings. In the case of the young people themselves they should be made to feel that however small a part they play in the industrial machine it is never without meaning because it always serves the good of the community.

Work is also teaching industrial workers at all levels the value of co-operation; and, while there may be need for less craftsmanship in industry, men and women in charge of complicated machines are proud of their charge and the products they produce in relation to the whole. Sir Wilfrid also described the educative value of various training schemes in industry and those organized for industrial workers by such organizations as the Outward Bound Trust, Brathay Hall, and the Young Men's Christian Association.

He was followed by Sir George Schuster on the theme of human relations and production, who stated that what is chiefly needed is the application of already existing ideas; the main practical problem is to get those unprogressive elements in British industry—about 90 per cent—to accept the principles and practices of the others. In the nationalized industries, particularly, the study of human relations should be regarded as a matter of vital importance: in general, one of the grave issues of the post-war world is the moral disintegration which has affected other countries in Europe more than Britain. Another difficulty is that the workers still carry bitter memories of their oppression over a period of more than a hundred years. Nor has educational development kept in step with material development. With Rostovtzeff, Sir George speculates whether it is possible to extend a higher civilization to the lower classes without debasing its standard and diluting its qualities to the vanishing point? "Is not every civilization bound to decay as soon as it begins to penetrate the masses?" Britain has not yet evolved a satisfactory pattern of an educated and democratic industrial society. If human relations in industry are to be satisfactory, three essential conditions must be fulfilled. First, each individual must be treated as an end in himself, and not as a means to an end. Secondly, he must be given the basis for the good life, including his status in society. Thirdly, the individual must recognize that he can only realize himself satisfactorily as a member of a community. Nor can any man lead a good life unless he is doing a good job of work despite those conflicting loyalties born of an industrial society. Here joint consultation properly interpreted is an essential condition for establishing the right kind of human relationships in industry. Nor can 'loyalty' be expected unless the individual really accepts the belief that he 'belongs' to the firm.

Prof. C. A. Mace considered under what conditions work may be made not only more effective but also a source of greater satisfaction to those who do it. In general, work is not attractive or repulsive because of any particular feature in isolation; it depends upon the pattern of the work as a whole. It is not repetition or variety that matters but the ratio of repetition to variety. Everyone needs the element of adventure or risk against a background of fundamental security. In industry to-day there is a lack of balance, a lack of individuality, the worker feeling deprived of the sense of responsibility for an individual task. The new industrial order can be created only by slow progressive stages, taking each job one by one, and by the gradual development and application of new principles, new policies and new procedures of management. Sufficient evidence is already available to show that sub-division, standardization and simplification have been overdone and that efficiency and satisfaction in the job will be enhanced by a reversal of these trends.

To help in understanding how people work in industrial societies, Prof. S. F. Nadel addressed the conference on work in relatively simple, pre-industrial and pre-literate societies. In these primitive societies men mostly work on their own, the typical use of capital, whereby certain individuals pay for the services and efforts of others, being largely unknown. Nor, in primitive societies, do people work so that they may enjoy pursuits out of work; their enjoyments are often so directly connected with the work and its results that the completion of the job, its reward, and the desired enjoyments merge into one.

One important and widespread incentive in primitive societies lies in the work itself. In settled agricultural communities the people always attach great importance to the attractive lay-out of the farms; anthropologists have long been struck by the great importance of display in primitive economy, the chance of displaying success probably acting as the strongest incentive to work. Behind the activity of most individuals is the wish to attain prestige or to win the admiration and approval of others. In other societies where there is a choice of work, like weaving or leatherwork, the individual conceives of his work as being in some measure the concern of supernatural powers. For each individual work is a duty which he does not question, rooted in religious belief and buttressed by the idea that it has been vested in his family or line of descent since times immemorial. For primitive man work may be regarded as a 'passport', if not to social excellence, at least to the fulfilment of an ethical or religious code.

In discussing motivations and the effects of motivation on productivity, Mrs. Winifred Raphael suggested that productivity is an attitude of mind. When there is not a strong motivation to work, there is poor output and high labour wastage; there is also boredom and discontent. Whether a person is bored or interested in his work depends upon whether he is properly suited to that work; some people are suited by supervisory jobs, and others are most happy when doing apparently dull, routine, mechanical jobs. To be properly suited all individuals should be helped to find the right job when they leave school and, later, in any change they make; and, when labour is short, it is most important to use the labour force to the best advantage. It was Sir Walter Raleigh who said, "The nightingale did not win a prize in the poultry show"; a real attempt must be made to match the person to the job and the job to the person. Boredom or interest will also depend upon the extent to which the individual participates in the affairs of the firm; this may be encouraged by formal and informal joint consultation. Interest also depends upon the social environment and, for many people in industry, what matters most is neither the job nor the pay but the people they are working with; workers' solidarity is one of the strongest motives in industry.

Probably, however, the greatest effect upon motivation depends upon whether an individual feels he is being fairly treated; pay is always thought of in relation to other individuals. Another factor affecting motivation for or against work is whether individuals are repressed or encouraged; pride in the job is an important incentive. Training is also important since the individual feels that opportunities for training may lead to promotion.

After discussing motivating forces in general, Mr. E. W. Hughes advocated the use of intelligent rather than sentimental control of the prime urges to action. Among the more permanent incentives he regarded the need to satisfy self-expression through some activity as one of the most important, especially if the effort is recognized by the group in terms accepted by the group. Mr. Hughes has had special experience in the mining industry, and here, although many motivation problems are similar to those of other industries, the industry still has a long leeway to make up in certain conditions of work. But the effort is being made, and the National Coal Board is making a genuine and not unsuccessful attempt to remove factors which cause accidents, the stigma which goes with dirty faces and dirty clothes, and other deterrents. At Keresley Colliery, near Coventry, for example, the surface lay-out is such that, but for the pit-head gear, the colliery could be mistaken for a light engineering factory. In South Wales the casualties caused by dust resulted in a drift from the industry. The dust problem has been energetically tackled, and miners are returning to the industry.

Among the reasons why people enter the coal-mining industry is security of tenure. This is particularly true of young men and, for them, various apprenticeship and training schemes have been devised. Good wages have not the incentive value usually described, as is shown by the reduction of the mining labour force despite considerable increases in pay. Mr. Hughes also expressed the need for an extended system of joint consultation at horizontal levels in the mining industry.

In his address on organization and the person Mr. R. W. Latham suggested that joint consultation is not consultative procedure but an attitude of mind. Nor is it new despite the official introduction of joint consultation to industry by Sir Stafford Cripps in 1942; some small firms in Britain had established machinery for joint consultation in the eighteenth century. Mr. Latham also pleaded for the use of *ad hoc* committees in those departments of a factory which have particular problems. But he could not agree with other speakers who believed that, apart from wages negotiations, confidential matters to the firm and about individuals, nothing should be barred from discussion at works councils. According to Latham, most workers do not understand balance sheets or market research, and he advocated the education of industrial employees as one of the most urgent needs of to-day; this should be undertaken by the trade unions themselves. The majority of workers do want to participate in the activities of their firm, but, despite the clamour of a small minority, they do not want control.

In the ensuing discussion probably the most interesting point which arose concerned the profit motive and the social purpose of industry. This was summarized by one speaker as consisting of three main factors: first, it is generally accepted that private industry cannot be allowed to follow its own way without an ethical code; secondly, bureaucratic control is bad for industry because it is so negative; thirdly, there is a considerable and justifiable demand for participation in the control of industry and responsibility for running it by all who are engaged in it.

T. H. Hawkins

INDUSTRIAL RADIOLOGY GROUP OF THE INSTITUTE OF PHYSICS

SUMMER MEETING

THE summer meeting of the Industrial Radiology Group of the Institute of Physics was held at the Institute's House, 47 Belgrave Square, London, S.W.1, during July 23–25. A programme of lectures, covering a wide field of interest to the industrial radiologist, was arranged. One of the most interesting was that by Mr. L. van Ouwerkerk (Rontgen Technische Dienst, Holland), with the title "Xeroradiography", which it was explained is a dry method without the use of photographic films and is at present in the laboratory stage.

Mr. van Ouwerkerk stressed that his was largely a report of what had been done in the United States on this subject. Starting with a description of the application of xerography to photography, he described how a layer of photo-conducting insulating material, deposited on a metal plate, is charged and then exposed to light, with the resultant leaking away of the charge in proportion to the light falling on any spot. This latent image is developed by dusting with a fine powder which adheres only where the plate is charged. Prints can be made by transferring and fixing the powder image to paper. In elaborating these points Mr. van Ouwerkerk described in detail the requirements of the photo-sensitive plate as regards electrical conductivity and how it is charged under corona discharge, as well as the action of incident light in discharging it. He said that the latent image can be retained on the plate for several days, and described how it is developed by a powder mixture consisting of a fine resinous powder and a granular carrier of relatively large particle size, which serves to generate a charge on the smaller powder particles.

This powder image can be transferred to paper, plastic, material, etc., charged with the opposite sign and placed in contact with it, and is then fixed by fusing the resinous powder.

In considering the application of the method to radiography, Mr. van Ouwerkerk said that the inherent unsharpness due to grain size is better than for photographic film. Finer powders are used for development than in the case of xerography. One interesting point is that a crack in the object being radiographed gives an enhanced effect due to the localized charge there. The method has been successful with energies between 5 kV. and 10 MeV., exposure times required being somewhat less than for X-ray films. Good definition is obtained. In concluding, Mr. van Ouwerkerk said that the obvious advantages of the method make it merit our attention in the future.

In opening the discussion on Mr. van Ouwerkerk's paper, Mr. D. T. O'Connor related his own experiences with xeroradiography. The materials are inexpensive, the main difficulty being the selenium-coated plate, produced by the vacuum coating technique. For charging the plate almost any material is suitable, such as powdered charcoal, the cloud method being the simplest process. In this the powder is blown through a tube by means of compressed air into a box containing the plate. Mr. O'Connor spoke of the high cost of X-ray films for radiography and of their possible scarcity. Mr. van Ouwerkerk said that some loss of sensitivity is unavoidable in making permanent records by fusion of the sprayed powder ; but it should be possible to compensate for this to some extent by increasing the contrast in copying. The only limitation in the size of the plate is in obtaining a uniform coating of selenium. Metal intensifying screens must, of course, not be in metallic contact with the plate, but this does not appear to cause loss of definition. He agreed that atmospheric humidity may cause some loss of charge of the plate.

One morning session was devoted to a symposium on "Penetrameters", and in introducing this Mr. J. C. Rockley (Aeronautical Inspection Directorate, Harefield) stated that a wider use of these is desirable ; but that guidance is needed in their correct use, since the results obtained from different types do not always agree. He said that the function of the penetrameter is that of quality control, and in his opinion the step type gives a good idea of sensitivity and contrast, while the wire or ball type gives an idea of definition. He concluded with some remarks on deciding the position of the penetrameter on the specimen.

The principal speaker in the symposium, Mr. B. Schuil (Röntgen Technische Dienst) started by criticizing the name 'penetrameter', since the device neither measures nor expresses any quality in accepted units. penetration cannot, he claimed, be measured by expressing it as thickness-sensitivity, that is, the percentage of the wall thickness indicated by the last visible step or wire, since this depends on both geometry and exposure technique. A true penetrameter should compare the intensity of radiation after passing the object with that of the primary beam. In asking why we use penetrameters, Mr. Schuil said that their use means getting the best penetrameter image as regards contrast and definition. He gave as an example a case in which, by using salt screens instead of lead screens, a higher sensitivity was obtained due to greater contrast, in spite of the poorer quality image. But an optimum penetrameter image does not, he maintained, guarantee a sound object ; many other factors influence the detection of flaws. Again, with very hard radiation, the absolute flaw sensitivity increases, and it is not possible to express it as a percentage of the plate thickness ; rather, a certain minimum thickness can be revealed. Regarding different types of penetrameter, Mr. Schuil said that there is no ideal form, but he prefers, in general, those using wires to those using step-wedges or test plates, such as are recommended by the boiler code of the American Society of Mechanical Engineers. He concluded with some remarks on the practical use of penetrameters and the ideal penetrameter.

In opening the discussion on penetrameters, the chairman, Mr. C. Croxson (Armament Research Establishment, Woolwich), pointed out the advantages of having separate checks for definition and contrast, as embodied, for example, in the Ministry of Supply penetrameter. As a check on definition he suggested (*a*) fine wires of material similar to that of the specimen for use with small thicknesses, and (*b*) drilled holes in a plate, of similar material to that of the specimen, about 0·02 in. in diameter and of minimum depth to give just perceptible images ; the latter for use with thick specimens. Mr. O'Connor said that a test object of comparatively large area is needed to assess contrast, and one of small area to assess definition. He expressed no particular preference for the step wedge type over the strip type used by the American Army Ordnance. Dr. A. Nemet pointed out the interrelation of contrast and definition; and while Mr. Croxson agreed, he said that nevertheless a more sensitive penetrameter can be made by having separate checks for the two, as he had suggested. Mr. E. Owen (Hadfields, Ltd.) said that he has found that the ball type of penetrameter has the poorest sensitivity. Other points made were the desirability of an identification mark as an integral part of a penetrameter ; the necessity for a robust inexpensive construction ; and the desirability of flexibility for penetrameters to be used on curved surfaces. The comments appeared on the whole to favour the wire type of penetrameter, but it was evident that it is as yet premature to consider the standardization of any particular types.

At further sessions Mr. D. Bromley (Admiralty Materials Laboratory, Poole) spoke on "An Analysis of the Quality of Radiographs", Mr. J. Rhodes (Royal Ordnance Factory, Woolwich) on "Gamma-ray Stereography", and Mr. H. Vinter (Denmark) on "The Correlation of Radiographic Results with Weld Strength". A comprehensive paper describing non-destructive testing in Germany was read for Prof. R. Berthold (formerly of the Reichsröntgenstelle, Berlin) in his absence, and Mr. E. van Someren (Murex Welding Processes, Ltd.) gave a paper entitled "Short Range Radiography". The meeting concluded with a symposium on "The Site Radiography of Pipe Welds", at which Mr. F. H. Gottfeld (Solus Schall, Ltd.) and Mr. R. V. Walker (Ministry of Supply) were the principal speakers.

An exhibition of apparatus of interest to the industrial radiologist, arranged by Mr. J. C. Rockley, was held concurrently with the summer meeting and comprised six sections. The first illustrated radioactive materials in industrial radiography and showed, as an example, the construction of a radiographic source containing radon and the extraction of the necessary radon. Further exhibits showed containers for gamma-ray sources and devices for handling them, a total of nine exhibits. Six of these were available commercially, and the remainder had been designed by individual radiologists to meet their own needs. Protection was covered in this section by a selection of portable monitors, dosemeters and film badges suitable for workers with gamma-rays. Further exhibits showed the lay-out of X-ray laboratories by means of a model and photographs, as well as samples of many of the protective materials on the market. A section of outstanding interest showed by means of specimens the development of X-ray tubes from 1896 to the present day, mostly loaned by Messrs. Newton Victor, Ltd. In a section devoted to special applications of X- and gamma-rays, interesting examples were those on the use of X-rays in micro-radiography by the Bristol Aeroplane Co., Ltd., the autoradiography of radium and radon containers as a check on the correct distribution of the radioactive material by the Radiochemical Centre, Amersham, and electron radiographs of bank-notes taken by the Atomic Energy Research Establishment, Harwell, from the scattered electrons using an iridium-192 source. The section on stereoradiography, arranged by Ilford, Ltd., showed some striking applications of stereo work in radiography, together with examples of the apparatus required for this work. The section on radiographs covered a wide field in which twelve firms exhibited. Johnson Matthey and Co., Ltd., showed radiographs of brazed fittings, and Kodak, Ltd., had an instructive exhibit showing how gratuitous markings on the film due to various external causes can mislead the radiographer. Exhibits by the Aeronautical Inspection Directorate and the Atomic Energy Research Establishment showed the wide range of problems ranging from plywoods to wire-wound resistors that had been dealt with by these establishments. A final section showed a working model of a beta-ray thickness gauge.

B. N. Clack

EFFECT OF COLD ON MICRO-ORGANISMS

The autumn meeting of the Society for Applied Bacteriology was held in the lecture hall of the London Medical Society on October 23, when a symposium was held on the subject of "The Effect of Cold on Micro-Organisms". There were about 120 members and visitors present.

Dr. A. T. R. Mattick (National Institute for Research in Dairying) opened the symposium by a short historical survey of the subject. He described how the lethal effect of freezing on bacterial cells, originally thought to be due to the crushing mechanism of ice crystals, has now given way to the concept of protein denaturation and precipitation. This is due to the classical work of Haines in 1937, who found that freezing at temperatures between −5° and −70° C. had no effect on the mortality of *Pseudomonas* species of bacteria, but that temperature is significant for survival on storage. Between −1° and −20° C., greater death-rates were found at the higher temperature, the critical maximum being −2° C. Extending these observations further, Weiser and Osterud in 1945 emphasized the difference between immediate death caused by the action of freezing, which is independent of temperature, and storage death, which is dependent on temperature and time. Storage death-rates are lower at temperatures below −30° C. than at temperatures above this value, such that at −195° C. no deaths appear to take place.

The limiting temperature below which all organisms cease to grow is about −8° C., although many bacteria will remain viable for long periods below this temperature. For example, *Streptococcus faecalis* has been found viable in cheese after seven years at −15° C., and coliforms and *Pseudomonas* species have been found in butter. The metabolism of many bacteria is affected by reduced temperatures, the effect being largely that of change from saccharolytic to proteolytic and lipolytic action.

Dr. J. G. Davis (United Dairies, London), discussing the effect of cold in relation to dairying, said that the changes in metabolism which many bacteria undergo at reduced temperatures often give rise to pigment formation; for example, *Pseudomonas* can readily produce colour in milk and has been known to impart a blue-black pigment to butter. Probably more significant is the bitter, or sometimes 'oxidized' or oily, taste acquired by milk due to the lipolytic activities of micro-organisms. Plate counts on such milk samples may not be significantly affected; but the methylene blue test shows a marked decline. It is doubtful whether any cryophilic organisms can survive pasteurization, but obviously any which might escape such treatment will be liable to exert an adverse effect on the milk.

Ice cream of good quality can be stored satisfactorily at −10° C., at which temperature the bacterial count tends to fall; and, contrary to early opinion, cheese can be ripened at low temperatures and gives a better product free from bitter taste.

Dr. M. Ingram (Low Temperature Research Station, Cambridge), dealing with cold in relation to the microbiology of foods, said that all spoilage is due in the first place to the activities of micro-organisms. Freezing, however, is not always possible with many foodstuffs—for example, fruit and meat—and chilling only can be employed. The Q_{10} value of 2, which usually obtains in chemical reactions, is subject to much variation in bacteriology and depends very much on the species of micro-organisms being considered. It is, in fact, much higher than 2 at lower temperatures; hence a difference of only 1 or 2° C. at these levels may have a considerable effect on rate of spoilage. With all tissue material, especially the living tissues of fruit, a balance has to be sought between tissue damage or death and bacterial rot.

In general, pathogenic organisms cease to grow below about 5° C., *Bact. coli* at −5° C., and *Achromobacter* and *Pseudomonas* species at −3° C. Staphylococci and spore-forming bacteria do not suffer a high mortality on freezing, but most other types do. Mortality and storage death-rates are reduced by such substances as sugars and glycerol, and osmotic pressure plays a considerable part.

Enzyme action is not stopped by cold at anything like the same rate as bacterial growth; hence much lower temperatures are necessary for the preservation of some foods such as peas, herring and bacon.

Mr. H. Proom (Wellcome Physiological Research Laboratories, Beckenham) described some problems associated with freeze-drying. Freeze-drying for biological purposes was first described in 1909 by Shackle. Later, in 1933, Flosdorf and Mudd used a manifold process, and afterwards sublimation and spin-freezing methods were developed.

The effect of freeze-drying on the viability of bacteria varies with the species and the medium employed; but the importance of the process is in the fact that organisms so treated retain completely their serological characteristics, toxin production and other physiological properties for very long periods of time. Bacteria suspended in saline alone have a poor survival-rate; but the addition of broth, serum or gelatin exerts similar protective actions. Serum is suspect because of its hygroscopic nature and the consequent deleterious effect of moisture on the organisms.

Survival-rates after drying are dependent on a number of factors, including temperature; for example, reported comparative rates at 4° and at 37° C. are 83 per cent and 28 per cent respectively. The relationship between storage loss and time is allied to losses on heating at temperatures between 60° and 100° C., and short heatings at these temperatures can give a measure of storage survival. In spite of reports that there is an optimum small residual moisture content for maximum survival, it now appears quite certain that such an optimum is not obtained, and greatest survivals are found in the driest preparations. It is desirable also to include a suitable reducing substance to prevent oxidation, and the gaseous atmosphere under which the dried material is sealed is important. Dry nitrogen or sealing *in vacuo* gives the best survival conditions, the rates being nine or ten times better than those with oxygen or air.

Following the main papers there was active discussion and questioning, during which two comments were made on changes observed in properties of bacteria on freezing and thawing. One concerned the destruction of phage associated with lactobacilli, and the other, changes in antigenic reactions of some streptococci. Mr. Proom said this was the first evidence he had heard of any change produced by freezing, and the suggestion was made that it may be due to the high and selective death-rate leaving a residue of viable cells which might not be fully representative of the original.

In reply to other questions, Dr. Ingram said that moulds will grow readily in chill rooms, and that flowing air and reduction of relative humidity to less than 96 per cent will practically stop the growth of bacteria.

COMMONWEALTH OF AUSTRALIA SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

REPORT FOR THE YEAR 1949–50

THE second annual report of the Commonwealth of Australia Scientific and Industrial Research Organization* has been published, for the year ended June 30, 1950. The Organization, which now comprises sixteen Divisions, as well as several independent Sections and five regional centres, continues to face great difficulties in developing its research programmes because of the lack of suitable buildings, and many Divisions are working under crowded and difficult conditions. Work is proceeding throughout the Commonwealth on the mapping of soils and the determination of their physical and chemical properties. Further progress is reported in the development of spectrochemical techniques for analysing soil and plant material. Some fundamental work on the downward flow of water into soil was completed, and the magnitude of movements of water in soil due to temperature gradients investigated. Soil microbiological studies centred mainly round *Rhizobium*, the genus of bacteria responsible for the nodulation of leguminous plants, and the investigations commenced in 1947 into its establishment in field soils, have been concluded.

The general programme of work on pastures continued on the same basis as in the previous year; at Canberra three systems of grazing management were being compared on a *Phalaris* – subterranean clover pasture, and at the Dickson Experiment Station a series of long-term trials on the relation of pasture and cropping practice to soil fertility trends, and especially on the factors involved in such changes in fertility, was being initiated. An ecological survey of vegetation and pastures at Trangie, New South Wales, was nearing completion, while at Deniliquin, New South Wales, investigations have been completed on irrigated pastures; these were begun in 1949 to determine the factors involved in the emergence of pasture and forage species sown in various conditions and depths and with different treatments of organic litter and fungicides. Weed investigations have included studies on the use of plant growth-regulating substances for the control of perennial weeds, the mechanism of action of such substances, and the control of perennial grass weeds; and, besides the trials of new pasture and forage plants, investigations with linseed and other vegetable oil plants have continued. Search has been made for apple rootstocks which give better performance under Australian conditions and also for improved rootstocks for pears and plums. The general results of the opium poppy improvement programme were published during the year, and the survey of native plants for sources of substances of pharmacological value and chemical interest has been concerned mainly with the Queensland flora. The promising prospects for expanding tobacco production by irrigation during the 'dry' season in northern Australia have opened up a new field of research requiring immediate attention. Among plant disease investigations may be mentioned those on potato virus *X*, the use of plant tissue culture techniques for controlled studies of virus recovery phenomena, and the control of 'dollar spot' (*Sclerotinia homoeocarpa*) on turf by fungicides; a study of the effect of nutrition on the development of *Fusarium* wilt of tomato was concluded.

Other plant investigations are carried out at the irrigation research stations at Merbein, Victoria, and at Griffith, New South Wales, the former being concerned with the problems of irrigated horticultural lands of the middle and lower Murray, particularly the cultivation and processing of grapes, and the latter, besides studies on irrigation and soil salting, being concerned especially with the development and nutrition requirements of such crops as oranges and vegetables. Successful control of hardhead (*Centaurea picris*) with the weedkiller 'Hormex' and of hoary cress (*Lepidium draba*) with 'Methoxone' and 'Hormex' is reported.

The Division of Animal Health and Production, which has its headquarters in Melbourne, has been concerned mainly with problems in the sheep and cattle industries. Besides a further study of the nutritional factors which determine wool production, this work on sheep has included studies of the processes of rumination, the toxicity of large rations of wheat, the effect of cobalt and copper deficiencies in nutrition, the physiology of reproduction, biological studies of the growth of skin and wool, the efficacy of phenothiazine against the large-mouth bowel worm (*Charbertia ovina*), resistance to nematode infestation, and the value of DDT and BHC preparations in preventing body strike as well as tests with insecticidal fogs for this purpose. Cattle investigations have included studies on pleuropneumonia, tuberculosis and brucellosis, the value of antibiotics in eliminating udder infections, the epidemiology of parasitic gastro-enteritis of cattle; the ecology of the non-parasitic stages of the cattle tick and bio-assay tests with a number of chlorinated hydrocarbons and organic phosphates which permit the division of potential acaricides into three main classes. Other work on nutrition has embraced studies of the influence of copper or zinc deficiency on the phosphorus metabolism of Algerian oat plants in aqueous culture, on accessory food factors and on the reactions of amino-acids.

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* Second Annual Report of the Commonwealth Scientific and Industrial Research Organization for the Year ending 30th June, 1950. Pp. 157. (Canberra: Commonwealth Government Printer, 1950.) 9s.

Some of the work which has been here noted was carried out in association with the Division of Entomology, which, besides work on various aspects of insect physiology, made an intensive field study of the control of St. John's wort, *Hypericum perforatum* L., with *Chrysomela hyperici* and *C. gemellata*. Encouraging results were also obtained in the biological control of the cabbage moth, *Plutella maculipennis*, with the ichneumonid parasites, *Angitia cerophaga* and *Diadromus collaris*. Preliminary work on population dynamics has been based on the sheep blowfly, and work has continued on the ecological control of the Australian plague locust, *Chortoicetes terminifera*, and on the distribution and ecology of the pasture cockchafer, *Aphodius howitti* Hope. The Wild Life Survey Section, established early in 1949, has been solely concerned with basic ecological studies on the rabbit, further trials of the virus disease, *Myxomatosis cuniculi*, and of poisons for the same pest (see *Nature*, Dec. 1, p. 932).

Fisheries investigations included work on the races of the Australian salmon (*Arripis trutta*), a survey of tuna resources in northern Australia, a study of barracuta in the Bass Strait area, further investigations of the properties of the deep waters off Rottnest Island, Western Australia, and continued surveys on crayfish and sand crabs. Work on pilchards is described in two papers to appear in the new periodical, the *Australian Journal of Marine and Freshwater Research*, publication of which commenced in April 1950 (see *Nature*, 166, 719; 1950). Food research included investigations on the anaerobic destruction of ascorbic acid, on the natural coating of apples and on protein denaturation. Investigation of the factors affecting the germination of heat-treated spores continued, as well as of the effects of oil and other coatings applied to the shells of eggs before storage, the variability in the storage behaviour of apples, the canning of peas, the dehydration of fruit and meat, and the drying of sultanas. Studies on the incorporation of skim milk powder in bread have been resumed and those on the chemistry of the taint in butter caused by *Coronopus didymus* continued.

Work has continued in the Division of Forest Products on wood structure in relation to properties, the chemistry of wood, creep in wood, the physical properties of wood and related materials, timber mechanics and seasoning, as well as on the toxicity and permanence of water-borne preservatives and on veneer and plywood manufacture. The status of the Building Research Section has been raised to that of a Division, and the experimental work on foamed concrete continued. Investigations on surfacing materials have included a study of the physiological effects of the thermal and mechanical properties of concrete floors, while the acoustic behaviour of rooms and halls, the suitability of bituminous membranes for flat roofs and the efficiency of the inter-layer bond of membranes of various kinds as well as the sulphide staining and growth of mould on water-paint films on fibrous plaster are all being studied. A new Wool Textile Research Laboratory was being organized in each of the three major textile centres—Melbourne, Sydney and Geelong—and studies were being made on detergency in connexion with wool scouring, the aliphatic alcohols of wool wax, the recovery of wool from skin pieces by complete digestion of the skin pieces, the application of resins to wool, the action of shrinkproofing agents on wool, the structure of the cuticle of wool fibre, and the molecular structure of amino-acids, lower peptides, synthetic polypeptides and natural fibrous proteins. In the Flax Research Laboratory efforts have been made to devise methods of carrying on the retting bacteria from ret to ret so as to avoid the necessity of inoculating each ret separately.

In the Division of Industrial Chemistry, promising results have been obtained in the refining of sugar-cane wax recovered from waste materials from the sugar mills, while a project on the utilization of brown coal provides the basic data for a programme for producing liquid fuels and organic chemicals from the extensive low-grade coals of Australia. A report on the clay resources of South Australia was in preparation, and extensive research to improve the performance of refractories, particularly for the gas and cement industries, was in progress. Other investigations include the application of surface chemistry to the study of the flotation of minerals, the kinetics of the phenol-formaldehyde condensation and the physical properties of fluids at high pressures. In the Section of Physical Metallurgy work on the strength and structure of metals has been continued, particularly on the mechanism of failure by fatigue and the influence of rate of strain on the mechanism of deformation at high temperatures; but attention has been given chiefly to the constitution and properties of alloys of titanium, the allotropy of titanium and the creep of lead alloys.

The Division of Tribophysics reports further progress in the study of friction and lubrication, and plastic deformation and phase changes of metals. The work of the Division of Metrology has been largely directed towards meeting the requirements of the National Standards Commission and so enabling the Weights and Measures (National Standards) Act, 1948, to be proclaimed. Much of the work of the Division of Physics also consisted in research on the maintenance of standards and on methods of accurate measurement. The Division also investigated the composition and temperature distribution of the solar atmosphere, and a spectroheliograph which will take photographs of phenomena such as flares and prominences on the sun's surface is being constructed. Much work has also been done on the construction of equipment for researches on the properties of matter at very low temperatures and for the measurement of the elastic properties of wool by supersonic techniques. In the Division of Electrotechnology, besides work on electrical measurements and standards, the dielectric properties of materials have been investigated with particular reference to the mechanism of dielectric loss. In the Division of Radiophysics further advance has been made in the knowledge of the radiofrequency radiation which reaches the earth from the sun, from radio-stars and from the galaxy, as well as in our understanding of the processes by which natural rain occurs; and a new programme of radio and radar aids to navigation was introduced, including microwave direction-finding and relay radar. The Organization has also been co-operating with the University of Melbourne in research on nuclear physics and cosmic rays under the direction of Prof. L. H. Martin.

LABOUR TURNOVER AND ABSENCE IN GREAT BRITAIN UNDER FULL EMPLOYMENT

IT is generally believed that rates of labour turnover and absence in Great Britain have been higher under full employment than they were before the Second World War, and constitute a substantial obstacle to industrial efficiency; but hitherto there have not been records in sufficient detail to reveal the course and causes of turnover and absence in a particular setting. Accordingly two monographs[*] published by the University of Birmingham Faculty of Commerce and Social Science—"Labour Turnover under Full Employment", by Dr. Joyce R. Long, and "Absence under Full Employment", by Hilde Behrend—are important. They report and analyse the experience of factories in the Midlands, employing between them upwards of sixty thousand persons, mostly in engineering and metal working. The collection of this material was made possible through the Midland Advisory Council on Industrial Productivity.

Each monograph sets out what evidence there is for the difference between recent working and that of the interwar years. Such evidence is scanty; but, so far as it goes, it shows less difference than common report suggests. A survey by the National Institute of Industrial Psychology[1] in 1937 gave annual turnover-rates of 18 per cent for men and 51 per cent for women in a sample of London firms, and 11 per cent for men and 34 per cent for women in a Leeds sample. Records for 1949 collected by the British Institute of Management give rates of 21–24 per cent for men, and 38–41 per cent for women. Rates vary so much from firm to firm that generalizations from samples are hazardous; but these inquiries at least show considerable overlap between the pre-war and post-war ranges. As regards absence, the only continuous record is that for the coal miners, and, though the percentage of possible shifts missed has been around 12 of recent years as against 6 before the War, Miss Behrend in her monograph shows that this is due to a rise in the number of possible shifts rather than to a fall in attendances, which remain fairly steady, now as in the interwar years, around 4·7 shifts a week.

The main finding of Dr. Long's study of turnover is perhaps that the rate of turnover depends on the type of worker rather than on the type of firm, and that some types of worker have high rates of turnover whereas the majority are stable. She calculates a stability-rate, defined as the percentage of a firm's employees who have not left it during a certain period, and finds that the same firm may have both a high stability-rate and a high turnover-rate. Herein lies much of the explanation of the negative relation which she shows has generally held between unemployment and turnover: turnover is lower when unemployment is high not because all types of labour change jobs less often then, so much as because the unemployed contain a high proportion of types whose turnover-rates are habitually high. The characteristics associated with such rates are chiefly youth, lack of skill, and coming to work from a distance. Long service may be a source of stability; but it is hard to separate this influence, for those who have stayed on will be those who were more stable initially. Women usually show higher rates than men; but much of this seems to depend on lack of skill rather than on sex, for men doing unskilled work often have rates as high as the women, or higher. By contrast with these personal factors, the conditions of employment, such as the size of the firm, the level of pay and the working environment, show no clear association with the turnover-rate, though some differences between the rates of otherwise similar groups of workers are attributable to the state of personal relations in the plants, and especially the quality of supervision.

The special contribution of Miss Behrend's study of absence is the means it proposes for measuring controllable and uncontrollable absence separately. One element of the uncontrollable part is 'unavoidable' absence due to sickness, accidents and family affairs; but Miss Behrend holds that there is a further element which likewise is largely beyond the power of management to control because it is inherent in the nature of the work and of the labour force this work attracts. A sample of daily absence-rates shows marked differences between one day of the week and another, with Friday usually the lowest, and a given plant or department seems to have a characteristic and persistent weekly pattern: Miss Behrend suggests that it should take its Friday-rate as the measure of the uncontrollable absence specific to it, and the excess of absence on other days as the measure of controllable absence (see *Nature*, 165, 831; 1950). More particularly, she proposes a 'Blue Monday' index, giving the shortfall of Monday's attendance below Friday's as an indication of the workers' attitude to their work. In a study of two companies she finds that the 'Blue Monday' index is not correlated with the total absence-rate, for this depends mostly on sickness and workers' ages, whereas the 'Blue Monday' index singles out voluntary absenteeism. This is high among short-service workers and where work is unskilled or is reckoned to impose psychological strain, but it does not seem to be associated with other working conditions.

These studies collect evidence on an important problem on which exact information has hitherto been scanty in Great Britain. Their analysis of it is thorough, suggestive and directed towards practical application. It shows how collaboration between industry and the universities in this field can yield results useful to industry.

E. H. Phelps Brown

[*] University of Birmingham Studies in Economics and Society. Monograph A.2: Labour Turnover under Full Employment. By Dr. Joyce R. Long (pp. 134). Monograph A.3: Absence under Full Employment. By Hilde Behrend (pp. 137). (Birmingham Faculty of Commerce and Social Science, 1951.) 15s. each.

[1] *Occupational Psychology*, 12, Nos. 3 and 4 (1938).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Mutation in a Bacterial Virus

In a recent paper[1], data have been given which suggest that certain of the symbiotic bacterial viruses (bacteriophages) found in *Salmonella typhi-murium* undergo diphasic variation. The normally innocuous symbionts occasionally throw off lytic mutants which multiply actively and destroy the host bacterium. This leads to the liberation of virus particles, some of which, when brought in contact with a susceptible host bacterium, develop as symbionts and reproduce the original type of infection, while others are lytic in nature and multiply actively at the expense of the bacterium. Of the particles generated in this lytic cycle the majority are themselves lytic; but a minority—perhaps about 5 per cent— are potential symbionts. In cultures on solid medium the latter produce symbiotically infected and hence 'immune' bacteria which multiply unscathed and form the characteristic 'solid centre' of the plaque.

Another kind of mutation has now been observed which is common to most, if not all, the Group *A* phages of *S. typhi-murium*. The mutants in question can be recovered either from the supernatant fluid of a spun broth-culture of the symbiotically infected (lysogenic) strain, or from the lysate resulting from the action of these phages on an indicator strain. To detect and isolate them, a suitable dilution of either type of lysate is flooded over an agar plate sown with the indicator strain. This plate is incubated overnight. A careful search may reveal, among the characteristic 'solid centre' plaques, an occasional one showing a varying number of small granules on a clear background (Fig. 1). Such plaques may, in exceptional cases, be relatively common; but usually they are scanty, and several plates carrying many thousands of 'solid centre' plaques may be searched before one such mutant is found.

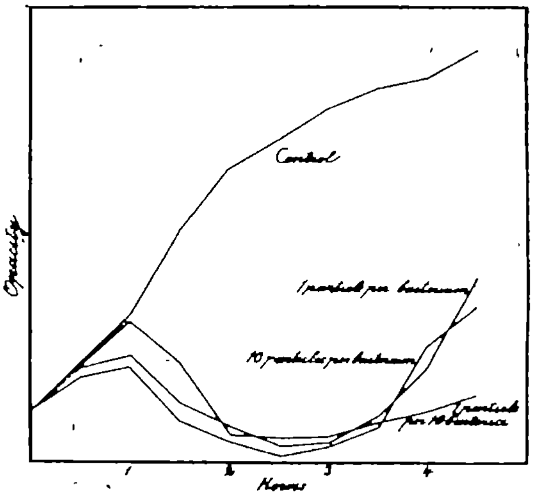

Fig. 3. Turbidity curves of cultures of phage-sensitive *Salmonella typhi-murium* initially exposed to the action of different concentrations of lytic mutant

When cultivated on an indicator strain of bacteria, these mutants in the main breed true, and show no tendency towards a general reversion to the type of particle which produces 'solid centre' plaques. Nevertheless, particles of this kind do occur, though with great rarity, in cultures of the lytic mutant, and can be identified by a corresponding technique (Fig. 2). The lytic mutants have the same antigenic structure as the strain from which they were derived, and the same resistance to heat, being able to survive exposure to temperatures of 80° C.

The organisms which make up the granules within the plaques are *not*, as in the case of the 'solid centre' plaques, symbiotically infected. The majority are phage-sensitive, and appear to exist in a state of balance with the virus. A minority are phage-resistant, and after more prolonged incubation some may be both rough and resistant. In most respects these mutants resemble the *N* phages described by Burnet[2].

The lytic character of the mutant is well shown by the turbidity curves of a growing culture of an indicator bacterium exposed to different concentrations of particles (Fig. 3). As with the familiar lytic phages, the higher the concentration of particles, the earlier the onset of lysis and clearing. This is in contrast to the curves which result when the same experiment is carried out with the parent virus where, in the presence of a high concentration of particles, no very obvious bacterial lysis occurs because significant numbers of bacteria become symbiotically infected and continue to multiply (Fig. 4), an

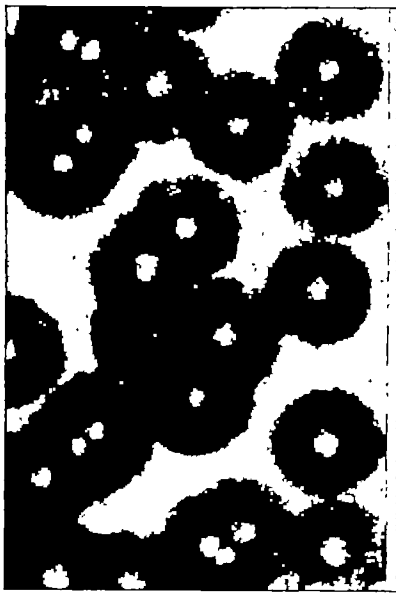

Fig. 1. Plaques of phage *A*1 showing a lytic mutant among normal 'solid centre' plaques. × 5

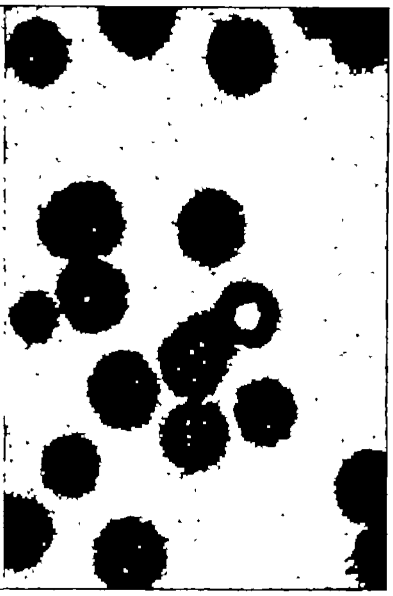

Fig. 2. Plaques from a culture of the lytic mutant showing a single 'solid centre' plaque, one of two found in sixteen plates examined. × 5

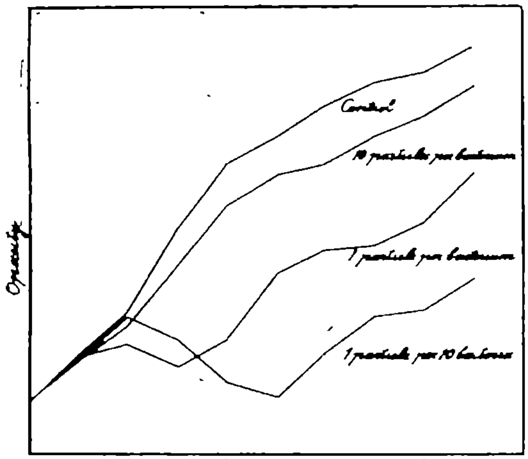

Fig. 4. Similar to Fig. 3, but exposed to virus of the type which undergoes diphasic variation, and produces 'solid centre' plaques

result which parallels the development of the 'solid centre' in the plaque.

The recognition of these stable lytic mutants is further evidence in favour of a suggestion previously made—that lytic (virulent) bacterial viruses have their origin and continuing source in innocuous parent symbionts, and represent only a single phase in the life-history of the virus.

Details of this work will be published elsewhere.

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Transplantation of Mouse Eggs

The transplantation of mammalian eggs into a host uterus is usually achieved by means of an operation on the recipient female. It would clearly be of advantage in several respects if transference could be effected without the necessity of opening the body cavity of the recipient. As described below, mouse eggs transferred directly through the cervical opening into a host uterus have come to term. This seems to be the first mammal in which a direct non-operative transplantation has succeeded. It is suggested that the procedure could be called 'inovulation', by analogy with the word insemination[1].

Fertilized mouse eggs were obtained in the usual way from the uterus or Fallopian tubes of a previously mated female, sacrificed for the purpose. The apparatus (a 1-c.c. syringe bearing an obliquely blunted needle of about 0·2 mm. internal diameter), and the general procedure, were as described by Snell, Hummel and Abelmann[2] for artificial insemination of mice, except that a 4-in. needle was thought to lessen the danger of losing eggs in the lumen of the syringe. The eggs, held in the lumen of the needle in Pannett–Compton solution, were expelled into the uterus of a recipient female, the sexual cycle of which had been set into operation by mating with another male. Eggs were transferred to one horn only of the recipient uterus. Genetic marks were arranged to enable the young born of transferred eggs to be distinguished from the young of the recipient female itself (for example, transferred embryos homozygous albino, host embryos homozygous non-albino). Tested sterile males, homozygous for the dominant marker Rex as an extra precaution, were sometimes used to activate the recipient female, and the young born in two such cases were necessarily derived from transferred eggs only.

No maternal effects were observed. As scored by eye colour at birth, young from homozygous non-brown transferred eggs developed black eyes in a maternal environment homozygous for brown and pink eye; eyes which were homozygous brown developed normally in a homozygous non-brown host. In these cases, the transferred eggs and the host were all homozygous for non-agouti. In young scored a fortnight after birth, homozygous Rex and homozygous albino both showed normal expression after gestation in a host homozygous for absence of Rex and albino.

The ages of transferred eggs and recipient females were timed from the formation of a vaginal plug, with an absolute error of plus or minus a ¼-day, and the developmental stage of each egg was noted. Transplantation of fifty-five morulæ and blastulæ into recipients the sexual state of which was out of phase with the age of the eggs by a day or more, and transplantation of forty-four 1- and 2-cell stages, were unsuccessful. The five successes achieved were with morulæ and blastulæ transferred into recipients of almost exactly the appropriate sexual stage, as shown in the accompanying table. Similar optimal conditions for transfer had already been found by Fekete and Little[3], using an operative technique.

TRANSFERENCE OF MOUSE MORULÆ AND BLASTULÆ INTO RECIPIENT FEMALES OF SIMILAR AGE FROM COPULATION

Data concerning females which failed to produce any young at all are excluded. In each successful inovulation, one transferred egg per recipient female was recovered in the resulting litter

Age from copulation (days)		No. of recipient females	No. of eggs transferred	No. of transferred eggs recovered as young
Transferred eggs	Recipient females			
2¼	2	1	5	0
2½	2½	2	8	1
3	3½	1	4	1
3½	3	1	6	1
3¼	3¼	8	36	2

The present results show that eggs transferred by inovulation can come to term, but further work is necessary to establish whether the technique can develop into a routine method for egg transference.

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An Electrophoresis Apparatus for analysing Several Sera Simultaneously

A SYSTEMATIC study, such as we contemplate, on the influence of disease on the electrophoresis pattern of serum, requires observations on large numbers of sera. Such an investigation is laborious and time-consuming when the available techniques and apparatus are utilized, because only a very limited number of experiments can be completed in one day. We have, therefore, devised a method whereby two electrophoretic analyses can be made simultaneously using the Tiselius apparatus with a standard central section.

The apparatus is illustrated in Fig. 1. The electrode vessels are connected on to 'Perspex' adaptors (*A* and *B*) and the standard central section of the electrophoresis cell held between them. Prior to assembly, the ground surfaces of the 'Perspex' adaptors as well as those of the electrode cell are well greased, and thin 'Cellophane' membranes are then clamped between the sections in the position indicated (M_1 and M_2). The protein solutions to be analysed are held between the membranes, and the rest of the apparatus filled with buffer and saturated potassium chloride in the usual way. The dimensions of the adaptors are such that they fit the Hilger electrophoresis bath and cell holder.

A *p*H for electrophoresis must be selected where all the components present migrate towards the bottom membrane. In the case of serum, this is achieved at *p*H values above neutrality.

In Fig. 2 are shown electrophoresis diagrams of two samples of the same bovine serum obtained simultaneously using the two limbs of the standard electrophoresis cell. On inspection of the diagrams it will be noticed that they are identical. The reason for the markedly enhanced δ-effect visible at the beginning of the electrophoresis diagram is, as yet, unexplained. In the diagram of the same serum obtained with the standard apparatus, the δ-effect was small.

Electrosmotic effects do exist; but apparently they have no effect on the electrophoresis diagram. Mobility measurements calculated from electrophoresis diagrams obtained in the modified apparatus described are likely to be affected by the electrosmotic effects, but the samples studied simultaneously are comparable.

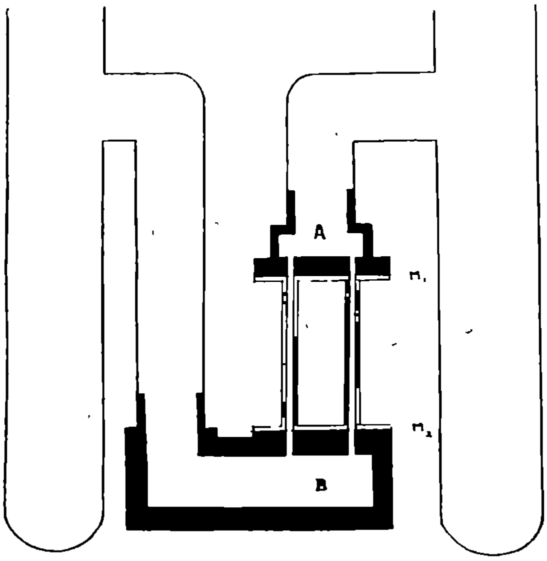

Fig. 1. Assembled electrophoresis cell. Shaded parts (*A* and *B*) are made of 'Perspex'. M_1 and M_2 are 'Cellophane' membranes

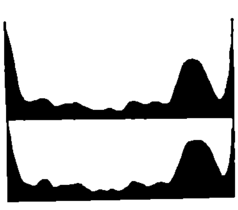

Fig. 2

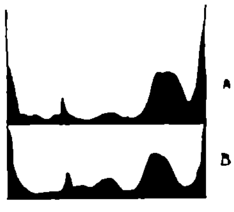

Fig. 3

Fig. 2. Electrophoresis diagrams of two samples of the same bovine serum obtained simultaneously

Fig. 3. Electrophoresis diagrams of normal serum (*A*) and serum from a chronic nephritic (*B*). They were obtained simultaneously by the use of the modified cell

The technique described points the way to a means of mass electrophoresis of sera, as there is no theoretical limit to the number of compartments which can be built into the analytical section of the cell.

A further advantage of this type of cell is that exact comparisons can be made between sera obtained from different sources. This advantage is clearly brought out in Fig. 3, which shows the difference between the serum from a normal and a chronic nephritic subject. The nephritic serum albumin has a mobility slightly less than that of the normal albumin. The α-globulin has the same mobility in both sera, and the β-globulin in the normal serum has, in turn, a lower migration-rate than the corresponding globulin in nephritic serum.

This investigation was assisted by grants from the Council for Scientific and Industrial Research and the Nkane Kitwe Poliomyelitis Research Fund.

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Isolation of a Crystalline Disaccharide, Hyalobiuronic Acid, from Hyaluronic Acid

THE structure of hyaluronic acid, an important constituent of the 'ground substance', has been the subject of intensive study in recent years. Applications of conventional methylation and periodate consumption methods to the intact polysaccharide[1,2] have indicated that such methods will not yield substantial evidence of structure. The isolation and clarification of structure of crystalline oligosaccharides derived from hyaluronic acid is the most rigorous method of studying the structural details of this physiologically important substance. Such well-defined compounds are also required as models for establishing the specificity of the enzyme systems acting on hyaluronic acid.

The present communication is concerned with the isolation and characterization of a crystalline aldobiuronic acid from sodium hyaluronate in relatively high yield, following degradation by a combination of enzymic and mild acid hydrolysis. Sodium hyaluronate (analysis[3] : nitrogen, 3·78 ; uronic acid, 44·0 ; hexosamine, 38·8 ; sulphate, less than 0·5) was hydrolysed with purified testicular hyaluronidase

(600 turbidity reducing units per mgm.) until the increase in reducing sugar[4] was equal to 0·35 mgm. of glucose equivalent per mgm. of substrate. The small precipitate obtained on addition of two volumes of ethanol was removed, and the filtrate was then concentrated *in vacuo* to remove the ethanol. Addition of 4 volumes of absolute ethanol resulted in separation of a syrup, which was hardened with ethanol. The colourless, amorphous product was dried over calcium chloride and gave the following analysis: nitrogen, 2·81; uronic acid, 39·7; hexosamine, 37·9; reducing sugar (as glucose), 30·9. The yield from 1·91 gm. of sodium hyaluronate was 1·84 gm. A solution of 1·00 gm. of this product in 20 ml. of 1·0 *N* sulphuric acid was heated for 3 hr. at 99° in a sealed tube, then cooled and neutralized to *p*H 5·0 with saturated barium hydroxide. After removal of the precipitate, the amber solution was concentrated to 7 ml. and chilled, whereupon 300 mgm. of colourless material, appearing as rectangular, long prisms under the microscope, was deposited. Reheating the filtrate and washings with sulphuric acid, followed by neutralization and concentration, yielded an additional 130 mgm. Reprecipitation from 0·2 *N* hydrochloric acid solution with 1·0 *N* sodium carbonate gave homogeneous, long, rectangular prisms, weighing 232 mgm. after drying *in vacuo* over calcium chloride. The analysis of this material is presented in the accompanying table, with the values calculated for a disaccharide containing one residue of glucosamine and one of glucuronic acid.

ANALYSIS OF HYALOBIURONIC ACID

	Calc. for $C_{12}H_{21}O_{11}N$	Found
Carbon	40·56	40·01
Hydrogen	5·96	6·02
Nitrogen (Dumas)	3·94	3·99
Amino nitrogen (van Slyke)	3·94	3·96
Hexosamine	50·5	49·0
Uronic acid (gasometric)	55·2	54·3
Reducing sugar, ferricyanide[4]		68·0
Reducing sugar, hypoiodite[5]		61·0
[α, 24°, *D*] (2·00 per cent in 0·10 *N* hydrochloric acid)		+31°

Potentiometric titration indicated a substance with a pK_1' of 2·6 and a pK_2' of 7·1. On a micro hot-stage, the substance slowly decomposed without melting, beginning to darken at about 200°. The material was insoluble in glacial acetic acid, ethanol, methanol and pyridine, and almost insoluble in water. It was sparingly soluble in hot water, dilute hydrochloric acid, and dilute sodium bicarbonate. On a paper chromatogram developed by the ascending method with butanol – acetic acid – water (38 : 12 : 50) and then sprayed with *p*-dimethylaminobenzaldehyde, the material migrated with an R_F of 0·13, compared with 0·29 for glucosamine, and 0·43 for N-acetylglucosamine. The colour was identical with that given by glucosamine. The direct Elson–Morgan reaction (without preliminary hydrolysis) gave a colour value equivalent to 29 per cent of glucosamine by weight. The glucosamine residue, therefore, has a colour yield in this reaction which is only about 60 per cent of that of free glucosamine on a molar basis.

Despite the constancy of the chemical properties of all fractions examined in the course of these experiments, and the homogeneity with respect to crystal habit of the fraction described here, the analysis of this fraction by a solubility method gave results not consistent with the presence of a single species. This observation may be the result of an artefact of the analytical method, or of physical or chemical transformations which frequently occur with carbohydrate compounds. On the other hand, it may reflect the presence of two species with a structural difference due to the structure of the original polysaccharide. Further study will be required to clarify this point.

In any event, the isolated material, for which we propose the name 'hyalobiuronic acid', has the structure of a glucuronido–glucosamine with the free reducing group in the glucosamine residue. The insolubility in water must be attributed in part to the existence of the material in zwitterionic form. The stability to acid hydrolysis indicates that the glucuronic acid residue is present as a pyranoside. It is perhaps worth while to point out that hyalobiuronic acid will require re-acetylation of its amino group before a model can be obtained which will be suitable for comparison with the products obtained by enzymic hydrolysis of hyaluronic acid.

This investigation was supported by a grant from the Helen Hay Whitney Foundation.

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A Brown Discoloration of Pig Fat and Vitamin E Deficiency

THE consumption of vitamin E-deficient diets rich in highly unsaturated fatty acids, by chicks and by rats, is followed by the appearance of a yellow-brown coloration of the adipose tissue[1,2]. This pigmentation can be prevented by feeding a supplement of α-tocopherol acetate[3].

In an experiment carried out at the Agricultural Research Institute (N.I.), six female pigs were given a vitamin E-deficient diet containing 5 per cent dried skim milk powder, 5 per cent dried yeast, 5 per cent white fish meal, 5 per cent liver meal, 15 per cent palm kernel meal (ext.) and 65 per cent cassava meal, with a mineral supplement of salt and limestone; the vitamin E content was less than 0·1 mgm./100 gm. In addition, two of the pigs (group *A*) received 1 oz. cod-liver oil, as a vitamin supplement, once per week from weaning until they reached 100 lb. live-weight, two pigs (group *B*) received cod-liver oil throughout, at the rate of 5 per cent of their meal ration, while the remaining pigs (group *C*) received cod-liver oil at the 5 per cent level, together with 50 mgm. *dl*-α-tocopherol acetate a head each day. The meal was fed individually to all pigs, as a wet mash, on a slightly restricted scale of feeding[4]; in groups *B* and *C* the cod-liver oil was added directly to each morning feed, and in group *C* the tocopherol acetate was added as pellets to the afternoon feed. The animals, which had been reared normally until weaning at about 30 lb. live-weight, were then all placed on the control diet; the full experimental feeding commenced at 50 lb. weight. They made satisfactory growth and exhibited no unusual external symptoms up to the time of slaughter at 210 lb. weight, after an experimental period of 120 days.

After slaughter at a bacon factory, the carcases were commercially graded, and samples of fat removed for analyses. The back-fats of group *B* were deep yellow-brown in colour and with a slightly 'oxidized' odour; the carcases were condemned as unfit for curing. The back-fats of the remaining pigs were normal in appearance and the carcases were passed through all stages of curing.

The average peroxide values[5] of whole samples of extracted loin back-fat from groups *A*, *B* and *C* were 0, 5 and 0 respectively, while the induction periods[6] were 72, 12 and 17 and the iodine values 57, 74 and 80. Determinations of vitamin E[7] gave figures of 3·0, 0 and 2·8 mgm./100 gm. Examination of the brown pigment in the fat samples from group *B* suggests that it is similar to that described by Dam and Granados[3] in connexion with vitamin E-deficient rats and chicks. Moreover, there is reason to believe that it is also related to the discoloration of carcases occasionally encountered commercially when pigs have been fed diets containing high levels of fish oils.

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Cholinesterase Inhibition by Parathion *in vivo*

WE have shown[1] that OO-diethyl-O-*p*-nitrophenyl thiophosphate, an insecticidal compound generally known as parathion or *E*605, has not, when pure, any measurable *in vitro* inhibition of rat's brain cholinesterase. Nevertheless, pure parathion is a powerful inhibitor of cholinesterase *in vivo*, and there is little doubt that its mammalian toxicity is due to this property. When parathion is administered intraperitoneally to male rats (180–220 gm.) the dose necessary to produce a 50 per cent inhibition of brain cholinesterase within 30 min. is about 1·5 mgm./kgm., a figure of the same order as that required for OS-diethyl-O-*p*-nitrophenyl thiophosphate, the S-ethyl isomer of parathion, which is a highly active *in vitro* inhibitor[1]. With a dose of 3 mgm./kgm. the onset of the typical symptoms of parasympathetic stimulation occurs within 10 min. with both compounds. The cholinesterase activity of rat's blood, which is mainly due to specific enzyme in the red cells, is also unaffected by parathion *in vitro*; but *in vivo* it can readily be completely inhibited by injected parathion. There is, however, a slight but significant difference between the action of parathion and its S-ethyl isomer *in vivo*; when a dose of the former, which produces complete inhibition, is administered intravenously, there is a lag of a few minutes before the inhibition develops, whereas with the same dose of the latter the inhibition reaches completion very rapidly after injection.

These observations lead to the hypothesis that parathion undergoes a change to an active inhibitor after injection, and in confirmation of this it has been found that rat's blood may readily be inhibited by parathion *in vitro* in the presence of liver slices or homogenate. For example, 5 ml. heparinized whole blood was incubated at 37° C. with 2·5 gm. liver slices and 0·0056 ml. parathion solution (1·5 per cent in ethanol), added by means of a micrometer syringe; the cholinesterase activity of the blood was completely inhibited within 10 min. The presumed metabolite must be very unstable in blood, for if inhibited blood is withdrawn from a dosed animal it is not capable of inhibiting further cholinesterase added to it, nor does partly inhibited blood undergo a decrease in activity when incubated *in vitro*.

The inference from this investigation is that parathion administered to a rat is rapidly converted by the liver to an unstable cholinesterase inhibitor. Experiments previously performed in this Laboratory on hepatectomized rats by Dr. M. W. Goldblatt and Mr. J. Frodsham have indicated that the liver cannot be the sole site of such a presumed metabolic change, for when it has been removed a rat is not less sensitive to parathion. Moreover, the miotic effect observed when parathion is instilled into a rabbit's eye suggests that an active cholinesterase inhibitor is produced in the region of that organ. Experiments at present in progress with muscle and other tissues have not so far yielded positive results.

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'Double-Action' of Trichothecin and its Production in Soil

TRICHOTHECIN was the name given by Freeman and Morrison[1] to a stable antifungal agent produced by *Trichothecium roseum*. They report the ability of this antibiotic to withstand boiling, and it has been found here that its activity is unaffected by autoclaving for 1 hr. at 20 lb./sq. in. pressure on three successive occasions. This marked thermostability and the neutral reaction of trichothecin have prompted its use in this laboratory for studies on antibiotic production in the soil; *Fusarium oxysporum* var. *cubense* was the test fungus used and the lethal dose 90 was adopted as the activity unit.

A technique was devised for the study of the effect of an antibiotic on mycelial growth as apart from the effect on spore germination and subsequent growth. A standard amount of the test fungus (mycelium on agar) was placed at the centres of a series of plates, each containing 10 ml. of the Freeman and Morrison[1] medium solidified with agar. After incubating for 48 hr. at 25° C., the diameters of the colonies were measured and to the nutrient agar surface was added 5 ml. of the antibiotic solution, each plate being rotated so that the solution formed a liquid film over the surface. The test plates and appropriate controls were then incubated for a further 18 hr. and the diameters remeasured. The interesting result here was that when exceedingly small concentrations of trichothecin (0·00018–0·0018 units/ml.) were used there was a well-marked stimulation of growth. In higher concentrations (0·0018–10 units/ml.) the effect was fungistatic. Above these amounts there was a killing effect, and with 44 units/ml. the effect was wholly fungicidal.

A 'double-action' of long-chain unsaturated fatty acids on some bacteria has been reported[2,3]. When the concentration of trichothecin used was more than 10 units/ml., a pronounced swelling of the hyphal tips was noted, together with a bursting of some of these tips. The surface activity of the antibiotic is indicated by its reducing effect on surface tension.

It is suggested that trichothecin accelerates the bond-break phase of growth. In very minute amounts, trichothecin stimulates growth by slightly accelerating bond-break, enough to allow increased elongation but not enough to result in molecular disorganization. It is thought that it is this disorganization of the molecular make-up of the wall that in higher concentrations is responsible for the inhibition of growth and in still higher concentrations for the swelling and bursting of the tip.

In my experience, there is no report in the literature of a demonstration of the production of an antibiotic in sterile but otherwise untreated soil as well as in artificial media. This point was emphasized more than once at the seventh International Botanical Congress at Stockholm[4]. The following method has provided a positive demonstration of the production in sterile soil of trichothecin by *Trichothecium roseum*.

A sample of sterile garden soil (pH 6) was inoculated with *T. roseum* and incubated at 25° C. for ten days. Shallow layers of this soil-culture were added to a series of Petri dishes and triple autoclaved, together with dishes containing sterile soil as controls. After autoclaving, 10 ml. of Freeman and Morrison agar was poured into each plate in order to anchor the soil layer. An extra 20 ml. was then added to form a smooth-surfaced layer in which the soil was embedded. These plates were left for 20 hr. to allow diffusion into the medium of any antibiotic produced by the growth of the fungus. A standard amount of the test fungus was then placed at the centre of each plate, the plates being incubated at 25° C. for four days. In each case there was a 9·6 per cent reduction in the diameter of the test fungus colony over the soil where *T. roseum* had been grown as compared with growth over sterile soil. After 18 days growth in the soil, a 10·9 per cent reduction in linear growth was recorded.

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October 25.

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The Fermentation-inhibiting Properties of Orange Oil

The recent communication by Zukerman[1] leads us to give a preliminary note on our investigations on the antimicrobial properties of orange oil.

The starting point in these investigations was the observation that non-preserved fruit drinks, prepared from emulsified orange oil, inhibited the fermentation at 25° C. at an inoculum of 10^4 cells/ml. *Saccharomyces cerevisiae*[2].

Experiments were carried out with a semi-synthetic medium, containing 10 per cent sucrose and 0·25 per cent yeast autolysate ('Difco') at $pH = 5{\cdot}3 \pm 0{\cdot}2$. Florida orange oil (aldehydes, calculated as decylaldehyde = 1·6 per cent) was added in alcoholic solution to a final concentration of 1 per cent v/v of alcohol. It appeared that 0·01 or more per cent of oil could retard the fermentation of the medium by the inoculum referred to in such a way as increasing the time required for complete fermentation (in blank experiments, 48 hr. or less) to at least 96 hr.

Since Guenther[3] claims that the antimicrobial properties of essential oils such as orange oil are due to the terpenes rather than to the fraction containing oxygen derivatives, a Guinea orange oil (aldehydes = 1·7 per cent) and both the terpenes and the oxygen compounds (3·6 per cent) derived from it by 'Duosol' extraction with 90 per cent methanol/pentane[4] were studied. This investigation revealed that the terpenes possessed the same order of fermentation-inhibiting activity as the oil, whereas the oxygen fraction was inactive in concentrations occurring in additions of orange oil of the order of 0·1 per cent.

During the experiments the terpenes were stored in the refrigerator. They showed $[n]_D^{18} = 1{\cdot}4726$ and a peroxide value of 6·8 m.eq. oxygen/kgm.

Research along these lines is being continued.

I am greatly indebted to Messrs. N.V. Chemische Fabriek "Naarden", Naarden, Netherlands, for their very helpful co-operation in procuring the essential oils and oil fractions used in this investigation.

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Chlorosaccus ulvaceus Messik. and Vischer

Between April and October of this year, a rare member of the Xanthophyceæ, *Chlorosaccus*[1], a genus not previously recorded in the British Isles, has been collected on eight different occasions in east Yorkshire. It occurs in two much-shaded streams, one of them near South Cave, the other at Cottingham. From the former locality *Chlorosaccus* has now disappeared and in the latter it is extremely rare.

The pale yellow-green palmelloid colonies become macroscopic, irregular in shape and reach several centimetres in length; they are free-floating or entangled in submerged twigs. Actively swimming zoospores were obtained from material collected in June, July, September and (in smaller numbers) in

October. A full account of the species will be published elsewhere.

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Oct. 19.

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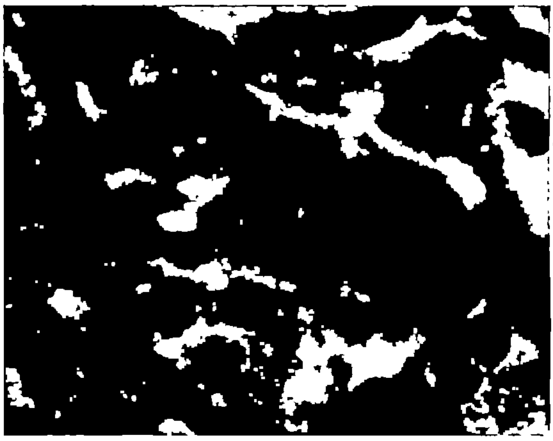
Fluorochromy as an Aid in the Resolution of the Specific Granules of the Islets of Langerhans

Visualization of individual granules in beta-cells of the islets of Langerhans is particularly difficult in many species, including man. Aside from electron microscopy, few techniques provide sufficient resolution to detect variations in the size or shape of individual granules owing to their minute size. Phase microscopy of stained specimens has proved satisfactory for observing extreme deviations from the normal[1]; but variations of less magnitude are difficult to assess. Strongly fluorescent granules illuminated by long ultra-violet rays (λ 300–400 mμ) act as self-luminous sources of visible light located within the specimen, and this permits use of the maximum aperture of apochromatic oil-immersion objectives. As the autofluorescence of islet cell granules is weak[2], their fluorescence must be intensified for adequate results. Various fluorochrome dyes were tried for this purpose and some yielded results which appear definitely superior to those obtained by either conventional or phase microscopy. The methods evolved are briefly outlined here, as most reports concerning fluorescence microscopy of the pancreas[3-4] make little reference to the use of fluorochrome dyes.

Paraffin sections (3 μ) of Bouin-fixed pancreatic tissue obtained from normal Wistar albino rats were washed in tap water until all visible traces of yellow were removed. Thorough washing is necessary in order to remove picric salts, for if these remain in the sections fluorescence is quenched. A number of fluorochrome dyes were tried, including primuline, thioflavine *S*, acridine yellow (*H* 107), acriflavine, coriphosphine, auramine *O* (all obtained from Edward Gurr, Ltd., London) and rhodamine *B* (749, Hopkin and Williams, Ltd., London). Sections were immersed for 2–4 min. in filtrates of saturated aqueous solutions of the various dyes, either alone or in combination. After a brief rinse in tap water, slides were blotted, rapidly dehydrated by a few dips in absolute ethyl alcohol, and cleared in xylol. Preliminary trials with a variety of mounting media indicated that the greater the difference between the refractive index of the granules and that of the mounting media the more intense the fluorescence. Xylol was found very satisfactory for temporary mounts (refractive index 1·494). The light source was a 250-watt high-pressure mercury lamp (British Thomson-Houston) with all appreciable visible light removed by a thick (5 mm.) filter of Wood's glass. A quartz reflecting prism and a quartz condenser were employed, although others of glass will serve almost as well. A Cooke apochromatic oil-immersion objective (N.A. 1·32) was used in combination with a 10 × ocular and a green glass eyepiece filter to eliminate the ultra-violet background. Shillaber's immersion oil was employed because of its low fluorescence.

The best results were obtained with sections stained with acriflavine, although those treated with either primuline or thioflavine *S* were almost equally satisfactory. These imparted an intense (yellowish) fluorescence to the granules in islet cells, as illustrated in the accompanying photomicrograph. After initial treatment with any of these fluorochromes, if the sections are counterstained with rhodamine *B*, the islets are sharply differentiated from surrounding acinar cells, for the latter emit a strong orange fluorescence from their basal portions. Tinctorial differentiation of alpha- and beta-cells was not achieved with any of the fluorescent dyes tried; but characteristics of individual granules are so clearly resolved that cell-types may be identified by the size and number of their granules. In these sections, the granules appear larger than when stained by more conventional methods. Adsorption of dye on the surface of the granule may be responsible, at least in part, for this phenomenon. Alpha-cells appear brighter than beta-cells, for granules in the former are more numerous and closely packed. Beta-cell granules can be so clearly resolved that it is quite possible to observe distinctly their individual size and shape in many instances. This should prove of distinct value in studies of the experimental histology and pathology of the islets of Langerhans.



Pancreas stained with acriflavine illuminated by long ultra-violet rays. Details of fixation and staining are given in text. The unstained nuclei appear as oval black areas. The granules in both acinar and islet cells appear white against a black background. Acinar granules can be seen in the lower right corner. Cytoplasm of an alpha-cell just to the left of this appears almost entirely white, for its granules are crowded closely together. The remainder of the islet, which nearly fills the entire field, is made up of beta-cells. Their granules appear as small white bodies. Final magnification, 1,100 ×

The possibilities of fluorochromy as an aid in visualization of the details of very small structures do not seem to have been fully explored. It is possible that applications of this technique to other organs might be of assistance to cytologists in resolving minute bodies.

The techniques described were developed in the Department of Human Anatomy, University Museum, Oxford, during study leave from the University of Toronto. Thanks are due to Dr. Robert Barer for providing facilities and for his continuous advice and encouragement.

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Sept. 1.

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Adaptation in Rodent Moles and Insectivorous Moles, and the Theory of Convergence

STUDIES in connexion with the life-history of the Orange Free State rodent mole, *Cryptomys*, brought to light a remarkable degree of adaptation, anatomically and psychologically, to its mode of life in total darkness.

The most interesting expression of psychological adaptation is observed with regard to the animal's power of orientation, keeping in mind the fact that it is totally blind. Damage to its tunnels may be caused by several factors, the most important of which are large and small Ungulates, rain, dogs and man. The tunnels are bored only a few inches below the surface. In this manner, tunnel damage may be a daily occurrence where cattle and horses are grazing. A tunnel may be damaged to such an extent that, for fairly long distances, it cannot be used. However, where such damage occurs in connexion with mole systems, proper connexion between even widely separated undisturbed tunnel sections is effected in a remarkably short time and correct manner, while at the same time the mole displays highly developed powers of orientation. No matter how severely damaged these tunnels may be, either cutting off the moles in the veldt from the nest or *vice versa*, these animals reach their goal unfailingly without trial or error.

Experiments and observations confirmed this interesting power of orientation, a more detailed discussion of which has already been published[1].

Briefly, the experiments were conducted as follows: (*a*) In one set of experiments a tunnel was opened up for a certain distance, for example, fifty feet from its terminal portion in the veldt; (*b*) in another set of experiments the tunnel was opened up between nest and veldt terminus; (*c*) in still another set of experiments the tunnels radiating from the nest were opened up all around the nest for some distance veldtwards.

In (*a*) the mole plugged the mouth of the undisturbed portion of the tunnel and started to bore another one parallel to the one destroyed, ultimately reaching the veldt terminal spot again. This process of boring parallel to destroyed tunnels has been observed to be repeated as many as twelve times.

In (*b*) the mole, after plugging the one opening, bored another tunnel parallel to the portion opened up, connecting up correctly with the remaining intact portion, the opening of which was then also plugged. As in (*a*), the process may be repeated.

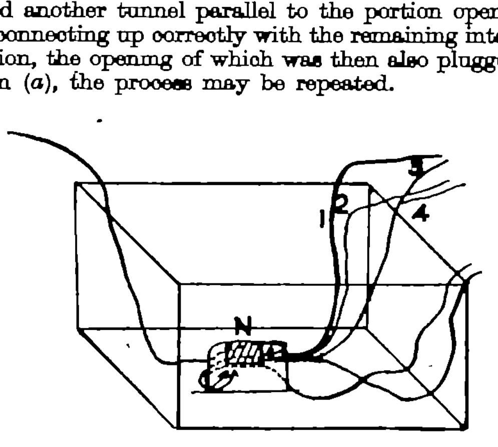

Fig. 1. Tunnels 1, 2, 3, 4 bored consecutively after opening up previous one; thus tunnel 2 is bored after tunnel 1 is opened up. *N*, nest

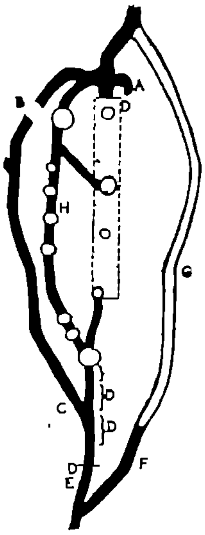

Fig. 2. Orientation in *Bathyergus maritimus*. *A*, Feb. 10, 1951; *H*, tunnel bored Feb. 10; *C*, Feb. 12; *F*, new tunnel bored Feb. 12; *B*, gap of 1½ ft. between two approaching tunnels not completely connected; *D*, tunnel plugged here when opened up on Feb. 13, *E*, tunnel opened up on Feb. 13; *G*, old, plugged-up tunnel repaired and taken into use again

In (*c*) the moles bored nestward, reaching their destination without trial or error (Fig. 1). Here, too, the experiment may be repeated with the same result.

Consequent to these observations on the mole rat *Cryptomys*, observations were also made on three other rodent mole species, including the large dune mole *Bathyergus maritimus*. They all showed the same ability of orientation as *Cryptomys*.

Bathyergus maritimus, for example, is the largest rodent mole of South Africa and inhabits the sandy sea-shores, six hundred or more miles away from the habitat of *Cryptomys*, which inhabits the dry Free State veldt. Its tunnels are dug by means of strongly developed front claws, whereas *Cryptomys* bores by means of its lower incisors, which in contrast to those of *Bathyergus* are separately movable as no ossification takes place at the mandibular symphysis. Thus other differences obtain. However, both species are blind and subterranean. Experiments of type (*b*) described above yielded the same results with regard to *Bathyergus maritimus* (Fig. 2).

Similar observations on the Cape Golden mole, which belongs to the order Insectivora, showed that, so far as orientation is concerned, the two different orders display a high degree of biological convergence, as in fact the absence of visual sense, absence of external ear pinnæ, reduced tail, strong front- and hind-quarter musculature and other anatomical homologies, express the phenomenon of convergence associated with similar mode of living.

An interesting question arises as to which sensory organ or organs make this orientation possible.

Thanks to the fact that the mole rat is easily bred in glass cages containing damp soil, modes of behaviour could be recorded which otherwise might escape observation. By means of apparatus adapted to the mole, we are studying its sense organs, learning ability and reactions. We were greatly struck by the strong and quick reactions (40 σ) to air currents, vibration and sounds. It seems as if the explanation of the orientation behaviour must be looked for in a combination of these senses.

I am grateful to the Council for Scientific and Industrial Research and to Prof. Immelman and Mr. Brits, of the Department of Physics, for technical aid.

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Sept. 14.

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A Quantum Mechanical Study of Lithium Hydride

The electronic energy of lithium hydride has been computed by the Hartree–Fock approximation. The computations were carried out both by the linear combination of atomic orbitals approximation according to the molecular orbital method, and by the electron-pair approximation according to Heitler and London with inclusion of ionic terms. When only the two valence electrons were considered, the computed values of the binding energy were as follows:

Linear combination of atomic orbitals approximation of molecular orbitals	3·57 eV.
Electron-pair method without ionic terms	2·64 „
Electron-pair method with ionic terms	3·68 „
Experimental value[1]	2·64 ± 0·2 eV.

In these computations the value of the interatomic distance, R, was put equal to the experimental value, 1·6 A. As the computed energy values are larger than the experimental value, the neglect of the repulsion between the valence electrons and the electrons in the inner shell of the lithium atom seems to cause a considerable error. This fact is in agreement with the result of James's calculations[2] on the lithium molecule (Li_2). Therefore the energy of the lithium hydride molecule was computed with a wave function including molecular orbitals for all the four electrons of the molecule. This more accurate treatment resulted in a computed value of the binding energy of 2·0 eV. when $R = 1·6$ A. The computations will be repeated with other values of this parameter. It seems reasonable to expect that these new computations will result in energy values not much different from the one computed already.

Although the value of the binding energy is evidently rather sensitive to the method of approximation, it may be hoped that the form obtained for the wave function and thus the electron distribution is more insensitive. Both in the two-electron cases and in the four-electron case, the best values of the parameters in the wave function indicate that the structure Li^+H^- is the most important one. This fact emphasizes that no significance should be attributed to the apparently excellent agreement between the experimental value of the binding energy and that computed according to the electron-pair method without ionic terms. The same objection is applicable to the calculations on lithium hydride by Hutchisson and Muskat[3]. The calculated structure Li^+H^- is in good agreement with the experimental fact that hydrogen is obtained at the anode during electrolysis of lithium hydride.

Another interesting point in the results of the calculations is the relative importance of 2*s*- and 2*p*-orbitals around the lithium atom, that is, the degree of '*s*,*p*-hybridization'. If this degree of hybridization is calculated according to the criterion of maximum overlapping, the *s*- and *p*-orbitals are found to be of about equal importance. Almost the same result is obtained when only the two valence electrons are considered in the calculations of the energy. However, when the molecular orbitals of all the four electrons are included in the wave function, the 2*p*-orbital is found to be much less important than the 2*s*-orbital. This result seems to be reasonable, as the 2*p*-energy-level of the free lithium atom lies as much as 1·85 eV. above the ground-level.

Full details of this investigation will be published elsewhere.

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June 23.

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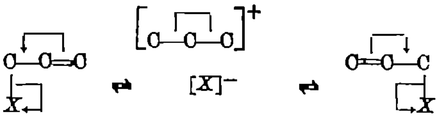
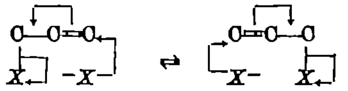
Demonstration of Bimolecular Anionotropic Change

Though it has long been accepted that the unimolecular process S_N1' represents a common mechanism of isomeric rearrangement and of substitution with rearrangement in anionotropic systems, for example,



(S_N1')

the idea has been extant since 1938[1] that a bimolecular mode of rearrangement S_N2' might also exist:

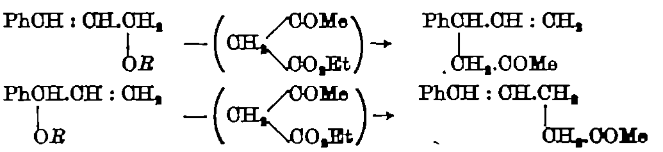


(S_N2')

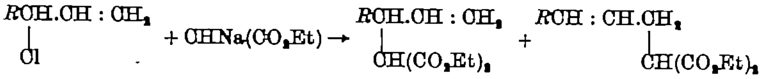
In these formulations X^- represents a general anion, so that the X's which engage in different processes, or together participate in the same process, may, or may not, be chemically identical.

The earlier attempts[2] to detect mechanism S_N2' resulted (*a*) in producing new evidence substantiating the mechanism S_N1', and (*b*) in showing that, under conditions leading only to bimolecular reactions, any bimolecular substitution with rearrangement S_N2' was so relatively unimportant as to be masked by bimolecular substitution without rearrangement S_N2 in the systems studied.

There is, however, one group of cases in which evidence for bimolecular rearrangement S_N2' has been claimed. They are all of one type: the entering substituent comes from a pseudo-acid. By treatment with ethyl acetoacetate and a basic catalyst, cinnamyl alcohol has been converted, probably through its esters, to 1-phenylallylacetone, and 1-phenylallyl alcohol has been similarly converted to cinnamylacetone[3]:

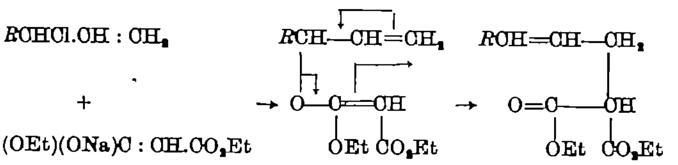


1-Methylallyl chloride has been converted by treatment with ethyl sodiomalonate partly into the normal substitution product, but partly also into the rearranged product, ethyl crotylmalonate; and 1-ethylallyl chloride has been found to undergo similar reactions[4a]:



$$\underset{\text{Cl}}{R\text{CH}}.\text{CH}:\text{CH}_2 + \text{CHNa(CO}_2\text{Et)} \rightarrow \underset{\text{CH(CO}_2\text{Et)}_2}{R\text{CH}}.\text{CH}:\text{CH}_2 + R\text{CH}:\text{CH}.\underset{\text{CH(CO}_2\text{Et)}_2}{\text{CH}_2}$$

However, as Dewar has pointed out[5], the difficulty about accepting such demonstrations of the S_N2' mechanism is that a pseudo-acid always has at least two reactive centres, so that the observed result could arise from a normal S_N2 substitution followed by a Claisen rearrangement (that is, the known intramolecular allyl transformation, as of phenyl allyl ether to *o*-allylphenol):



The formation of rearranged products has also been observed in the reactions of amines with allylic halides; but a careful scrutiny of the changes showed that no unambiguous evidence for the simple S_N2' mechanism could be derived from the results[4b].

As suggested previously, the difficulty about establishing mechanism S_N2' is, not that it does not exist, but that mechanism S_N2 is usually fast enough to mask it. Such masking can be avoided by the following method[6]. The allyl compound, for example, 1-methylallyl bromide, is allowed to interact, under conditions leading only to bimolecular substitution, with a supplied anion, for example, radiobromide ion, identical but for an isotopic distinction with the anion that could be given by the allyl compound. This secures that every individual molecular act of substitution by mechanism S_N2 will, for all ordinary chemical purposes, replace the original molecule by an identical one; so that the original substance never becomes used up by mechanism S_N2, but continues to be available indefinitely for the observation, at any necessary temperature, of isomerization by mechanism S_N2'. The kinetics of the latter reaction can be controlled, and its rate determined, by ordinary chemical means; and this S_N2' rate can be compared with the rate of the S_N2 exchange, which is also kinetically controlled, as determined by radiochemical means. This programme has been carried through for the bimolecular reactions of both 1-methylallyl bromide and crotyl bromide with lithium bromide in acetone. The kinetic data[7] are in the accompanying table: they furnish what at present is the only indubitable demonstration of the S_N2' mechanism.

RATE CONSTANTS AND ARRHENIUS PARAMETERS OF BIMOLECULAR BROMIDE EXCHANGE (S_N2) AND BIMOLECULAR ISOMERIZATION (S_N2') OF ALLYL BROMIDES WITH LITHIUM BROMIDE IN ACETONE
(k_2 and A_2 in sec.$^{-1}$ mole^{-1} l., and E_A in kcal. mole.$^{-1}$)

Bromide	Reaction	$10^6 k_2$ (25°)	$\log_{10} A_2$	E_A
1-Methylallyl	S_N2	879	9·06	16·5
	S_N2'	14·9	9·40	19·4
Crotyl	S_N2	141,000	9·93	14 7
	S_N2'	5	~9	~19

It will be seen that both halides undergo both bimolecular reactions. But for 1-methylallyl bromide, the S_N2 reaction goes 60 times faster than the S_N2' process, while for crotyl bromide the S_N2 exchange proceeds 28,000 times faster than the S_N2' isomerizations. It is easy to understand why the S_N2' mechanism is difficult to observe when a concomitant S_N2 substitution can mask it. However, it is also clear that the difference in the two rate-ratios, S_N2/S_N2', arises mainly from the difference between the two S_N2 rates. Thus it is probable that the great drop in the ratio from 28,000 to 60 is largely a local effect of the 1-methyl substituent in repressing the local S_N2 reaction; and this supports an earlier suggestion[8] that S_N2' rearrangements should be sought in the reactions of 1-*tert*.-butylallyl halides, a task which we now have in hand. The generally reduced rates of the S_N2' as compared with the S_N2 reactions have been ascribed[9] to the circumstance that in the former the reagent attacks a nucleus of unsaturated carbon, which is protected by the double π-electron layer, while in the latter it attacks a nucleus of saturated carbon, which has no such protection. (The π-electrons of C=C will be displaced somewhat towards the group CH_2Br: otherwise the S_N2' reactions would be slower still.)

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London, W.C.1. July 12.

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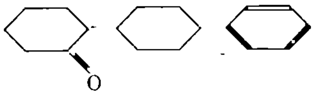
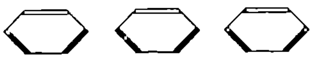
A New Synthesis of *p*-Terphenyl and its Derivatives

WHEN unsaturated ketones in cyclic systems are subjected to Friedel–Crafts reaction[1] in presence of anhydrous aluminium chloride, they give rise to unexpected products. Some significant observations have been made in this laboratory[2] on the Friedel–Crafts reaction involving unsaturated ketones, and this reaction, when extended to *cyclo*hexenyl–*cyclo*hexanone, led to a new method of synthesis of *p*-terphenyl and its derivatives. Although a number of such syntheses have been described in the literature[3–7], the present method offers a more convenient synthesis of *p*-terphenyl and its derivatives starting from easily available materials. Moreover, studies on the condensation of *cyclo*hexenyl–*cyclo*hexanone with biphenyl, *p*-terphenyl, etc., are in progress, which may eventually lead to the development of a new general method for synthesis of polyphenyls.

*Cyclo*hexenyl–*cyclo*hexanone, prepared according to the method of Wallach[8], was condensed with benzene in presence of anhydrous aluminium chloride to give the ketone (I, boiling point 185–190°/2 mm. in 85 per cent yield; semicarbazone, crystallized from ethanol, melting point 227–228°). The ketone I was dehydrogenated by heating with palladized-charcoal (30 per cent) at 260–320° for 8 hr., and the main product isolated after crystallization from benzene–ethanol was found to be *p*-terphenyl (II, melting point 212°; lit.[7] 210–211·5°; lit.[5] 213°; calc. for $C_{18}H_{14}$: C, 93·91; H, 6·08; found: C, 93·74; H, 5·95 per cent). Nitration of *p*-terphenyl, gave the *pp*′-dinitro derivative of *p*-terphenyl (melting point 278–279°; lit.[7] 275°; lit.[12] 277°). Complete separation of *p*-terphenyl left a thick oil which crystallized from ethanol to give *m*-terphenyl (melting point 87–88°; lit.[8] 86–87°; lit.[10] 89°; calc. for $C_{18}H_{14}$: C, 93·91; H, 6·08; found: C, 93·106; H, 5·75 per cent); but attempts to isolate *o*-terphenyl[9] were not successful.



I



II

Reduction of the Friedel–Crafts product by Huang-Minlon's method[11] gave a hydrocarbon (boiling point 170–172°/3 mm.), which on subsequent dehydrogenation by palladized-charcoal (30 per cent) at 260–320° for 8 hr. furnished mainly *p*-terphenyl and a small quantity of *m*-terphenyl; but no *o*-terphenyl could be isolated.

Grignard reaction between methyl-iodide and the ketone I, followed by dehydration of the crude Grignard product with phosphorus pentoxide, gave a liquid hydrocarbon (boiling point 178–180°/3 mm.) which was dehydrogenated by palladized-charcoal (30 per cent) at 260–320° for 8 hr. to give *p*-(2-methyl)-terphenyl (melting point 91–92°, from ethanol; lit.[7,10] 91–92°; calc. for $C_{19}H_{16}$: C, 93·44; H, 6·55; found: C, 93·36; H, 6·46 per cent).

The assignment of the structure I to the Friedel–Crafts reaction product is not above scrutiny, as rearrangement under the drastic condition of dehydrogenation may well have taken place to give *m*- and *p*-substituted products[4]. This finds some support in the isolation from the product of dehydrogenation of a considerable quantity of *m*-terphenyl. However, this point is now receiving consideration.

Microanalyses were carried out by Drs. Weiler and Strauss (Oxford).

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Determination of the Mean Life-time of μ-Mesons

THE photographic emulsion method has been applied to the determination of the mean life-time of μ-mesons from their anomalous absorption. Ilford *C* 2 plates with emulsion thicknesses 140 μ, 150 μ and 185 μ were exposed to cosmic radiation under controlled conditions for 42 days during the winter of 1950 in the High Tatra Mountains. One batch of plates was exposed without any absorber at Skalnaté Pleso (1,780 m.) and another one was placed on the top of Lomnický Štít (2,640 m.) under 12 cm. of lead absorber, corresponding in stopping power to the layer of air, 85 gm./cm.², between the two stations. The plates were developed by the freezing method of C. C. Dilworth[1].

The mean life-time τ_0 of μ-mesons was calculated from the formula

$$\tau_0 = \frac{m_0}{p} L, \tag{1}$$

where m_0 is the rest mass of the μ-meson, p is the effective momentum and L is the mean range before decay. The rest mass of mesons was determined by grain counting and Coulomb scattering methods, giving the result $m_0 = 110$ MeV./c^2. The effective momentum p was calculated by numerical integration of the Bethe–Bloch formula and corrected according to B. Rossi and D. B. Hall[2]. The mean range before decay was calculated from the formula:

$$L = -(H_1 - H_2)\left(\log \frac{N_2}{N_1}\right)^{-1}, \tag{2}$$

where H_1 is the height of Lomnický Štít, H_2 is the height of Skalnaté Pleso, N_1 is the number of mesons in a given volume of the emulsion from the higher station under lead, N_2 is the number of mesons in the same volume of the emulsion exposed at the lower station.

Substituting the measured and calculated values of m_0, p, and L in formula (1), we obtained for the mean life-time of the μ-meson, $\tau_0 = (2{\cdot}3 \pm 0{\cdot}3) \times 10^{-6}$ sec., in good agreement with the value $\tau_0 = (2{\cdot}15 \pm 0{\cdot}1) \times 10^{-6}$ sec. from direct measurements.

This method makes it possible to work with mesons in the low-energy region where the absorption anomaly[3] is more pronounced and where the polarization of the medium[3] is negligible. Since it is possible to measure the mass m_0 of mesons from the tracks observed, we were able to determine the value of τ_0 directly, whereas using Geiger–Müller counters it is possible to obtain from the anomalous absorption the value of the ratio τ_0/m_0 only. In this way, our measurements show that ρ-mesons are almost exclusively μ-mesons.

A detailed account of this work will be published in the *Bulletin international de l'Académie tchèque des Sciences*. I am indebted to Prof. V. Petržílka for helpful discussions during the course of this work.

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[1] Dilworth, C. C., Occhialini, G. P. S., and Vermaesen, L., *Bull. Centre Phys. Nuc., Bruxelles*, Note No. 13 a (1949).

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Nuclear Disintegrations caused by Fast Cosmic-Ray Neutrons in Photographic Emulsions

On the same plates as those described in my previous communication[1], I have studied the relation between the single tracks and the stars, and tried to elucidate the question of their origin. A detailed analysis of 600 stars and of 3,000 single tracks was carried out. My measurements support the assumption that the single tracks are caused mainly by fast neutrons in glancing collision with the nuclei of the emulsion. From the topological distribution of the stars on the plates and from the angular and energy distributions of their prongs (protons, α-particles and recoil tracks), I have shown, applying the results of the evaporation theory[2], that the great majority of the stars are also caused by fast neutrons in glancing collision without the capture of the incident neutrons in the nuclei. The energy distribution of fast protons emitted from stars was used to determine the range of nuclear forces following E. Bagge[3] and G. Ortner[4]. From my measurements I obtained the value $\varkappa^{-1} = (2 \cdot 6 \pm 0 \cdot 4) \times 10^{-13}$ cm.

Details of this work will be published in the *Bulletin international de l'Académie tchèque des Sciences*. I wish to express my gratitude to Prof. V. Petržílka for helpful advice in this work.

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[1] Pernegr, J. (see preceding communication).
[2] Le Couteur, K. J., *Proc. Phys. Soc.*, A, 63, 259 (1950).
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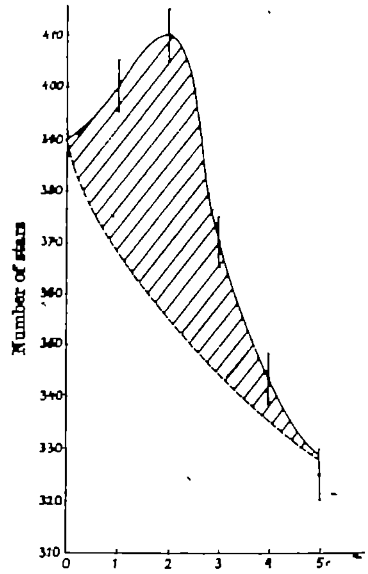
[4] Ortner, G., *Ber. Akad. Wien*, 149, 259 (1940).

Transition Effect of the Star-producing Radiation

To prove the existence of the transition effect of the star-producing radiation suggested by G. Bernardini[1], an experiment relating to this question was carried out in the High Tatras in the winter of 1950. Six batches of Ilford *C* 2 plates with emulsion thickness of 200 μ were exposed during 45 days at Lomnický Štít (2,640 m.). One batch of plates was exposed without any absorber, while the others were placed under different layers of lead of increasing thicknesses from 1 cm. to 5 cm.

The experimental results concerning the numbers of stars observed in the same volumes of the emulsion under different thicknesses of the absorber are plotted in the accompanying graph. Comparison of the experimental values with the postulated exponential absorption curve shows a well-pronounced maximum of the frequency of stars under the layer of about 20 gm./cm.² lead. The dotted exponential line was drawn using the value for the absorption coefficient $\lambda^b = 310$ gm./cm.².

Further observations are being collected, and definite measurements with possible interpretations of this effect will be published later in the *Bulletin international de l'Académie tchèque des Sciences*.



Transition effect of star-producing radiation : - - - - -, theoretical exponential absorption ; ———, experimental

I wish to thank Dr. J. Pernegr for suggestions and help in this work.

Note added in proof. Since this communication was written, G. Belliboni, L. Fabrichesi, L. de Marco and M. Merlin[2] have published a paper in which they describe measurements similar to those I have made.

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July 25.

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The Decay Scheme of Zinc-65

According to a short report given by Good and Peacock[1], the radioactive isotope zinc-65 decays 97·8 per cent by *K*-capture and 2·2 per cent by positron emission. They also found that 54 per cent of the capture processes go directly to the ground-state of the product nucleus copper-65, while 46 per cent go to the 1·11-MeV. excited state.

In the present work, the branching ratio between the two capture processes has been investigated, using a selective method for the detection of the X-rays in addition to X–γ coincidences and a calibrated γ-ray counter.

The source used was a thin layer of finely ground zinc-65 spread on a 'Cellophane' foil and covered with a few drops of a diluted solution of cellulose. This source was placed between two cylindrical Geiger–Muller counters—an ordinary γ-ray counter with 1-mm. thick brass walls, and an X-ray counter with aluminium walls 0·05 mm. thick.

Let K_1 be the number of capture processes going to the ground-state and K_2 the number going to the excited state. Then a branching ratio p can be defined as :

$$p = K_2/(K_1 + K_2). \quad (1)$$

The characteristic X-rays of copper resulting from the K-capture are converted to the extent of about 63 per cent into Auger electrons[2]. As this Auger effect should be of the same magnitude in both branches, p can be written:

$$p = X_2/(X_1 + X_2), \quad (2)$$

where X_1 and X_2 denote the number of X-rays in the two branches.

As the following relation is valid:

$$C = pN_X\,(N_\gamma/N_{\epsilon\gamma}), \quad (3)$$

p can be determined from the absolute microcurie γ-strength of the source $N_{\epsilon\gamma}$, and from the counting-rates of (i) true X–γ coincidences (C), (ii) X-rays detected in the aluminium counter (N_X), and (iii) γ-rays detected in the brass counter (N_γ). Equation (3) holds exactly provided that there is no internal conversion of γ-rays; the conversion factor for zinc-65 is $2 \cdot 3 \times 10^{-4}$ according to Wagooner *et al.*[3], and is thus negligible in this case.

Concerning the quantities in equation (3), C and N_γ can be measured directly with due correction for background and chance coincidences. $N_{\epsilon\gamma}$ was determined from the counting-rates (in the brass counter) obtained respectively from the zinc-65 source and a cobalt-60 standard using identical geometry. However, the value of N_X was difficult to deduce from the measured counting-rate N_{Al} in the thin-walled aluminium counter, because of the simultaneous detection in this counter of positrons and Compton electrons due to γ-quanta.

To avoid these difficulties a selective method was used, based on varying the efficiency of the aluminium counter for X-rays, those for γ- and β-rays remaining constant. The characteristic X-rays of copper (8·05 keV.) are absorbed in the gas only by photo-effect, and this process accounts for the greater part of the counting-rate, the contribution from the walls being relatively small. Therefore the difference of efficiency aimed at is easily achieved by varying the pressure, that is, the absorption probability in the gas, and thus the value of N_X[4]. On the other hand, the yields of γ- and β-rays are scarcely dependent on the gas pressure in the counter, as has been confirmed by special experiments. A somewhat similar method has been described by Gráf[5].

From equation (3) it is clear that, when varying the X-ray efficiency according to the method described, a linear relation between C and N_{Al} is to be expected, since N_{Al} differs from N_X by a nearly constant amount. Thus, the dependence of C on N_{Al} is given by a straight line, and p can be calculated from the slope of this line. Errors in C due to annihilation radiation and scattering are independent of the variation and will thus have no influence on the calculation of p.

The present measurements were carried out at three different pressures of argon, namely, at 90, 270, and 487 mm. of mercury. The results obtained confirm the presumed linearity between C and N_{Al}, and a value of $p = 0 \cdot 44 \pm 0 \cdot 03$ has been found. This is in fair agreement with the value 0·46 given by Good and Peacock.

I wish to express my thanks to Prof. L. Meitner for her help and guidance throughout this work.

Note added in proof (*November* 19). In the meantime, a paper[6] has been published, where zinc-65 is reported to decay to the extent of 0·8 per cent by positron emission.

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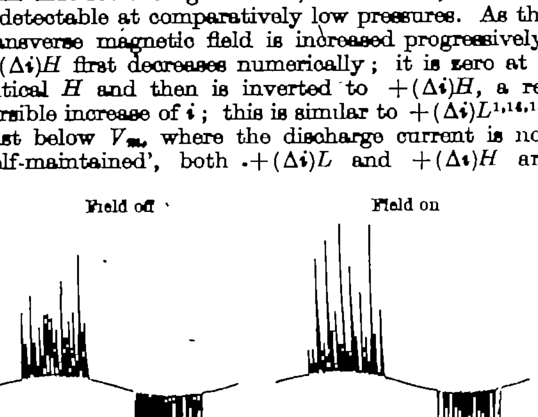
A Magnetic Analogue of the Joshi Effect

FOLLOWING Joshi's observation[1,2] that the discharge current i due to a potential V depends on $V - V_m$, where V_m is the threshold potential characteristic of a discharge reaction, and that V_m is affected by a transverse magnetic field H, we have carried out some detailed investigations of a change with H of i in several gases and vapours excited in an ozonizer, at various frequencies n.

This effect is found ordinarily to be one of suppression $-(\Delta i)H$, which is remarkably similar to the Joshi effect $-(\Delta i)L$ caused by irradiation from the extreme red[3] to X-rays[4]. Both the light and magnetic effects involve practically a negligible time-lag[5,6], are reversible[6,7], are influenced markedly by 'ageing' under discharge[1,8,9], show hysteresis[9,10] which is maximum near V_m and are affected adversely by heating and by increase of n[11,12]. They cannot be detected below the threshold potential[7,13] V_m, where the discharge current i is entirely capacitative ($2\pi nCV$, C being the distributed capacity), despite the use of intense transverse magnetic field H or irradiation. A limited increase of potential above V_m favours either of the negative effects, magnetic field or irradiation being constant. The range of potentials for the production of the magnetic effect is greater than that for the light effect; the former, however, is detectable at comparatively low pressures. As the transverse magnetic field is increased progressively, $-(\Delta i)H$ first decreases numerically; it is zero at a critical H and then is inverted to $+(\Delta i)H$, a reversible increase of i; this is similar to $+(\Delta i)L$[1,14,15]. Just below V_m, where the discharge current is not 'self-maintained', both $+(\Delta i)L$ and $+(\Delta i)H$ are



Exciting potential, 1·8 kV. r.m.s. (50 c/s.); H_2, 0·04 mm. mercury; H, 890 gauss, current change due to H, −29 per cent observed under feeble light[1,12] and magnetic field[16,17] respectively. At a given potential V, either of the transitions[14-17] $-(\Delta i)L,H \rightleftarrows +(\Delta i)L,H$ can be caused *ad libitum* by varying the transverse magnetic field H or the intensity and frequency of light.

Both the light and magnetic effects are linked preferentially with the high-frequency component[5,7,11,12] of the discharge current i. The accompanying pair of oscillograms refers to a discharge in low-pressure hydrogen; essentially similar results are obtained in a number of media with a wide range of operative conditions. On the application of the transverse magnetic field in either half of the current cycle, the amplitude of some of the high-frequency spikes is reduced while that of others increased simultaneously; this is accompanied usually, though not invariably, by a change in the number of high-frequency spikes. A like effect, namely, simultaneous occurrence of $\pm(\Delta i)L$ in different parts of the current cycle, was observed in chlorine[10] and iodine vapour[18].

Our thanks are due to Prof. S. S. Joshi, of Benares, and Prof. V. N. Thatte, of Nagpur, for help and advice.

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Formula for Creep Curves of Metals

I WAS somewhat surprised to read in *Nature* of October 20 the letter of Prof. R. R. Hasiguti and his collaborator. Prof. Hasiguti sent me a copy of this letter in April and I replied to him on May 25, by air mail, pointing out that the only reason that he found that the four-constant formula, put forward by him, gave a better fit to his experimental results than my three-constant formula was that he had taken unfavourable values for the constants in my formula. I sent him the correct values of the constants, found by the method of Dr. A. J. Kennedy[1], which are $l_0 = 49 \cdot 57$ cm.; $\beta = 1 \cdot 1006 \times 10^{-2}$ sec.$^{-1/3}$; $\varkappa = 1 \cdot 4713 \times 10^{-4}$ sec.$^{-1}$. With these values, the "Length calculated from Andrade's formula" in Table 1 given in his letter come out to be 50·71, 51 35, 53·16, 57·30, 65·00. Prof. Hasiguti sent me in his original letter a much fuller list of values than that given in his Table 1, and, except at 7 sec., where the experimental reading cannot possibly be accurate (in view of the difficulty of deciding to within a second the moment of imposition of the load, inertia effects and the rapid rate of flow in the first ten seconds), the greatest difference between the values given by my equation and the experimental values was 0·08 per cent as against a greatest difference of 0·10 per cent with his equation. In fact, with the constants given above, my three-constant formula shows a better fit than his four-constant formula.

Unfortunately, the writers of the letter printed in *Nature* do not give the values of their four constants that lead to the figures for s given in their Table 1, and Dr. Kennedy has, after some effort, been unable to find values that yield these figures.

The validity of my formula has been often verified, both inside and outside my Laboratory[2], and it is recognized that the constants β and $\varkappa$ represent definite physical processes, β accounting for slip within the crystal grains of the polycrystalline metal and $\varkappa$ for relative movement of the grains[3]. The constants a, b, c in the four-constant formula appear to have no physical significance.

As far as the single crystal results are concerned, Cottrell and Aytekin[4] found very good agreement between their experimental result on single crystals of zinc and the formula

$$\gamma = \gamma_0 + \beta t^{1/3} + \varkappa t,$$

which is the appropriate form of my formula for a single crystal. As a purely empirical result, Dr. Kennedy has pointed out to me that the experimental results given in Prof. Hasiguti's Table 2 are much better fitted by the two-constant formula $\gamma = \gamma_0 t^{0 \cdot 015}$ than by Prof. Hasiguti's four-constant formula.

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"The Home Life of an Astronomer"

I AM very grateful to Prof. F. J. M. Stratton for his appreciative review of my book, "Ninth Astronomer Royal"[1], but I do not understand his saying that I have ascribed Einstein's special theory of relativity to Newton. Unless there is some error that has escaped my notice, this must refer to the statements on page 192: "According to the new Theory of Relativity the rays of light from these stars would be bent in passing the huge mass of the sun. This deflection would be twice as great as anything that could be accounted for by the old Newtonian theory. . . . Would it be the 1·74 seconds of arc indicated by Einstein's theory, or the 0·87 seconds of arc indicated by Newton's, or none at all?" Does this attribute the special theory of relativity to Newton? If so, I err in good company, that of Sir Arthur

Eddington, who writes in "Space, Time and Gravitation": "It must be understood that there were two questions to answer: first, whether light has weight (as suggested by Newton), or is indifferent to gravitation; secondly, if it has weight, is the amount of the deflection in accordance with Einstein's or Newton's laws?" (page 110). Further, "It will be remembered that Einstein's theory predicts a deflection of 1″·74. . . . The simple Newtonian deflection is half this, 0″·87" (page 118).

I gladly admit that I am not competent to do justice to my father's scientific work, but I took the precaution of asking astronomical and other scientific friends to check my manuscript, so I shall be surprised if there are any definite errors of statement on scientific matters in my book. In other respects, the review is only too kind.

MARGARET WILSON

The Chimes,
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Stafford.

[1] Nature, 168, 440 (1951).

THE use of the words "old Newtonian theory" in connexion with the value of the deflexion of light rays passing close to the sun predicted by Einstein's restricted theory of relativity was the cause of the critical remark of which Mrs. Wilson complains. Newton never developed any theory of the bending of light. He did raise a query whether bodies could bend rays of light. This was one of 22 which he propounded, but left to posterity to follow up. Eddington's reference to the value to be expected for the deflexion according to Newton's laws of gravitation is correct in form; his subsequent statement that "Newton's theory suggests no means for bringing about the bending but contents itself with predicting it on general principles" is misleading and accounts for the reference to "Newton's theory" criticized in my review.

F. J. M. STRATTON

Gonville and Caius College,
Cambridge.

The Clear Representation of Very Small Masses

MANY methods are used for representing small masses; some are not readily legible and others are not immediately comprehensible to those unfamiliar with the notation. Since few editors seem to have a settled policy in this matter, it may be profitable to set out some of the considerations involved.

Two main courses can be followed: we can use one unit of mass, such as the gram, and multiply it by a suitably expressed but complex number; or we can use a series of subunits, such as the milli- and micro-gram, and multiply by a simple number. When the first method was used in the older literature, we often had a long row of 0s. Now we generally have a simple number multiplied by 10 with a negative index, or a neater logarithmic form is used and the whole quantity appears in a negative non-integral index. The latter form has the advantage, shared by the pH notation, etc., that biological response often varies with the logarithm of a quantity rather than with the quantity itself, so that equal numerical intervals in the index correspond to similar changes in response. Each form has the defect that the most important part of the whole quantity, the index, is the least easily legible. With good printing and paper, one can by peering make out the quantity, but many publications now appear 'on grey paper with blunt type' and then the quantity can be lost irrevocably.

A new typographical convention is needed so that any number can be expressed briefly with type of normal size and on the line. The precise convention is a matter of detail which may await decision on the principle, but a strong case can be made for the general use of the prefix p to qualify any unit, as it qualifies hydrogen ion concentration in pH, and indicate that the number following is a negative logarithm.

Most microanalytical needs are satisfied by the subunits milligram and microgram. This sequence has now been[1] extended by the nanogram (ng $= 10^{-9}$ g) and picogram (pg $= 10^{-12}$ g), and it can be logically extended further to the picopicogram (ppg $= 10^{-24}$ g). With such a unit we have reached atomic dimensions, for the carbon atom weighs 2×10^{-23} g or 20 ppg. By judicious use of a subunit, any mass can therefore be expressed by a simple number and there is no need ever to use indices or logarithmic notation at all.

The biologist is sometimes concerned with a small mass; but he is more often concerned with concentrations, so that both mass and volume are being specified. Here simplicity should surely be aimed at and, by the use of units of concentration such as mg or μg per litre, indices and complex numbers should be avoided. In terms of molarity we do not have quite the same flexibility; but even here the more cumbrous forms can be avoided by using mM and μM. Few substances with definable molecular weights exert much action at the latter dilution.

There are obvious advantages in taking one-sixteenth of the mass of an oxygen atom as a unit. Various names and symbols have been proposed for this; for example, h [2], the Cannizzaro unit[3] and the Dalton (d) [4]. With such a unit, molecular masses have the same numerical form as the conventional molecular weight ratios, and there is no advantage in introducing a unit when small molecules are under consideration. But with not readily separable mixtures, for example, the higher fatty acids, the use of a unit increases the precision of a statement without the appearance of too much pedantry. The larger and the less well defined the particle the stronger becomes the case for a mass unit. Thus the application of the unqualified term 'molecular weight' to a protein may lead to a false certainty about what has been demonstrated. This can be avoided by some such phrase as 'particles of median mass 200,000 d or 0·2 Md'.

The points raised here can be summarized in the form of three complementary questions on which I invite comment. Do the advantages of avoiding indices outweigh the difficulties of establishing a new typographical convention? Is pico- a useful prefix, and should editors urge authors to use subunits wherever possible? Is the Dalton (d $= 1/16$ the mass of an oxygen atom $= 1 \cdot 66 \times 10^{-24}$ g) an acceptable and useful unit of mass?

N. W. PIRIE

Rothamsted Experimental Station,
Harpenden, Herts.

[1] A Report by the Symbols Committee of the Royal Society (1951).

[2] Pirie, *Biol. Rev.*, 15, 377 (1940).

[3] Sborgi, *Gazz. chim. ital.*, 15, 293 (1942).

[4] Landolt-Börnstein, "Tabellen" (1930).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, December 8

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 2.30 p.m.—Mr. F. A. Dixon: "Town and Country Planning in relation to Coal Industry Activities".

Monday, December 10

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. W. G. V. Balchin: "Erosion Surfaces of the Exmoor Area".

British Society for the History of Science, Philosophy of Science Group (in the Council Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. R. O. Kapp: "Problems and Theories of Causation".

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Sir Frederic Bartlett, F.R.S.: "Thinking". (Clayton Memorial Lecture.)*

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. D. H. Homis and Mr. R. J. Ryan: "The Van de Graaff Generator as a Million Volt D.C. Source".

Tuesday, December 11

Society of Chemical Industry, Agriculture Group (in the Chemistry Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Mr. T. P. Dee and Dr. Rice Williams: "Alternative Phosphatic Fertilizers".*

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. Pei-Su Hsia: "A Graphical Analysis for Non-linear Systems", Mr. J. C. West: "A System Utilising Coarse and Fine Position Measuring Elements simultaneously in R.P.C. Servo-Mechanisms".

Royal Society of Medicine, Experimental Medicine Section (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Sir Howard Florey, F.R.S.: "Some Problems in the Chemotherapy of Tuberculosis" (W. E. Dixon Lecture).

Society of Chemical Industry, Chemical Engineering Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. Burchall: "The Planning of Maintenance in Chemical Works".

Illuminating Engineering Society (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. W. J. Wellwood Ferguson: "Dark Adaptation and Miners' Nystagmus".

Manchester Geographical Society (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—The Rt. Hon. A. Creech Jones: "Some Problems in African Development".

Sheffield Metallurgical Association (at the Grand Hotel, Sheffield), at 7 p.m.—Mr. H. C. Child: "Resistance of Gas Turbine Alloys to Scaling and Vanadium Attack"; Dr. L. G. Finch: "The Evaluation of Residual Stresses in Metals by X-rays".

Wednesday, December 12

Iron and Steel Institute (joint meeting with the British Iron and Steel Research Association and the Corrosion Group of the Society of Chemical Industry, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 10 a.m.—Symposium on "The Corrosion of Buried Metals".

Institute of Fuel, North-Western Section (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Dr. A. C. Monkhouse: "Progress in Domestic Heating Research".

Royal Sanitary Institute (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Discussion on "Prevention of Damage by Pests—Progress of Rodent Control" (to be opened by Mr. W. McAuley Gracie).

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. Charles Hill: "Food and Fads" (Armstrong Memorial Lecture).

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Prof. F. H. Garner, Prof. F. Morton, Mr. W. D. Reid, Dr. A. H. Kiman, Dr. H. P. Wright and Mr. W. H. Malpas: "Pre-Flame Reactions in Diesel Engines".

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "Activity Methods in Technical Education" (to be opened by Mr. R. D. Watts).

Society of Chemical Industry, Nutrition Panel of the Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Discussion on "Sugar". (Mr. H. S. C. De Whalley: "Its Production, Purification and By-products"; Dr. R. D. Lawrence: "Its Place in the Dietary—Normal and Abnormal Metabolism".)

Thursday, December 13

Physical Society, Optical Group (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road London, S.W.7), at 2.30 p.m.—Scientific Papers.

Chadwick Public Lecture (in the Wright Fleming Institute of Microbiology, St. Mary's Hospital Medical School, Norfolk Place, London, W.2), at 4.30 p.m.—Prof. Robert Cruickshank: "The Epidemiology of some Skin Infections" (Malcolm Morris Memorial Lecture).*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. C. H. Andrewes, F.R.S.: "The Place of Viruses in Nature" (Leeuwenhoek Lecture).

Royal Society of Arts, Commonwealth Section (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Dr. V. E. Fuchs: "The Falkland Islands Dependencies Survey".

Institution of Electrical Engineers, Utilization Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. P. Bingley: "The Characteristics and Control of Rectifier-Motor Variable-Speed Drives".

British Institution of Radio Engineers (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Dr. W. Grey Walter and Mr. H. W. Shipton: "Electronic Analogues of Physiological Processes".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. D. H. Hey: "Some Recent Developments in the Chemistry of Free Radical Reactions in Solution" (Tilden Lecture).

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. D. B. Jelliffe: "The African Child".

Friday, December 14

Textile Institute, Lancashire Section (at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. J. W. Illingworth: "Textiles in the Rubber Industry".

Biochemical Society (at Guy's Hospital Medical School, London Bridge, London, S.E.1), at 2 p.m.—Scientific Papers.

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. C. P. Blacker: "Eugenic Experiments conducted by the Nazis on Human Subjects".*

Institution of Mechanical Engineers (joint meeting with the Hydraulics Group, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. A. H. Bingham: "Some Problems of Fluids for Hydraulic Power Transmission"; Mr. B. Cooke: "Low Pressure Reciprocating Seals for Hydraulic Control Valves".

Manchester Statistical Society, Industrial Study Group (at the Albert Hall, Peter Street, Manchester), at 6.45 p.m.—Mr. D. H. Ward: "Statistical Tests in the Comparison of Laboratories".

Institute of Physics, Manchester and District Branch (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Dr. J. Weston: "Full-scale Heating Research".

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7.30 p.m.—Discussion on "Glass Plant in Industry and Research" (introduced by Mr. B. H. Turpin).

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "The Mechanics of Metal Crystals".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (with an honours degree in electrical engineering, and research interests in electronics or radio communications field) in the Department of Engineering—The Secretary, The University, Edinburgh (December 14).

Assistant (Grade A) to teach Engineering Subjects (Mathematics, Drawing and Workshop Technology) to the standard of Inter City and Guilds (Machine Shop Engineering), at Pudsey Technical Institute—The Divisional Education Officer, Education Offices Richardshaw Lane, Pudsey, Leeds (December 15).

Assistant (Grade A) in the Mechanical Engineering Department, South Shields Marine and Technical College—The Director of Education, Town Hall, South Shields (December 15).

Head of the Mathematics Department, Coventry Technical College—The Director of Education, Council House, Coventry (December 15).

Senior Scientific Officer (with an honours degree in biochemistry, and research experience) in the Biochemistry Department, and a Scientific Officer (with an honours degree in chemistry) in the Technical Chemistry Department—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (December 17).

Senior Scientific Officers (4) in the Research and Development Branch at the Electronics Research Laboratory at Adelaide, South Australia, to be responsible to a Principal Scientific Officer for the detailed direction of the work of a team engaged on research and development for new defence equipment in the field of radio, radar and allied techniques—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (December 19).

Hydro-Electric Engineering Consultant for the Thal Development Authority, Punjab Province, Pakistan, under the Commonwealth Technical Co-operation Scheme for South and South-East Asia—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1. quoting D.477/51.OA (December 22).

Physicist (N.H.S. Senior grade), to develop a clinical radioactive isotope service for the hospital, and to carry out research on related biological problems—The Secretary and House Governor, Mount Vernon Hospital and the Radium Institute, Northwood, Middx. (December 22).

Research Director (with high academic qualifications and considerable experience in leading research) for a new large textile research association at Ahmedabad, Bombay State—The Scientific Adviser to the High Commission, India House, Aldwych, London, W.C.2 (December 22).

Senior Lecturer in the Department of Veterinary Pathology—The Secretary of University Court, The University, Glasgow (December 22).

Textile Technologist (with good professional qualifications and research or practical experience in spinning, weaving or wet processing) as Head of the Textile Technology Division of a new large textile research association at Ahmedabad, Bombay State—The Scientific Adviser to the High Commission, India House, Aldwych, London, W.C.2 (December 22).

Assistant Keeper in the Department of Biology—The Director, Museums and Art Gallery, New Walk, Leicester (December 31).

Cytologist (with experience in cancer work; medical qualification not necessary)—The Secretary and House Governor, Mount Vernon Hospital and the Radium Institute, Northwood, Middx. (December 31).

Physical Chemist and an Organic Chemist in the Section of Insecticides and Fungicides at the Long Ashton Research Station—The Registrar and Secretary, The University, Bristol (December 31).

Professor of Economics—The Secretary and Registrar, University College of North Wales, Bangor (December 31).

Assistant Heating Engineer in the County Architect's Department—The County Architect, The Castle, Winchester (January 1).

Bacteriologist at the Institute of Medical and Veterinary Science, South Australia—The Agent-General and Trade Commissioner for South Australia, Marble Arch, London, W.1 (January 2).

Assistant Inspectors of Ancient Monuments (with a University honours degree and enthusiasm for archæology, preferably with some practical experience)—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 4106/52 (January 3).

Engineering Inspector in the Electricity Division of the Ministry of Fuel and Power—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S 4105/52 (January 3).

Assistant Lecturer or Lecturer in the Department of Botany—The Secretary and Registrar, University College of North Wales, Bangor (January 15).

Chair of Physics in the University of Natal, Pietermaritzburg and Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 15).

Lecturer or Assistant Lecturer in Zoology or Botany—The Secretary, Girton College, Cambridge (January 25).

Aerodynamicists for research and development work in the Aerodynamics Department of the Royal Aircraft Establishment, Farnborough, and at a Ministry of Supply research establishment in Bedfordshire. Scientific Officer (Ref. C.722/51A) for aerodynamics research including experimental work in flight, in subsonic and supersonic wind tunnels and general theoretical work; Experimental Officers and Assistant Experimental Officers (Ref. C.723/51A) for experimental work in flight and in subsonic and supersonic wind tunnels, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

Assistant (Grade B) in the Electrical Engineering Department—The Registrar, Municipal College, Portsmouth

Assistant Lecturer to teach Electrical Installation work leading to the Course B and Course C examinations of the City and Guilds of London Institute, a Lecturer to teach Botany and Zoology to Inter.B.Sc. students and Chemistry and General Science to students of foodstuffs, and a Lecturer to teach Chemistry, Biology and General Science to students of foodstuffs—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

Assistant Meteorologists in Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27118/5/51.

Civil Engineers (Main grade) (Ref. H.251/51A) and Assistant Civil Engineers (Recruitment grade) (Ref. H.252/51A) in the Air Ministry Directorate General of Works in London and the Provinces—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

Electrical Engineer (corporate member of the I.E.E. with considerable experience in steam power stations and distribution, with knowledge of normal chemical analysis) in the Electrical Services Department, Nyasaland—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27326/50.

Electrical Engineers and Physicists (Scientific Officer grade (Ref. A.366/51A) and Experimental Officer grade (Ref. D.523/51A)) at a Ministry of Supply research and development establishment in the South Midlands, for work on Army radar equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

Electrical and Mechanical Engineers (Senior Scientific Officer grade) at a Ministry of Supply Design Establishment in the South-East of London. Electrical Engineer (Ref. D.511/51A) for the design and development of remote power controlled gear and servo systems; Mechanical Engineer (Ref. C.701/51A) for basic development of new projectiles and projectile systems, Electrical Engineer (Ref. D.512/51A) for work on instrumentation for measurement of pressures, stresses, vibration, etc., and for the design of trials apparatus—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

Elizabeth Macadam Research Fellowship for research into the aetiology and pathogenesis of osteoarthritis and/or the aetiology and pathogenesis of spondylitis ankylopoietica—The General Secretary, Empire Rheumatism Council, Tavistock House (N), Tavistock Square, London, W.C.1.

Engineer at a Ministry of Supply establishment, Farnborough, to control a small team dealing with, and be technically responsible for, the development of high-precision components for use in servo systems, and for liaison work within the industry—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting D.517/51A.

Engineer at a Ministry of Supply establishment at Hayes, Middlesex, to control section responsible for the technical direction of inspection of mass-produced miniature electronic devices—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting D.518/51A.

Engineer at the Ministry of Supply Factory at Capenhurst, Chester, to be responsible for the planning, progress and inspection work associated with the operation of a large factory—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs., quoting Ref. 272.

Engineer by the Ministry of Supply in London, to assist in planning and progressing production of electronic fuses and specialized thermionic devices—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting D.516/51A.

Lecturer in the Science Department (duties include the teaching of Chemistry to A.R.I.C. level to part-time day and evening students), St. Helens Municipal Technical College—The Director of Education, Education Office, St. Helens.

Lecturer (Grade B) in Physics—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

Mathematicians at a Ministry of Supply research and development establishment in the South-East of London: Senior Experimental Officer or Experimental Officer to take charge of, organize and build up a small computing section; Experimental Officer or Assistant Experimental Officer with interest in applied mathematics or numerical analysis—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting A.254/51A.

Mathematicians and Physicists (Senior Scientific Officer grade) at Ministry of Supply Design Establishments in Kent and Sussex: Mathematician or Mathematical Physicist (Ref. A.360/51A) preferably with knowledge of statistical methods for analysis work in connexion with assessment of weapons performance; Physicist (Ref. A.361/51A) with knowledge of optical and photographic work for scientific direction of Instrumentation Group; Physicist (Ref. A.362/51A) for the determination of rheological characteristics of fuels—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

Organic Chemist with experience in microchemistry (preferably with isotopes) to collaborate in biochemical and biophysical research—The Secretary, Middlesex Hospital Medical School, London, W.1.

Physicists and Physical or Inorganic Chemists at the Ministry of Supply Factory at Capenhurst, Chester, to supervise and participate in the work of a small team engaged in research and development—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 268.

Principal Scientific Officer at the Ministry of Supply London headquarters, to assist in the formulation, co-ordination and progressing of the research and development programme in Industry and at Government Establishments in connexion with propulsive units for guided weapons—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting C.706/51A.

Production Chemists for Royal Ordnance Factories in Irvine, Bishopton, Chorley, Swynnerton, Glascoed, Pembrey, Bridgwater, Thorp Arch, London headquarters of the Ministry of Supply, and elsewhere, to assist in technical control or administration of explosives and acids manufacture or ammunition filling, including development work—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting F.542/51A.

Senior Intelligence Officers (with a basis of scientific training, plus wide experience in technical information service and/or training in librarianship) in the Library and Intelligence Division—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

Senior Welding Engineer in the Research and Development Branch, Windscale Works, Sellafield, Cumberland, to conduct investigations into welding techniques of non-ferrous and ferrous materials—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting No. 275.

Zoologist (with at least a second-class honours degree in zoology of U.K. University and, preferably, postgraduate experience) to work at the Zoological Gardens, London, on Fact-Finding Survey of Literature on African Fauna—The Under-Secretary of State (S.610), Research Department, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

Southern Rhodesia. Rainfall Handbook. Prepared by the Department of Meteorological Services. Pp. 30. 7s. 6d. Rainfall Handbook Supplement No. 1: Totals of Monthly and Annual Rainfall for Stations in the Eastern Area. Prepared by the Department of Meteorological Services. Pp. 55. 2s. 6d. (Salisbury: Government Printing and Stationery Department, 1951.) [179

City of Durban: Durban Museum and Art Gallery. Annual Report for Municipal Year 1949–1950. Pp. 8. (Durban: Durban Museum and Art Gallery, 1951.) [179

Phyton. International Journal of Experimental Botany. Vol. 1, No. 1, Julio. Pp. ii+46. (Montevideo and Vicente Lopez (Bs.As.): Domus Plantarum, 1951.) Annual subscription, 20s., 3 U.S. dollars. [179

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THE NATIONAL TRUST

CLOSELY related to the planning of the use of the land in Britain and the inauguration of national parks and nature reserves (see *Nature*, December 8, p. 967) is the work of the National Trust. Both in its recent annual report and at the annual meeting of the Trust on October 12 at which it was presented, the need for action was stressed. Lord Crawford announced that the Trust had just acquired Penrhyn Castle, in Caernarvonshire, with 4,000 acres of agricultural and mountain land. This is three times larger than any other single property which the Trust holds, and the area has been acquired at a critical time. The water-power proposals of the British Electricity Authority cut into the Penrhyn estates both in the Ogwen valley and in the upper valley of the Conway. The transfer to the National Trust means that any electrical development on this land must be approved by Parliament.

The land cannot be acquired compulsorily, even for development, if purchase is opposed by the National Trust, without the Minister's order designating the land as subject to compulsory purchase being first submitted to Parliament. Parliament might, it is true, over-ride the Trust's objection, but that objection would carry great weight, and protection of this character is required in other areas that have been designated for national parks and nature reserves. Transfer of properties to the National Trust does, in fact, increase the safeguard, but this is scarcely the most appropriate general method. If the National Parks Commission and its constituent boards were properly constituted, such procedure should be unnecessary. Appeal to Parliament should only be required after every effort has been made to reconcile departmental claims at a proper level, and one at which there is no suggestion of a department judging its own cause.

What is clear from the annual report of the National Trust, and from its annual meeting, is the extent to which the Trust depends in its work of saving the scenic heritage of Britain on support from individuals. In spite, however, of an increase in membership, the financial position of the Trust is serious. Its membership on June 1, 1951, still stood only at 25,000, with annual subscriptions totalling £18,050. Even if the membership were more than doubled, the position would remain serious, largely owing to the continued work on repairs that accumulated during the war years. The rising cost of such work, together with inflation, is mainly responsible for the deficit of £56,000 on the year. This deficit has been partly met by drawing on the Jubilee Fund, which is now likely to be exhausted by the end of this year, while the repair programme is still unfinished. With a drop in legacies during 1950 to £27,000, as compared with £86,000 in 1949, the anxiety concerning the future of the Trust is understandable.

The Council's report rightly points out that, in an age of extreme taxation and high death duties, it will be more and more difficult for individuals to make gifts to the Trust. The successful pursuit of its work must in future depend increasingly upon the wide support of members and of the general public. Much must also depend upon Government support, both of the authority of the Trust and, particularly if new properties are to be acquired, on some action being taken on the recommendations of Sir Ernest Gowers' Committee on Houses of Outstanding Historic or Architectural Interest. So long ago as April 26 last, the Government of the day stated that it hoped to introduce legislation to give effect to some of these recommendations during the autumn session; but although this is not a party question, it cannot be assumed that the present Government is prepared to accept all the recommendations of the Gowers Committee, or even the same recommendations that its predecessors in office accepted. The possibility that direct relief from taxation will be granted to the harassed owners of historic country houses in return for an undertaking to open them to the public is not yet ruled out, particularly in view of the tacit admission that families should be encouraged to remain, wherever possible, in the houses with which they have been associated, often for generations. The principle that families may be granted some measure of relief by means of grants out of the National Land Fund is unlikely to be repudiated, and it may also be assumed that these grants will be administered by the Ministry of Works, and not by an independent Historic Buildings Council, as recommended by the report.

The Council of the National Trust accepted this decision in view of the assurance that the Ministry would co-operate with local authorities and the Trust, but reaffirms its view that, with its experience and specialized knowledge, the Trust is the body best qualified to hold and administer country houses and estates where the families continue to live but can only do so with assistance. It attaches the greatest importance to the proposal that, where houses no longer remain in the possession of the families, the Treasury should be empowered to accept chattels, as it already has power to accept land and buildings, in part payment of death duties. It is hoped that this relief, which has long been advocated by the Trust, will help to preserve *in situ* the pictures, tapestries, furniture, china and other collections which have been built up in many of the great houses of England and the dispersal of which would be an irreparable loss to the nation.

Here, however, as in regard to the preservation of scenic amenity, the need for action is urgent. "Every year sees the decay or disappearance of more great houses. Those that remain in private ownership are becoming increasingly difficult to maintain. Only some action by the State—whether by relief of taxation or in some other way—can save them. It is not practicable to wait until suitable uses are devised for these houses; action is required immediately and the most important of them should, if necessary, be maintained inexpensively by a skeleton staff until the ideal use can be found. No other course is permissible if our generation is to avoid the last censure of posterity." That statement could apply with equal force to the safeguarding of amenity, in the context of which the Gowers Committee interpreted its terms of reference, and of which the houses were considered to be a part. Particularly where the threats to houses of this character have come from officialdom, the consequences have been generally more disastrous to the setting of the houses than to the houses themselves. The Gowers Committee refers, for example, to Wentworth Woodhouse and Staunton Harold, and like many other bodies deplores both the absence of any effective control over Service and other departments by the Planning Minister, and the practice of allowing, for example, a Minister responsible for producing coal to judge his own cause.

A Conservative Government may well find it easier than a Labour Government to introduce the legislation required to give effect to the recommendations of the Gowers Committee. If such legislation is to be effective, it should be introduced without delay. The present emergency may well make the need more rather than less urgent, though with good will and co-operation between the parties the demands on Parliamentary time might be small. The question of interdepartmental co-ordination remains as pressing as ever. It was ignored during the War; but the reasons that were then accepted can no longer be urged to-day.

Meanwhile, it should be noted that the Council for the Preservation of Rural England, on which has fallen a major share of the responsibility of acting, in countless negotiations and inquiries, as counsel for the defence of natural beauty, is also in financial difficulties. The Council could not expect always to win, nor should it be expected to be infallible in its judgment. But the responsibility of defence can scarcely be left to the Government, because the prime difficulty of the Government in the matter is that it has to judge between such claims and those of government departments. The alertness, energy and persuasiveness with which the Council has brought its great knowledge to bear in defence of natural amenity entitle it to much more widespread and substantial support from the country-lovers it has served so well.

That support must be forthcoming promptly if the Council is to continue its work, and it is to be hoped that one outcome of the work of such institutions as the Council for the Promotion of Field Studies will be to awaken a keener interest in the preservation of the countryside among those young people who use its field-study centres, which will lead them in turn to support the work of such bodies as the Council. Meanwhile, more might be heard of the work of the Nature Conservancy. It is six months since the Conservancy proposed the setting aside of two nature reserves and several sites of special scientific importance within the Lake District National Park. One such reserve has now been created, in Scotland, by the purchase, announced on November 24, through its Scottish Office, by the Nature Conservancy, of 10,450 acres at Kinlochewe, Ross-shire, which will constitute the Beinn Eighe Nature Reserve. A chain of national nature reserves, mostly outside the national parks, was intended as complementary to the national parks. Several of the sites proposed in the Huxley Report have already been endangered by subsequent proposals for training areas, etc. On that score alone it is important to create these nature reserves without undue delay. Once they are established, they can scarcely fail to promote the formation of a public opinion which really understands what is involved, and which will both bring about a new attitude to the use of land and of the national parks and also be prompt to rally to the defence of amenity behind those bodies which, like the National Trust and the Council for the Preservation of Rural England, have done such sterling work in the past.

GRASSLAND: MODERN SCIENCE AND PRACTICE

Grassland and Grassland Products

By Prof. Stephen J. Watson. Pp. vii+200. (London: Edward Arnold and Co., 1951.) 21*s*. net.

IT is fortunate that Prof. S. J. Watson was appointed as Clive Behrens lecturer in the University of Leeds for the sessions 1948–49 and 1949–50, for otherwise it is likely that we should have to have waited some time for this masterly review of what has rapidly become a vast subject and one which goes to the core of modern agricultural practice in Great Britain.

Almost at the outset (p. 13) the reader is left in no uncertainty as to the guiding principle which must lie behind all grassland research and which must dominate practice. This principle is the more tellingly formulated since it is stated in the words of a man—Dr. David Wilson (later Sir David Wilson, Bart.)—who had obtained his evidence as long ago as 1885–88: "compared with the difference of composition at different stages of growth, the differences between the composition of the various grasses cut at the same stage are small". The mass of recent evidence which completely supports this dictum is fully discussed, and the influence of leafiness and rapidity of leaf growth on digestible crude protein is emphasized. It is not so generally realized "that the younger and leafier the plants the greater their content of the major mineral constituents such as calcium, phosphorus and potassium". The trace elements, on the other hand, Watson says, will be related entirely to the soil analysis; it is perhaps, however, premature to imply that a specific influence may not here exert itself. Speaking generally, "the younger the plants the greater will be their value as a source of vitamins".

In the chapters on the growing and management of grassland herbage, the salient points are made abundantly clear. Thus the losses from an acre of good grassland frequently cut for drying "may equal 7 to 8 cwt. of Sulphate of Ammonia, 3 cwt. of Superphosphate and 4 cwt. of Muriate of Potash". Very properly, a considerable amount of space is devoted to permanent grass, and the author does well to quote examples of practices adopted more than fifty years ago with the view of evening out and extending the grazing season—'early bite' is not a new conception. Modern methods of rotational grazings are fully discussed. In so far as ley farming is concerned, a little more might have been said as to the possibilities; and, although beyond the scope of the author's treatment, readers should be reminded that the most important feature of that system is that it adds to the arable acreage and that in a well-balanced rotation the ley sod is an invaluable aid to maintaining the structure and humus content of the soil.

The chapters on the conservation of grass are models of accurate and terse statement. A telling summary of the losses in nutrients that occur in the different conservation processes is given in Table 53. The factors respectively influencing the carotene and protein content of dried grass are fully explained. "The carotene content of dried grass is always falling." It is influenced by the methods adopted on the field, in the dryer and by "time and method of storage". The carotene content "can be no guide to stage of growth or protein content". After a full review, Prof. Watson states that "at the present juncture it is certain that ensilage is the process on which chief emphasis should be laid if we are to utilize grassland to its fullest extent".

The wealth of information packed into these two hundred pages is admirably arranged, the statements of fact are always concise, and at all stages the practical implications are simply and clearly brought out. The book will be of equal value and equally intelligible to the specialist, the student and to the up-to-date farmer. A valuable feature of the book is the excellence of the fifty-three tables, which have the merit of being readily understandable without repeated reference to the text. These are supported by twenty-two well-arranged graphs and diagrams and by thirty-one adequate illustrations. References to the extensive literature quoted are given at the end of each chapter. The index is in keeping with the high standard of the book and very properly is in two parts, author and subject.

R. George Stapledon

THE LOGIC OF ADAPTATION

Analytical Biology

By G. Sommerhoff. Pp. viii+208. (London: Oxford University Press, 1950.) 17*s*. 6*d*. net.

THIS book is a valuable addition to the comparatively small literature which deals with the logical analysis of biological notions. The author is bold enough to tackle the problem of "biological purposiveness", which has often been taken to justify the belief that theoretical biology must operate with categories which cannot be stated in the conventional terms of the physical sciences. He argues that all cases of apparent purposiveness can be regarded as instances of adaptation; and, of the latter concept, he proceeds to offer an attempt at a precise description. His definition is one which can most easily be envisaged in terms of a self-regulating mechanism such as an automatic gunsight.

The basic phenomenon of adaptation is given the name of "directive correlation", and the elements involved in its definition are four in number; the "coenetic variable", which is a prior condition having a causal influence on both the environmental situation which is adapted to, and the response which adapts, these two being jointly affected in such a way that they issue in the goal (or "focal condition") of the adaptation. The logical relations involved in such a notion are discussed both in normal language and in more precise mathematical terms, and the author then proceeds to some applications of the idea of directive correlation to general biological problems. It is, of course, true that such an idea is in no sense an answer to the problems which face biologists; its potential service is to lead to a more precise formulation of them.

Mr. Sommerhoff has made a worth-while contribution towards clarity of thought in a field in which precision has often been sadly lacking, and his book will be of value to all who find themselves tempted to wonder what the conventional biological phrases really denote. It seems to me, however, that he may have over-estimated the applicability of his concept of directive correlation, at least in its simple form. Many instances of "biological purposiveness" seem to involve not so much an adaptation to an external state of affairs, but rather the alteration of the environment to fit in with an internally determined course of action. A bird not only builds a nest to suit the lie of the twigs, but chooses a part of the bush which suits the nest. The model of a crystal growing in an impure solution may be as relevant as that of a radar gunsight. C. H. Waddington

BERKELEY'S SCIENTIFIC WORKS

The Works of George Berkeley, Bishop of Cloyne

Edited by A. A. Luce and T. E. Jessop. (Bibliotheca Britannica Philosophica.) Vol. 4: *De Motu* with an English translation, The Analyst, a Defence of Freethinking in Mathematics, Reasons for not replying to Mr. Walton's *Full Answer*, Arithmetica and Miscellanea Mathematica, Of Infinites, Letters on Vesuvius, on Petrifactions, and on Earthquakes, Description of the Cave of Dunmore. Edited by Dr. A. A. Luce. Pp. viii+264. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1951.) 30*s*. net.

This fourth volume of the new edition of Bishop Berkeley's works collects together those writings which can be labelled as scientific. Of these, "The Analyst" would have been considered the most important in his own day; but "De Motu" has a certain topical interest for the twentieth century which it did not have for the eighteenth.

The Latin text of the second edition of "De Motu" is reproduced here, with a translation by the editor. This essay was written for a prize offered by the Paris Academy of Sciences in 1720, which it failed to win. It would appear to have been hurriedly composed, as the argument is not so well put as in Berkeley's other works, and it does not live up to its very general title. As the editor says, it should have been called "Motion without Matter". Berkeley is arguing that the science of mechanics can be developed in accordance with his own philosophical principles and that by so doing obscurities and inconsistencies, for example, the Newtonian notion of absolute space and motion, can be eliminated. He is expounding what would now be called a Positivist or Phenomenalist interpretation of science, much on the lines of Ernst Mach a century and a half later, to mention only one, perhaps the best, exponent. Of course, Berkeley, unlike later phenomenalists, does not resolve the whole universe into phenomena, but makes a reservation in favour of active minds or spirits.

"The Analyst", first published in 1734, was an important contribution to the long controversy over the use of infinitesimals in mathematics; a controversy of which the echoes still remain and which really began with the paradoxes of Zeno in the fifth century B.C. Berkeley's purpose in entering on the controversy is characteristic of him, and stated in the sub-title, "A Discourse Addressed to an Infidel Mathematician". The mathematician addressed was probably Edmund Halley, who is said to have declared the doctrines of Christianity to be incomprehensible. Berkeley retorted that the doctrines of the new analytical school of mathematics were far less comprehensible, indeed downright contradictory, whether in the form of Leibniz's differential calculus or Newton's fluxions. "It is curious to observe what subtilty and skill this great genius [Newton] employs to struggle with an insuperable difficulty; and through what labyrinths he endeavours to escape the doctrine of infinitesimals; which as it intrudes upon him whether he will or no, so it is admitted and embraced by others without the least repugnance. Leibniz and his followers in their *calculus differentialis* making no manner of scruple, first to suppose, and secondly to reject, quantities infinitely small; . . ." (p. 75). Berkeley concludes that the method works by reason of compensating errors, and "that, however useful it may be, it must be considered only as a presumption, as a knack, an art, rather an artifice, but not a scientific demonstration" (p. 81). This seems to have been Newton's own view when he wrote his "Principia", though Berkeley also attacks some of the statements made there (Book 2, Lemma 2).

The remaining writings in the volume contain Berkeley's replies to critics in the mathematical controversy—good hard hitting, but bringing out no new mathematical points—and some early papers. The one on "Infinites" shows Berkeley already concerned with mathematical problems in 1705–9. The letters on "Vesuvius", "Petrifactions" and "Earthquakes" and the "Description of the Cave of Dunmore" show the strong empirical interests of this idealist philosopher. The editing and printing of this volume maintain the standards of its predecessors; higher praise is not necessary or possible.

A. D. Ritchie

MARINE ANIMALS AND PLANTS

Life of the Shore and Shallow Sea

By Dr. Douglas P. Wilson. Second edition, completely revised and reset. Pp. xvii+213+45 plates. (London: Nicholson and Watson, Ltd., 1951.) 15*s*. net.

The second edition of Dr. D. P. Wilson's popular book on marine animals and plants has been thoroughly revised and reset. The coloured frontispiece has been replaced by a black-and-white study of a John Dory poised over a gorgonid, and though the one hundred and twenty-eight photographs have been reduced to ninety-eight, many of these are new. Pictures are what one looks at first on opening such a book, and no praise can be high enough for the beauty, clarity and artistic merits of Dr. Wilson's photographs of living marine animals. The patience and skill that produced them are unequalled. Feather stars (Fig. 22), the beadlet anemone (Fig. 51), *Physalia* catching a fish (Fig. 61), larvæ from the plankton (Figs. 72–75) and sea horses (Fig. 91) are superb. Each photograph is accompanied by a magnification figure. If a suggestion can be made to so expert a photographer, it is that Fig. 31 of *Asterina gibbosa* does not give a fair idea of this little starfish, owing to the extended position of one of the arms in each of the specimens shown. The publisher and printer are also to be congratulated on the excellent reproduction of the photographs.

The text is as good as the illustrations. As zoologist at the laboratory of the Marine Biological Association of the United Kingdom, Dr. Wilson knows the Plymouth fauna thoroughly, and confines his examples almost entirely to that area. Written in a smoothly flowing style, the book is full of interesting observations on the living animals, their movements, feeding habits, breeding and development, relationships with one another, and the chemical and physical conditions of their environment. Dr. Wilson also draws largely on recent work, such as the studies of Corbin and Steven on the migrations of the mackerel, Moore on the relation between food and shell colour in *Nucella lapillus*, Wells and Newell on the habits and life-history of *Arenicola*, and his own beautiful work on the settlement of polychaete larvæ and the postponement of their metamorphosis until the correct material for their tubes has been found by the larvæ. He refers also to recent work on echo-sounding for the determination of the noises made by marine animals, and to the under-water photography now being undertaken by Dr. H. G. Vevers.

There are two statements that I regret to see perpetuated: the left eye of the young plaice does not 'move' in the sense that the reader will infer from the account on pp. 22 and 163; and the alternation of an asexual and a sexual form (p. 171) is not an "alternation of generations" but of phases in one life-history.

The references to *Chthamalus* on pp. 26, 50 and 68 are to Fig. 41; but this figure shows the wrong habitat for the barnacle. Should the reference be to Fig. 44?

There is an appendix of practical instructions, including useful hints on shore collecting, keeping an aquarium and photographing living marine animals. The book has been improved by its reduction to octavo size. It is very well printed and the price is reasonable.

N. B. Eales

AMERICAN HYDNUMS

The Stipitate Hydnums of the Eastern United States

By Prof. William Chambers Coker and Alma Holland Beers. Pp. viii+211 (60 plates). (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1951.) 40*s*. net.

PROF. W. C. COKER'S important contributions to the systematics of the higher fungi of North America are well known. His publications on the Hydnaceæ (Basidiomycetes) began in 1919, and the present work is a very convenient and welcome summary of the sixty non-resupinate species discovered in the eastern United States. They are placed in ten genera, which follow in the main Banker's classification (1901–13) and which are based on the macroscopic appearance of the fruit-body and the colour and marking of the spores. Twenty-three of these species occur also in Europe, and *Hydnum fragile* Fr. (1852) is given as a synonym of the new monotypic genus *Bankera*. Several of the species occur also in tropical and south-temperate countries. Indeed, in my experience, many of these apparently north-temperate species occur in conspecific or closely related form in the tropics; even the coniferous habitat of many does not seem obligatory, as in the case of *Sarcodon* (*Hydnum*) *imbricatus*, which Coker and Beers report as definitely associated with frondose woods in the eastern United States. Clearly, this book should be on the shelves of all mycologists, or libraries, concerned with the higher Basidiomycetes. The systematics of fungi are cosmopolitan, and this work is one of the indispensable stepping-stones to a world monograph of Hydnoid fungi.

The species are illustrated with characteristically good and well-reproduced photographs, mostly from living specimens, and there are clear line-drawings of spores and other microscopic details, as in Prof. Coker's previous monographs on *Clavaria*, Gasteromycetes and *Boletus*. Spore measurement would also appear precise, though it is not explained how spores, regular or irregular, are measurable to an accuracy of 0·1 μ. The specific descriptions are followed by critical notes on synonymy and related species.

The book bears, nevertheless, too much the stamp of compilation from separate papers, not only in the absence of critical summaries of such interesting matters as seasonal occurrence, geographical distribution, microchemical reaction, and variation in habitat, colour and size, but also in its plan. The usefulness of a systematic work, being primarily one of reference, is greatly enhanced by its usableness. It is not easy to find one's way about this book, small though it be, because the order is not apparent, the generic captions are ill-displayed, and indicative page-headings are lacking. To have always to consult the index does not make a book companionable. I have found that, in the uncertain state of knowledge of the natural affinities of Basidiomycetes, the alphabetical arrangement of genera, species and varieties is the most satisfactory: it is self-explanatory, self-indexing, and without disadvantage when, as in the present case, it is obvious from modern criteria that the genera do not form a natural family and the interrelations of the species, even if rightly placed in the same genus, are dubious. Again, for the comparison of descriptions, it is desirable to conform rigidly to the same order for the parts described and to italicize, as Fries did, the salient features of the species. In the case of the spores (for example, Plates 54–60), they should be orientated with respect to the apiculus, instead of the random presentation in the spore print. Distinctive type is also helpful in the indexing of synonyms along with legitimate names. Incidentally, the expression "threads of the flesh" for hyphæ is surely archaic.

According to the International Rules of Nomenclature, Fries (1821) is the starting point for these fungi. The authors, however, use pre-Friesian names, commonly without reference to the Systema Mycologicum, and in several cases it is impossible to know, without consulting Fries, if the epithet is legitimate, for example, *Bankera fuligineo-alba* (Schmidt) and *Hydnellum zonatum* (Batsch). In my opinion such names are nomenclaturally incorrect because the epithets have no nomenclatural standing, unless as invalid. Thus, to write *Hydnum* L. or *H. repandum* L., as the authors have done, is contrary to the Rules and should be discontinued. A more serious contravention is the absence of any Latin diagnoses for the new genus and two new species described in the book. It is to be hoped that the authors will validate their new taxa in a mycological journal at the earliest opportunity.

E. J. H. Corner

The Oxford Atlas

Edited by Brigadier Sir Clinton Lewis and Colonel J. D. Campbell, with the assistance of D. P. Bickmore and K. F. Cook. Pp. 96+xxvi+90. (London: Oxford University Press, 1951.) 30*s.* net.

A MODERN atlas should show political and natural features, include road communications and aerodrome sites as well as railways and have an index of all names shown on the maps, and, last but not least, should be relatively inexpensive. This "Oxford Atlas" fulfils these requirements. With pages slightly larger than 15 in. by 10 in., it consists of 120 pages of coloured maps (all specially drawn for this publication) and 88 pages of gazetteer entries (more than fifty thousand entries according to the reviewer's reckoning). The first 96 pages of maps cover all parts of the world and are of varying scales, coloured according to layer heights, and the other 24 are distribution maps of weather, population, land use, etc., the colours being used to indicate the relevant statistics.

For those who are more geometrically minded, perhaps the most intriguing part of the Atlas is the discussion of the types of projection used. Two tables give the distribution of errors over conical orthomorphic and transverse Mercator projections, and zenithal projections, respectively. Further, on each map there are figures in the border, those on the right-hand side showing the area in square miles (for that particular latitude) enclosed in the quadrilaterals formed by the parallels of latitude and longitude, and those on the left-hand side showing the distance in miles along each parallel of latitude between two successive meridians.

In the review copy received the detail of some of the maps is somewhat marred by poor workmanship in the colour printing; some obvious misalignments can be seen, for example, where political and natural boundaries should coincide.

Advances in Colloid Science

Vol. 3. Edited by Prof. H. Mark and E. J. W. Verwey. Pp. xi+384. (New York and London: Interscience Publishers, Inc., 1950.) 60*s.*

PROF. H. MARK is an international editor *par excellence*, and by his indefatigable travelling, lecturing, writing and editing in recent years has put all scientific workers in the field of colloid and polymer chemistry in his debt. Dr. E. J. W. Verwey, the other editor, provides an immediate link with the active Dutch school. The result of their editorial collaboration is the third volume of this useful series, which covers a variety of topics in the forefront of interest.

There is an excellent article by J. H. de Boer on atomic forces and adsorption in which he summarizes current theories of attractive and repulsive forces. A. E. Alexander discusses the application of surface chemistry to problems in colloid science and gives a number of interesting examples of which he has first-hand knowledge. G. Overbeek writes on a fundamental subject of which he is a master—the quantitative interpretation of the electrophoretic velocity of colloids. The various factors influencing the derivation of the zeta potential are analysed.

Theories of lyogel structure, old and new, are the topic of E. A. Hauser and D. S. Le Beau. The peculiar properties of thixotropy, rheopexy and dilatancy are described, and hypotheses given to account for their nature. The ultracentrifuge and, in particular, the sedimentation properties of threadlike molecules are the concern of P.-O. Kinell and B. G. Rånby, of the Uppsala school. J. H. Dillon discusses at length the little-understood phenomena of fatigue in high polymers, while S. R. B. Cooke deals with flotation, one of the most recent methods for the concentration of minerals. Altogether, this is a most useful volume destined for a permanent home on the bookshelf.

Ultrasonics

By Dr. P. Vigoureux. Pp. vi+163. (London: Chapman and Hall, Ltd., 1950.) 25*s.* net.

IN the number of books on ultrasonics which have appeared on the market in recent years, this one takes an honoured place. Dr. P. Vigoureux does not, as a number of other writers do, emphasize the technical applications which have been made of this radiation—which, indeed, in many cases are more suited to the industrial laboratory than the production plant—but shows rather what has been done with ultrasonics in the physical laboratory. He begins with an account of the generation and detection of these waves by piezoelectric and magnetostrictive transducers, and briefly describes the methods of observation of the radiation in fluids. Then follows an account of velocity data and—more briefly—absorption data in gases and liquids, and the theories which have been put forward to explain them. This is as far as the survey goes and, in particular, propagation in solids is not discussed.

A comprehensive bibliography of some three hundred papers dealing with these topics since 1939 is included; but the author has not always been careful in consulting his references, as occasionally measurements are ascribed to the writer of a general article or to the *rapporteur* of a symposium rather than to the man of science who did the work so reported. This is, however, a small point and does not detract from the merit of this useful survey.

E. G. R.

Metallurgical Abstracts (General and Non-Ferrous)

Editor: Lieut.-Colonel S. C. Guillan; Assistant Editor, Major W. G. Askew. Vol. 16, 1948–49. Pp. viii+1048. (London: Institute of Metals, 1949.) 60*s.*

THIS volume fully maintains the high standard of scientific writing associated with "Metallurgical Abstracts", a publication which is a necessity for any scientific worker concerned with non-ferrous metallurgy. The abstracts are well and clearly written and give as much detail and numerical data as can be expected. The defect of the work lies in the uncertainty existing as to how much ferrous metallurgy is included. On the purely scientific side, ferrous and non-ferrous metallurgy are part of one subject, and the present system means that many scientific workers have to consult both the Metallurgical Abstracts of the Institute of Metals and those of the *Journal of the Iron and Steel Institute* if they are to keep in touch with their subject. Seeing that both Institutes occupy the same building, this production of independent abstracts with uncertain overlapping is scarcely to their credit; and if a joint publication cannot be produced, metallurgists may reasonably ask for a common index. On the publication side, the present volume is not well bound. One omission noted is that of a list of the journals abstracted.

W. HUME-ROTHERY

ROYAL SOCIETY

ANNIVERSARY ADDRESS BY PROF. E. D. ADRIAN, O.M., F.R.S.

AWARD OF MEDALS, 1951

Copley Medal

THE COPLEY MEDAL is awarded to Prof. D. Keilin for his fundamental researches in the fields of protozoology, entomology and the biochemistry of enzymes.

Prof. Keilin's early work was on parasitic insects, and it contains much that is of lasting value and some which is regarded as classic. He made brilliant studies on the Anthomyid larvæ, on viviparous reproduction in higher flies, and on intersexes in the human louse.

It was Keilin's interest in parasitic insects which led him to study the peculiar hæmoglobin in the larvæ of the horse bot *Gastrophilus*, and from this developed the brilliant series of biochemical investigations which, in the ensuing twenty-five years, have resulted in his numerous important discoveries concerning hæm compounds and a range of catalysts of biological oxidations.

In 1925 Keilin published in the *Proceedings of the Royal Society* a paper "On Cytochrome, a Respiratory Pigment common to Animals, Yeast, and Higher Plants"; here he advanced evidence that the cytochrome system, consisting of three different hæmochromogen compounds, functions as an oxidation system in aerobic respiration. The general scheme developed in this paper for the aerobic respiration of cells has proved to be of fundamental importance, and Keilin's own contributions to this field have been remarkable in their variety and significance. Many of these have dealt with hæm, hæmoglobin, and their derivatives; in addition to characterizing components of the cytochrome system, he purified catalase and peroxidase and proved that these well-known enzymes are hæm compounds. He has studied the mechanism of the catalytic action of the different hæm compounds and demonstrated the part they play in cellular processes. In particular, he showed that the previously known indophenol oxidase in animal tissues is the specific oxidase for cytochrome *c*; he established the part played by the cytochrome system in the aerobic oxidation of succinate in tissue preparations; and his studies have thrown light on the mode of action of various respiratory inhibitors.

Keilin purified polyphenol oxidase and laccase, and showed that these enzymes are copper proteins. He discovered also hæmo-cuprein and hepato-cuprein, copper proteins from red blood cells and from liver respectively. The purification of carbonic anhydrase led to its characterization as a zinc protein. His researches have thus illuminated the role of other trace elements in addition to iron.

In these researches, and in others too numerous to mention, the work of Keilin displays constantly his powers of acute observation and brilliant analysis; and while he is able to focus these powers sharply upon the crucial detail of a biochemical problem, his deep interest in the wider biological setting is at all times evident.

Royal Medals

A ROYAL MEDAL is awarded to Sir Ian Heilbron for his distinguished contributions to organic chemistry, particularly in the field of vitamin A and polyene synthesis.

Sir Ian is distinguished for his many notable contributions to organic chemistry, particularly in the field of natural products and in the development and exploitation of synthetic methods applicable to them.

After some early researches on various dyestuffs, Heilbron made his first really important contribution by his work on the triterpenoid hydrocarbon squalene, which occurs in fish oils, and by his structural elucidation of batyl and selachyl alcohols from the same sources. This marked the start of a great research programme on naturally occurring unsaturated aliphatic compounds which has continued to the present time. His work on squalene was followed by research on the carotenoids and vitamin A, and in this he made extensive use of physical methods of investigation. His synthetic work in the carotenoid–vitamin A field led to the development by him of acetylene chemistry, and the numerous reactions of acetylenic compounds discovered by him have been applied in many fields. Of particular interest is the re-arrangement of acetylenic carbinols derived from unsaturated carbonyl compounds, which has permitted the synthesis of long conjugated polyene chains and made possible the total synthesis of β-carotene by other workers.

In the chemistry of steroids Heilbron has carried out pioneer work on ergosterol, on the irradiation products of ergosterol and on algal and fungal sterols. His extended researches on the triterpenoids included the discovery of the key alcohol, basseol, which has played a vital part in the systematization of the group. During the Second World War he made notable contributions to the chemistry of penicillin, and it is typical of him that he has exploited to the full novel synthetic reactions discovered in the course of his work on this subject and showed that they had wide application in other fields. His novel and elegant methods for the synthesis of purines, amino-acids and peptides are based largely on thiazole intermediates and stem directly from his penicillin work.

From the earliest days of his career Heilbron has realized the importance of the relationship between the physical properties of a compound and its molecular structure, and he has been a pioneer in the application of absorption spectroscopy and chromatography to organic chemical investigations. British chemists are probably more indebted to him than to any other chemist for the introduction of these techniques, and his influence has spread far beyond the confines of his own laboratory.

A ROYAL MEDAL is awarded to Sir Howard Florey for his distinguished contributions to pathology by his studies of the functions of mucin and by his work on penicillin and other antibiotics.

Sir Howard Florey is most widely known on account of his work on penicillin during the Second World War, and it is due chiefly to his initiative, and his persistent attack on the many difficult problems involved, that penicillin now holds the place it does in modern therapy.

Quite apart, however, from this outstanding contribution to medicine, Florey has established a reputation as one of the leading exponents of the experimental method applied to problems of physiology and pathology. He devised new techniques for the study of acute inflammation in the living animal, and by the use of cinematography demonstrated the part played by various types of cells in this process and also clarified the vexed question of the origin of the mononuclear phagocytes. He has made important contributions to the physiology of the small blood vessels of the brain and its membranes, emphasizing their control by the nervous system. He demonstrated the rhythmical contractility of some of the lymphatics in mammals, and by a study of lymphatic function showed the part played by these vessels in the removal of fluid from tissues.

Florey made the first detailed investigations into the production and function of mucus in different parts of both the respiratory and gastro-intestinal tracts and in other mucous membranes of mammals, including trachea, stomach, intestine and especially the colon. He thus established the part which mucus plays in removing irritants and other foreign material from the mucous membranes. Similarly, he was one of the first investigators to supply precise and accurate knowledge of the relationship of Brunner's glands to duodenal secretion, and he afforded the first definite proof that these glands are under nervous control.

His studies on regeneration of tissues and organs made significant additions to our knowledge of regeneration in the alimentary canal, and the remarkable powers of regeneration of lymph nodes even when mere fragments of such nodes are available for stimulation.

His impressive contributions to scientific knowledge in various fields of both physiology and pathology, and the part he has played in the practical applications of both his own work and that of others on antibiotics to the relief of human suffering, make Sir Howard Florey eminently suited to be the recipient of a Royal Medal.

Davy Medal

The Davy Medal is awarded to Sir Eric Rideal for his distinguished contributions to the subject of surface chemistry.

Sir Eric's work has covered a very wide field in physical chemistry; but the major theme has been surface chemistry and chemistry of colloids. He may be said to be the leader of the science of surface chemistry in Great Britain, and has done much to transform what was once a rather vague and unsatisfactory subject into one with a modern scientific form.

One of the principal fields of his activity has been the study of what may be called the two-dimensional state of matter. He and his collaborators have done much to apply special techniques for investigating surface films, including, for example, that which depends upon the measurement of the difference of potential at the surface. This has allowed many conclusions to be drawn about the structure and configuration of surface films and about the reactions which occur in them. This work has been extended to systems of biological importance, but it is only one of many examples of studies in which new and stimulating contributions have been made.

Another field is that of catalytic reactions, for example, hydrogenation at metal catalysts, in which the role taken by hydrogen atoms and other reacting species has been examined by *ortho-para*-hydrogen conversion and other techniques. Rideal has played a prominent part in the development of every possible physical method for the purpose, and in this respect has often launched junior collaborators on lines which they have continued to prosecute fruitfully to other ends. His influence on a large School has been profound and lasting, and he has done much for the healthy development of physical chemistry in Great Britain over the past twenty-five years.

Hughes Medal

The Hughes Medal is awarded to Prof. H. A. Kramers, professor of theoretical physics in the University of Leyden, for his distinguished work on the quantum theory, particularly its application to the optical and magnetic properties of matter.

Prof. Kramers' work covers a wide variety of fields, but his name is best known in connexion with the early application of quantum mechanics to atomic structure and radiation. In this field he has given constant inspiration to his students, and the spectacular development of quantum electro-dynamics in the past five years owes not a little to his influence.

His work in statistical mechanics also holds a high place, particularly his exact solution (with Wannier) of a problem in co-operative phenomena, which was the first success in a difficult field, yielding important results on which much subsequent work has been based. His work on magnetism and the lowest quantum states of atoms and ions, particularly the phenomena of Kramers degeneracy, is equally well known. The group theoretical methods developed for this purpose he later applied to the theory of the positron, introducing the now familiar concept of charge conjugation into the quantum theory of the electron field. In fact, it may be said that Prof. Kramers is one of the foremost theoretical physicists of the present time.

I must not conclude my year of office in the presidential chair without thanking my brother officers and Council for making it so easy. It is true that the year has not produced any major convulsions, any great expansion or alteration in the work which the Society undertakes: we have resisted the urge to set up new committees and have allowed one or two to hibernate; but we seem to have made the usual number of decisions and our business is not in arrears. If Council has had few lengthy meetings and no quarrels, it is not because we have had no important questions to settle; but because our business has been so well presented to us by Dr. D. C. Martin and his staff. Thanks to them we do not have to waste our time talking at cross-purposes. Thanks also to Sir Edward Salisbury and Sir David Brunt, our scientific meetings have maintained a high standard, both in regard to the matter presented and the clear manner of its presentation, and to the numbers attending. The policy of inviting the directors of various research institutes to give us an account of what they are doing has produced meetings of great interest, and the Fellows have had the privilege of visiting some of the laboratories to become acquainted with their work at first hand.

Although science does not advance because someone has set up a new committee, it is never a waste of time for scientific men to leave their laboratories to see new work in progress and to meet the men who are engaged on it; it is so much the better if the work lies outside the narrow field which they cultivate themselves. At the present time those of us who have much to do with the business of the Society feel this need particularly. The Royal Society has an important duty to the State, for it is an independent self-elected body; and because of this closely guarded independence it can act as an impartial adviser to the Government on matters of scientific policy; and the modern State has so many scientific activities and so much may turn on their wise direction that our responsibility is not to be treated lightly. If we are to give good advice, it is important that as many of us as possible should be well informed on the whole scientific effort of the country. Much of that effort is now expended in research institutes not directly attached to universities and in work which is not published in the journals devoted to academic science, since its purpose lies in the application of science to industry or agriculture or to the health of the community. We cannot afford to be ignorant of such work, and we have welcomed the opportunity of learning of it at first hand: we are most grateful to the directors and staffs of the institutions who have instructed us and to our secretaries who have induced them to do so.

The increasing difficulties of scientific publication are a source of anxiety to all scientific bodies. On the Secretaries of the Society falls the considerable burden of editing our *Proceedings*: the A *Proceedings* are now published at the rate of 3,000 pages a year, and the interval between the receipt of a paper and its publication has been reduced to an average of thirty weeks. But constant encouragement of referees and a constant effort at every stage is needed to prevent delay, and it may become necessary to take fresh steps to lighten the secretarial burden.

There is sad news about one of our publications. Dr. de Beer's many duties have made it impossible for him to continue the editorship of the *Notes and Records* of the Royal Society. In his hands this has become not merely a record of our ceremonial doings during the year but also a journal to which we can all turn to be reminded of our long history. Many of the papers which Dr. de Beer has published are important contributions to the history of science, and in every number there has been some interesting sidelight on the early days of the Society and on the work and fortunes of our great men. We are exceedingly sorry to lose the editor who has done so much to create this attractive addition to our more austere publications.

In his anniversary address last year, Sir Robert Robinson announced the appeal to create the Rutherford Memorial Fund, and the appeal was launched simultaneously in other parts of the Commonwealth. It was hoped that a sum of at least £100,000 would be raised, and I am glad to announce that in the United Kingdom about £70,000 has already been given or promised. In Canada the fund has reached 40,000 dollars and the National Research Council has offered one of its post-doctorate fellowships as the Canadian Rutherford Research Fellowship. We have news that Australia, India, South Africa and New Zealand, the birthplace of Rutherford, are collecting funds; our own lists are not closed, and we can be confidently assured that the £100,000 asked for will be exceeded. Encouraged by the response to the appeal, the Rutherford Memorial Committee has taken steps to advertise the first of the Rutherford scholarships, and the first Rutherford Memorial Scholar will be appointed to take up his scientific work in some part of the Commonwealth on October 1, 1952. Dr. E. Marsden has collected together the correspondence of Rutherford, and copies of this will be placed in those universities with which he was associated, namely, Canterbury College in New Zealand, McGill University in Canada, and the Universities of Manchester and Cambridge. On the recommendation of the Committee, Council has appointed Sir John Cockcroft as the first Rutherford Memorial Lecturer, and it is proposed that he should visit New Zealand in the autumn of 1952. By a happy concurrence of events he will go as a Nobel laureate for the work which he did in the Cavendish Laboratory under Rutherford. In fact, this year's award of the prize for physics to Cockcroft and Walton could not have been better timed as a reminder of all the great discoveries which had the stamp of Rutherford's genius on them.

There is one other honour which has given us all great pleasure. In the King's Birthday Honours List this year our accountant, Miss Roberts, was awarded the M.B.E., and all those who are familiar with the intricate business of the Society will know how well such recognition was deserved, and we can all join in congratulating her.

Dr. D. C. Martin, assistant secretary of the Society, has just returned from a five weeks visit to Canadian scientific institutions and universities at the invitation of the National Research Council of Canada. There and in the United States he has been able to see something of the organization of the academies and research councils whose members we know so well but whose collective responsibilities differ in some way from ours. The personal contacts which Dr. Martin has made will make it far easier for us to have a clear picture of the direction of scientific research on both sides of the Atlantic. There was no need to establish friendly relations with our colleagues; but it will help our mutual interests if we know something about what may be called their extra-laboratorial activities.

The need for personal contacts with the scientific men of our Commonwealth cannot be stressed too much. It is true that distances are short nowadays and that we are bound together by other ties than that of a relatively soft currency; but we are the oldest member of the family and the Royal Society has special obligations to fulfil. Our Fellows, elected for their science alone, have always been drawn from the whole Commonwealth. At present we have eighteen Fellows in Canada, twelve in Australia, seven in India, four in South Africa, three in New Zealand and two in East Africa. The number has risen in recent years and it must rise still further to keep pace with the increasing scientific effort overseas. I was privileged to witness some of this effort on a recent visit to Australia to attend the jubilee meeting of the Australian and New Zealand Association for the Advancement of Science, and on my return journey, which included a brief visit to the Royal Society of Canada. I hope the time may come when longer visits can be paid as a matter of course, when economic conditions may allow junior as well as senior men of science to move freely within the Commonwealth, to stay in any centre where important work goes on.

During the year the Society has been enabled by bequests, particularly by the Locke and the Stothert bequests, to increase its effort in the medical field by appointing three new research fellows. We have appointed Dr. C. E. Lumsden as Henry Head Research Fellow; but at the end of the year we shall be very sorry to lose our Foulerton Professor. Prof. A. V. Hill retires after a tenure of twenty-five years, during which he has given whole-hearted service to the Royal Society not only by scientific work of the highest quality, but also by his unselfish abandoning of that work when his help was needed in a wider field. That he could return to his laboratory to such good purpose after the War was no surprise to those who knew him, and we are very glad to think that his work will not be interrupted by his retirement from his chair.

I have kept to the last an item of our news which has given the greatest pleasure to all of us. On May 3 the Royal Society honoured itself by electing H.R.H. the Duke of Edinburgh as a Fellow under Statute 12. His visit to Burlington House to sign the Charter Book was a delightful occasion, and all those who listened to the Duke's presidential address to the British Association in Edinburgh will realize our good fortune in having such a worthy, as well as such a distinguished, addition to our roll of Fellows.

PHYSIOLOGY OF THE NERVOUS SYSTEM

Natural science advances so rapidly that it would be pointless to try to survey the front line or to predict where the new movements will be. At the moment the most striking activities are still those which have come from the peaceful application of war-time research, for we are still reaping the fruits of highly organized scientific effort directed into unusual channels and maintained at fierce intensity for the six years of the War. Medical research still feels the impetus of penicillin, developed to combat septic wounds, and medical scientists have still to sample all the possibilities of an abundant supply of isotopes and radioactive materials. Their use as tracers in the body has already passed into clinical practice as well as into the practice of engineering and of the chemical laboratory. Physical science enjoys the technique of radar and short-wave communication, developed to thwart the approaching enemy and now used for investigating the upper atmosphere and the farthest extensions of space. It has given us the new science of radio-astronomy with its detailed maps of invisible material in the region of the fixed stars, and we are still wondering what these maps reveal. The electronic calculating machines have multiplied and are kept busy solving problems in pure mathematics instead of in ballistics, and those who use them are not afraid to compare their powers with those of the human brain.

In the face of such advances physiology has little to show, although the radioactive tracer method has given some striking confirmation of biophysical theories. But the physiology of the nervous system still offers an enticing variety of problems which lead beyond the specialized regions of pure neurology. They do so because we suppose that a better understanding of the nervous system will lead to a better understanding of its most remarkable product, the behaviour of the human species.

The prospect is not free from all anxiety. A better understanding of the roots of human behaviour will almost certainly lead to an increased power of control: this in itself is not a responsibility to treat lightly, and at present we are in the difficult stage of having some control but little understanding of its nature. It is known that behaviour can be changed by certain operations on the brain and that the effects of the change can be beneficial to the subject, but we do not know why they occur. The study of such effects falls mainly to the psychiatrist, for the most that can be done by a frontal leucotomy or lobectomy is to reduce the excessive cares which have interfered with normal life. But without more knowledge of why the change comes about, we are a long way from any precise control of the forces which lead to anxiety and self-criticism. What is remarkable is not so much that they can be altered by interfering with the structure of the brain, but that these particular forces can be dissected out, so to speak, leaving the rest of the personality not greatly altered. We do not know enough to predict how far such dissection might go, but it has to be realized that the surgery of the brain is much less formidable than it used to be. All kinds of interference can be done with impunity, and electrical records of the brain's activity are now used before and during the operation to guide the surgeon to a diseased focus.

This line of approach is still largely empirical. An entirely different line is that which uses the theories of the communication engineer and the analogy of the calculation machine to define the functions and powers of the nervous system and to suggest the way in which these functions may be carried out. The brain has been so often compared to a telephone exchange that it is interesting to have this new and much more informative comparison with the mechanism of electric controlling devices. It stresses the feed-back system which is used to control movement by the aid of signals sent back from the moving parts to the controlling mechanism. The nervous system certainly achieves its nice control of the muscles by the aid of such a feed-back. This was shown by Sir Charles Sherrington in 1893, and it is a measure of the importance of the system that, of the nerve fibres supplying the muscles, Sherrington found as many as a quarter to a half to be sensory and not motor in function. Quite recently the system has turned out to be even more elaborate than we used to think. Kuffler has found that, of the efferent nerve fibres in the motor roots of the spinal cord, only two-thirds are concerned in producing muscular contraction: the remaining third, distinguished by their smaller diameter, go to the receptor apparatus, the muscle spindles which are sensory elements in the feed-back system, and alter their sensitivity according to the circumstances of the movement. We can say, therefore, that more than half the nerve supply of a muscle is concerned in the central adjustment of the motor nerve cell discharge.

The small nerve fibres which adjust the sensitivity of the muscle spindles are clearly an important part in the feed-back system, but most of the sense organs have some adjusting mechanism to focus them on their source of information, to move them so as to scan it and to protect them from too intense excitation. Thus the nerve fibres to the muscle spindles are comparable to the nerve fibres which open and close the pupil of the eye to admit more or less light. At all events, although we have been well aware of the way in which all movement, visceral as well as skeletal, is regulated by signals from the moving parts, it has been of great value to physiologists to have their problems examined from an entirely different angle and brought into line with similar problems in man-made mechanism. For, those who study the nervous system are always faced with the dilemma arising from its structure: it is made up of a very large number of cells all of which behave, we suppose, according to much the same general principles, but the co-operation of these cells achieves the unified and purposive behaviour of the individual. We can begin at either end, studying the cell reactions, the impulses in the nerve fibres and the synaptic events to see how these might be built up into an integrated system, or we can try to analyse the final product into simple components, as Sherrington did in his study of the spinal reflexes. After a period in which the single units have been in the foreground, we are coming to realize how much depends on their co-operative effect, particularly on the sensory side.

The importance of the feed-back mechanism is one reminder of this; but we have others from the action of almost any of the sense organs in the body. To illustrate this I am going to consider a sense organ which has suffered undue neglect, largely because it plays a relatively small part in guiding human behaviour. Sensations of smell are chiefly interesting for their great variety. The olfactory organ is very large, with a sensory surface which in many animals is much greater than that of the eye; and clearly there must be some differences in its reaction to all the different kinds of molecule which have a distinctive smell. It is not difficult to record the impulses which are sent from it into the brain when it is stimulated by smell; they are of the familiar kind, with the frequency increasing with intensity of excitation, and from a study of these impulse discharges we might hope to find out how olfactory discrimination is accomplished. It is too early to give a definite decision, but it looks very much as though discrimination depends in the main on differences in the general distribution of excitation over the whole organ, in the spatial and temporal pattern of the activity set up by the arrival of different kinds of molecule. There are slight but distinct differences in the sensitivity of different receptors to different kinds of smell, for when we use threshold concentrations we often find that the impulses are set up in different conducting units; there is no rigid differentiation of the receptors, however, for most of them react to most smells when their concentration is much above the threshold. But the receptors with these slightly different properties are not evenly distributed over the whole organ, and so it comes about that particular smells in weak concentrations have their greatest effect in particular regions. This regional effect turns mainly on the solubility of the stimulating substance in the watery layer which covers the olfactory membrane: at all events, substances which are soluble to some extent in water have a greater effect in the anterior parts of the organ, and those which are soluble only in oil have a greater effect in the posterior parts. There is a similar distinction in the speed of the reaction, for the latency of the discharge is considerably shorter with water-soluble than with oil-soluble molecules.

Clearly there must be other factors involved, chemical as well as physical, if the organ is to give a distinctive pattern of excitation for every kind of smell; but its surface is large and there will always be outlying regions which are reached by only a few of the molecules, so that slight differences in sensitivity may well show up in the distribution and timing of the discharge from different parts of it.

Studies of the olfactory organ place the emphasis more on the whole pattern of the discharge from it than on the reactions of the individual receptors, though these certainly determine the pattern. But the emphasis ought really to be shifted still further. The olfactory organ is not the only sensitive structure in the nose. The whole of the surface of the elaborate turbinate bones in front is supplied by sensory fibres from the fifth nerve, and many of the substances which we can smell excite these sensory endings as well as those in the olfactory organ. The action of ammonia is a good example. If we sniff a solution in water we are usually aware that the sensation has some localization to the front of the nose. A rabbit turns its head away, as we do; but when we examine the discharge from the olfactory organ in the rabbit, we find that it is small or absent altogether. The fact is that in the rabbit, where the anterior turbinate bones are much more elaborate than ours, the ammonia may never reach the olfactory organ at all, for it is filtered away by absorption in the anterior parts of the nose: if absorption there is eliminated by leading the air current directly to the organ through a hole in the roof of the nose, ammonia produces a violent olfactory discharge which has, incidentally, the very short latency we should expect from a substance highly soluble in water.

One cannot, of course, argue freely from the rabbit to man when the structure of the nose is so much more elaborate in the former, but we must certainly take into account the effect of discharges which may be set up in the fifth as well as in the olfactory nerves when we try to explain olfactory discrimination; and when we consider the flavours of food, the nerves of taste and all the sensory endings in the mouth will be involved as well to give the composite pattern which we recognize as that to be expected from, for example, an anchovy or a banana: and the picture is receiving further elaboration all the time as the result of the movement of air past the fauces and the movements of the tongue and jaws.

It is of some interest to inquire whether this picture is all painted in one part of the brain or whether the different ingredients are sent to different parts of the cerebral cortex and collected together at a later stage. The discharges from the olfactory organ certainly go in the first instance to specialized receiving areas in the ventral parts of the brain; but there is some indication that they are relayed from there to the main sensory receiving area for the nose and mouth on the lateral surface of the cerebral cortex. At all events, the complete picture is an elaborate one even when the smell comes from a remote source and not from inside the mouth.

When we compare our own rather simple olfactory judgments with those of an animal which depends as much on its nose as on its eyes, we see even more clearly how behaviour is guided by complex clues from every available source. The remarkable powers of dogs in following a trail by scent were investigated by Romanes in 1887, and a recent paper by McCartney gives an excellent account of more recent work. One thing that emerges very clearly is that the dog employs his eyes, his nose, and indeed all his powers in following the trail. Unless he is specially trained he may be guided by vision as much as by scent, and the scent which guides him is that of the crushed earth as well as that of the boots which crushed it.

The sense organs which pick all these clues will not have to wait for the environment to provide them. It will be actively scanned by movements of the eyes and ears, by sniffing, turning the head, etc.; and the sensitivity of the organs will be actively adjusted to give the best results, the pupils will be made to dilate or contract and the air entry to the nose will be adjusted by the force of inspiration and the control of the nostrils. All these adjustments will be regulated by the sensory discharges from the organs concerned as well as by the sensory feed-back from the muscles which carry them out.

In fact, the nervous system will be guided by a picture of the largest possible size, each item of which has been actively focused. The neurophysiologist has still a great many problems concerning the individual receptor cells; but the interest is shifting to their collective effect. The problem for the future will be to decide how the nervous system can react as it does to such a picture, how it is recognized and what determines the next step that the organism should take.

POST OFFICE ENGINEERING RESEARCH STATION

'OPEN DAYS'

THE Post Office Engineering Research Station at Dollis Hill was open for inspection during September 27–28, when a large number of representatives of science, industry, the technical press, etc., were invited to visit the Station and view its activities. The Station houses the Research and Radio Experimental Branches of the Engineer-in-Chief's Office of the Post Office Engineering Department, and the greater part of Post Office research work is done there, though other headquarters branches have small development laboratories in which many of their problems are studied. The staff, which at present totals nearly 1,100, is housed entirely in brick buildings erected since 1926, including two administrative blocks, which contain offices and laboratories, and a number of outbuildings in which are laboratories and workshops. The primary purpose of the work at Dollis Hill is to maintain and improve the efficiency of the telecommunication services which the Post Office provides for the public. The Station is consulted on telecommunications problems by other government departments, and some work is done for them. The work at the Research Station is split into seven main Divisions dealing with the following subjects: electronics, materials, mathematics and physics research, radio, switching, telephone and telegraph apparatus (including postal engineering), and transmission.

Two kinds of workshop facilities are provided. There are the central model shops equipped so that most types of apparatus can be made in small numbers; these shops serve all the Divisions and are capable of all kinds of constructional work from metal-welding to high-class instrument-making. Although there is a comprehensive array of machine tools, a certain amount of work is put out to specialist firms. Supplementing the main shops, most Divisions have small workshops in which the laboratory staffs themselves make experimental models and do jobs which are considered too small to be sent to the central shops. These divisional workshops are equipped with suitable hand-tools and a few simple power-tools. The divisional workshop was introduced during the Second World War and is now an important link in the organization. It performs the dual function of relieving the skilled instrument-makers of the need for carrying out many tasks which do not call for their skill, and it removes the laboratory workers' sense of frustration at the delay which sometimes occurs to small jobs in a big shop. Library, technical information and patent services are centralized, and these services are provided for the whole Engineering Department of the Post Office. A small mathematics group provides expert assistance on mathematical problems.

It is usually difficult to estimate the cash value of a research establishment in a commercial concern, and the Post Office Research Station is no exception to the general rule. It is true that some of its developments such as the speaking clock, have been put into service in such a way that a net revenue account can be readily compiled, but much of the result of successful research is tangible only as improvements in the services provided for the public. Typical of a development of this kind is the test set for detecting faulty connexions. It may not be generally realized that speech between people speaking over a single trunk circuit must pass through ten thousand or more connexions in the line equipment alone. Any one of these, if faulty, is liable to cause great annoyance to the speakers and may in the end lead to a loss of revenue. Test sets have now been developed for locating faulty connexions, in the first place, by tracing them to individual units (for example, amplifiers). These testers are sensitive enough to indicate a transmission variation of one millibel (0·01 db.) in magnitude and one millisecond in duration. When the fault has been traced to one unit, another instrument is used to test individual joints and contacts; this indicates short-duration resistance changes of 0·001 ohm.

The Transmission Division is keenly interested in problems relating to submerged repeaters. Shallow-water repeaters such as have been used with success on cables to the Continent since the Second World War are established engineering practice and have obviated the cost of many additional cables. Deep-water repeaters involve new mechanical and electrical problems. Glands to admit plastic cables must be watertight at 4 tons/sq. in., and casings, not too unwieldy to handle on a cable ship, must be designed for this pressure. On the electrical side there are difficulties due to the long lines and the need to run many repeaters in tandem; an amplifier, designed for this service, is unaffected by any single open-circuit or short-circuit in the majority of its components, including valves.

Progress to-day depends a lot on the development of new materials and the improvement in properties or consistency in known ones. To an engineer, consistency is often at least as important as improved properties; it enables him to design more economically without performance falling below prescribed limits. Present-day policy is to concentrate effort on a few selected fields; those of greatest interest are magnetic materials, dielectrics, semi-conductors, plastics and some metals. Grain-oriented materials, both metal and plastic, are of great interest and the importance of germanium in the telecommunications industry is fully realized. Contact problems in switching and connecting devices are also studied.

The work of the Switching Division is at present mainly concentrated on the immediate problem of operator-dialling over trunk circuits; less urgent, but even more important, are the problems of subscriber-dialling over trunk circuits and the long-term study of the application of electronic methods to automatic telephone switching.

A growing feature of the work at Dollis Hill is that connected with the postal service. Statistical studies of the work in sorting offices are leading to important results, and the more precise knowledge gained may make useful improvements in routing possible in the future. Experimental work on the mechanical sorting of mail was started before the Second World War, but was dropped for more urgent matters A new start has been made and an experimental letter-facing machine built, based on photoelectric selection. The general principle of photoelectric scanning is applicable to other purposes, such as the conversion of pencil-stroke codes on white tickets, to other forms, such as punched-hole codes which can be handled by conventional office machinery.

The Electronics Division has made considerable progress in its experimental studies of the factors affecting valve life. The manner in which valves fail is now largely understood, and effort is being concentrated on practical means for eliminating the principal causes of cathode failure, gas poisoning and interface growth. It is also concerned with the performance of crystal diodes and triodes, which are essential for some of the latest developments in communications techniques.

Much of the work in the radio laboratories is directed towards improved overseas radio-telephony services. The single-sideband technique is being more and more used in these services, and a new receiver for this type of signal has recently been developed. Efficient aerials are essential in long-distance services, and there is a group of workers concerned with aerial development. The steadily increasing number of aerials at large radio stations tends to cause congestion, and a model technique using centimetre wave-lengths has recently been brought into use in the investigation of the effects of obstructions upon the directional properties of aerials.

Turning to internal radio communications, the development of microwave systems for the transmission of multi-channel telephone or television signals between large cities continues. Precise information on propagation is necessary in the design of such systems, and several experimental links, over land and over water, are under observation. At the other extreme, radio links are useful for providing single-channel telephone communication with isolated communities, such as live on some of the small islands off the coasts of Britain: a primary-battery-operated, very-high-frequency system for this purpose is on trial. A radio service may be partly or completely upset by interference from electrical machinery or another radio service, and the Post Office tries to minimize such interference by regulation, licensing and technical assistance. In this connexion it is necessary to develop and test interference-measuring sets and to determine the degree of interference that can be tolerated in various radio systems. Recent work includes the determination of the amount of co-channel and adjacent-channel interference permissible in television reception.

Accurate frequency control is necessary in both line carrier and radio communication, and a frequency standard is maintained at Dollis Hill. It includes a number of quartz ring crystals, in improved mountings; these crystals have an outstandingly good performance, and some have been supplied to the National Physical Laboratory and to the Royal Observatory. Equipment similar to that at Dollis Hill has been installed at Rugby radio station to control the standard frequency transmission that the Post Office provides for the Department of Scientific and Industrial Research. The Post Office has recently taken part in international discussions to determine the best form of distress signal for use on 2,182 kc./s. in the marine radio-telephone band, for the operation of automatic distress-signal receivers. A simple device for use with a conventional receiver has been developed; although sensitive, it is remarkably immune to false operation by ordinary speech.

It should be remembered that the whole of the work in Great Britain on civil telecommunication research is not confined to Dollis Hill; all the large manufacturers of telecommunication equipment, radio and line plant have their own research departments where much original work is done. There is also the Radio Research Station at Slough, of the Department of Scientific and Industrial Research. Since the final development stages of equipment which is to be manufactured in quantity are best done in laboratories associated with factories, arrangements exist for the transition from laboratory model to large-scale production to be undertaken by contractors.

APPLICATIONS OF PHYSICS IN THE DIAGNOSIS AND TREATMENT OF CANCER

AMONG a number of scientific and medical gatherings to mark the centenary of the Royal Cancer Hospital, London, S.W.3, the Physical Society held a symposium on the "Applications of Physics in the Diagnosis and Treatment of Cancer" in the Physics Department of the Hospital during October 5–6; Prof. L. F. Bates, president of the Physical Society, took the chair for the first session.

Opening the meeting, Prof. W. V. Mayneord remarked that this was the first occasion on which the Society had met in a hospital and, in doing so, marked yet another stage in the recognition that the applications of physics in medicine now constitute an important branch of applied physics. He gave a brief historical sketch of the influence of the physical sciences on medical thought and practice from early times, and stressed the present need for physicists trained in biology and biophysics.

In his paper on "The Use of High-Energy Particle Accelerators", Dr. D. A. Layne discussed the difficulties of the treatment of deep-seated tumours by normal-voltage X-ray therapy and the ways in which the use of high-energy particle accelerators can help to overcome them. The application of high-energy beams of X-rays and particulate radiation were considered and also the most probable useful energy ranges for each type of radiation. It was emphasized that considerable preparation, both physical and biological, is necessary before any generator of this type can be applied clinically. Each machine has its own special problems, but, as an example, particular reference was made to those encountered in the clinical preparation of the 30-MeV. synchrotron at the Royal Cancer Hospital. Finally, attention was paid to experimental and theoretical work on the process of particle injection into betatron orbits, undertaken in the hope of increasing the X-ray output. It is normally supposed that, for most betatrons and electron-synchrotrons, only 1–2 per cent of the theoretical maximum charge is actually accelerated, but the work described suggests that this theoretical limit has been incorrectly assessed and that the working efficiency is actually nearer 50–100 per cent.

Dr. W. K. Sinclair, in a paper on "The Use of Radioactive Isotopes", spoke of the early hopes of these substances in the diagnosis and treatment of cancer. It was thought that isotopes might be found which become localized specifically in tumour rather than in normal tissue, or in particular organs to the exclusion of other organs, and in specific parts, for example, the nucleus, of the living cell. Unfortunately these hopes have been realized in only a very limited degree, but other ways of using the substances have been found. They have, for example, been localized physically in particular regions of tissue and have provided medical men with a wide range of flexible sources which can be used to treat sites in the body inaccessible to beams of X-rays. The present use of isotopes in the diagnosis of thyroid conditions, skin lesions and brain tumours, and in the treatment of widespread systemic cancer by internally administered phosphorus-32 and physically localized gold-198, and the use of discrete sources in cavities, superficially and interstitially, were considered. Some of the principal physical aspects of these methods were outlined. Concluding, Dr. Sinclair reviewed briefly the principles of localization by external counting, beta-ray and gamma-ray dose estimation, the distribution of dose in tissues in a variety of circumstances, the measurement of beta-ray and gamma-ray sources, and the protection measures necessary in handling the high activities required for therapeutic techniques.

Concluding the first session of the meeting, Dr. R. C. Turner, in a paper on "Electronics", described the part played by this subject in the diagnosis and treatment of cancer, particularly in relation to the development of instruments for the measurement of ionizing radiations. He discussed electronic instruments which have been developed for the control of the radiation dosage delivered to specific sites in and on the bodies of patients undergoing radiation treatment, for the laboratory study and evaluation of new radiation techniques and for the monitoring of personnel and control of levels existing throughout the Royal Cancer Hospital. Various types of direct-reading instruments in routine clinical use were described. An experimental apparatus aimed at presenting a visual image on an oscillograph screen of a distribution of radioactive material or of radiation is in operation, and is yielding some promising results. Dr. Turner discussed the possibility of applying supersonic techniques to the localization of small tumours in specific sites and of its diagnostic significance.

During the evening of October 5 demonstrations were shown in the Physics Department of the Royal Cancer Hospital as follows: scintillation counting; instrument making; physical chemistry; clinical physics and treatment planning; electronics; photographic investigations; isotope investigations; biophysical investigations and autoradiography; and work on high-energy X-rays (30-MeV. synchrotron and 2-MeV. Van de Graaff generator).

Prof. G. I. Finch presided over the second session of the meeting on the morning of October 6, and the opening paper was read by Dr. E. H. Belcher on "Scintillation Counting". He reported that the scintillation counter has found an increasing variety of applications in the field of medical physics during the past three years, by virtue of its high detecting-efficiency for gamma-radiation and the small size of the luminophor used as the detecting element. Dr. Belcher outlined the fundamental principles of the device. The mechanism of production of scintillations varies with the luminophor used, but it is possible to distinguish between pure luminophors such as calcium tungstate in which the emission process is restricted to the luminescent centre, and impurity-activated luminophors such as the thallium-activated alkali halides in which luminescence depends upon the existence of electron-trapping sites in the lattice, which may be remote from the luminescent centre. The design of practical counters for clinical measurements was discussed. It is frequently desirable to separate the luminophor from the photomultiplier tube by a light guide, and in such cases it is often necessary to cool the photomultiplier by liquid nitrogen. Directional and probing counters making use of such techniques were described. Dr. Belcher discussed the absolute sensitivity of scintillation counters. Where a pure luminophor is used, the observed counting-rate may be related directly to the rate of absorption of gamma-ray quanta in the luminophor. In impurity-activated luminophors, on the other hand, the observed counting-rate may be many times greater, because of the phosphorescent emission resulting from the slow release of electrons from trapping sites. Experimental results demonstrating these effects were presented. Further experimental results relating to the luminescence of 'Perspex' and of transparent liquids under gamma-irradiation were also discussed, which suggest that the luminescence of such media may be attributed to the Cerenkov effect. The significance of these results in the fields of biology and radiation chemistry was assessed. Experimental work is in progress on luminescence produced by dissolved radioactive isotopes.

In his paper on "Photographic Measurements of Ionizing Radiation", Dr. G. Spiegler discussed the sensitivity of photographic films per unit of dose as measured by ionization methods, and the sensitivity per unit of absorbed energy. He described the problems involved when a film is used in dosimetric work, emphasizing the energy dependence of the photographic emulsion and the problems of determination of the energy of the incident quanta from the film itself. The chief methods used, such as the 'filter' method and the 'metal foil' method, were described, the former depending upon the absorption in a test filter as indicator of the quality, and the latter making use of the variation with energy of the electronic emission from metal foils. The result of work on the sensitivity of emulsions to beta-particles and investigations on the Ilford *PM*-1 film, used for personnel monitoring, were reported. The absorption of beta-particles in the clothing of personnel, and the relationship between 'tolerance dose' and blackening, were discussed. Dr. Spiegler showed radiographs taken with the 30-MeV. synchrotron, demonstrating the significance of conditions in the high-energy region.

Concluding the meeting, Dr. L. F. Lamerton, in a paper on "Autoradiography", remarked that, when radioactive materials are used either as therapeutic agents or as tracers for the investigation of normal body function, it is always an advantage, and often quite essential, to have precise knowledge of the distribution of the isotope throughout the tissue. The autoradiographic method provides a means of obtaining this information, subject to two main limitations: first, in the preparation of the tissue for autoradiography some of the radioactive material may be lost or its position change; and secondly, when isotopes are used as tracers, the amount of isotope necessary to give a satisfactory autoradiograph may be such as itself to produce biological effects.

Various types of autoradiographic techniques are available, differing in sensitivity and resolution, in general a high resolution being obtained only at the expense of sensitivity. By the use of nuclear emulsions a sufficiently high resolution can be obtained to give information on the intracellular distribution of isotopes, such work so far being done using a Kodak nuclear emulsion, 4 microns thick, in stripping form. However, work is now being carried out on the possible use of more sensitive nuclear emulsions poured over the specimen. In this way, individual electron tracks can be observed for low-energy electrons. This method will undoubtedly be of considerable value for low-energy beta-ray emitters, but its value is problematic for the high-energy beta-ray emitters such as phosphorus-32. An investigation was described which showed the application of various types of autoradiographic technique. This concerned the non-uniform distribution of radioactive phosphate in certain tissues following intravenous administration, and was shown to be due to the concentration of activity on particulate material. It has been shown that the particulate material can arise in the preparation of the active solution and also by allowing the solution to stand in a syringe, unless special precautions have been taken. The non-uniformity of activity resulting may affect considerably the dosage distribution in the tissue.

NEWS and VIEWS

Astronomy at University College, London: Prof. W. C. Allen

A SUBSTANTIAL bequest from the estate of the late Mr. F. Perren has made possible the establishment of the Perren chair of astronomy in the University of London at University College. The chair will be associated with the Observatory at Mill Hill. The first holder of the new chair is Dr. W. C. Allen. Since 1927 he has been on the staff of the Commonwealth Solar Observatory at Canberra. He has also carried out research work at the Solar Physics Observatory, Cambridge, and at Mount Wilson, and later took part in eclipse expeditions to Japan and to South Africa. Prof. Allen has been concerned actively in many different aspects of astronomical research work. He was one of the first to carry out accurate photometric measurement of the Fraunhofer lines in a very thorough investigation, the results of which are still widely referred to as standard. In recent years, Prof. Allen has made many important contributions to the study of solar and terrestrial relations and to solar physics generally. In collaboration with Prof. R. van der R. Woolley he has worked out a theoretical description of the outer region of the sun's atmosphere, and he has been closely associated on the astronomical side with the fruitful developments of radioastronomy in Australia.

Inter-African Bureau of Epizootic Diseases: Mr. W. G. Beaton

UNDER the auspices of the Commission for Technical Co-operation in Africa south of the Sahara, an Inter-African Bureau of Epizootic Diseases is to be set up in Kenya on the site of the East African Veterinary Research Organization at Mugaga, near Nairobi, and Mr. William Gaudenz Beaton, the retiring director of veterinary services, Nigeria, has been appointed director of the Bureau. Mr. Beaton, who has spent his entire career in Nigeria, was born in 1900 and educated at the Royal Veterinary College, London, the Universities of Edinburgh and Liverpool and at the Pasteur Institute, Paris. He entered the Colonial Veterinary Service as a veterinary officer in 1925, becoming a research officer in 1929 and then senior veterinary officer in 1938. In the same year he became deputy director of veterinary services, and in 1948 was appointed director. Mr. Beaton was delegate for Nigeria to the Anglo-French Colonial veterinary conference, held at Dakar in 1946, and in 1948 he attended three conferences: the Colonial genetic conference at Edinburgh, the international rinderpest conference at Nairobi and the United Nations Food and Agriculture Organization conference on rinderpest, also at Nairobi.

Royal Naval Scientific Service: Chief Scientific Officers

THE following promotions to the rank of chief scientific officer in the Royal Naval Scientific Service have been announced:

Mr. J. Anderson, C.B.E., chief scientist at the Admiralty Signal and Radar Establishment, Haslemere. Mr. Anderson was educated at the Royal Technical College, Glasgow. After two years postgraduate training in the Rugby works of the British Thomson-Houston Co., Ltd., he joined the Admiralty Experimental Station at Parkeston Quay, Harwich, in May 1918. Mr. Anderson assisted Prof. R. W. Boyle in the very early stages of the development of Asdic equipment for the detection and location of submarines, and has been associated with the subsequent development of this equipment, first at H.M. Signal School, and later at H.M. Anti-Submarine Experimental Establishment. In 1943 he became chief scientist at this Establishment, which in 1946 was renamed H.M. Underwater Detection Establishment. He went to his present post in May 1951.

Colonel A. V. Kerrison, director of Aeronautical and Engineering Research, Admiralty. After service in France throughout the First World War, and two years on intelligence missions in South Russia, Colonel Kerrison returned to England to work on mathematical analyses of artillery ballistics and anti-aircraft gunnery problems. He eventually became Army liaison officer at the Admiralty Research Laboratory, Teddington, where he initiated systematic research in the development of gunnery fire control. His experimental work on aided laying opened up a new line of development in anti-aircraft gunnery fire control, his design of a close-range predictor based on it being adopted by both the British and United States armies.

Dr. E. C. S. Megaw, director of physical research, Admiralty. After graduation in electrical engineering at Queen's University, Belfast, Dr. Megaw spent two years as a Beit Scientific Research Fellow under Prof. C. L. Fortescue at the Imperial College of Science and Technology, London. His research on valve oscillators at high frequencies was continued after joining the Research Laboratories of the General Electric Company in 1930. Specializing in the study of transit-time oscillators for the highest frequencies, he soon began a long association with what was then the Experimental Department of H.M. Signal School, one of the results of which was that sea-going communication equipment using resonator-stabilized magnetrons was available at the beginning of the Second World War. During the War Dr. Megaw led a team which made many significant contributions to magnetron development, while he was also responsible for the G.E.C.'s part in the war-time studies of centimetric wave propagation. In 1946 he joined the Admiralty, becoming eventually superintendent of research at the Admiralty Signal and Radar Establishment. Recently Dr. Megaw has directed attention to the effect of the turbulent fluctuations of refractive index in the atmosphere on radio wave propagation beyond the horizon.

Exhibition on Wild Life Preservation

THE Zoological Department of the National Museum of Wales, Cardiff, has arranged an exhibition to show how man has affected the wild animals of the world, causing some to become rare and others extinct; and how, in more recent times, he has sought to preserve those in danger of depletion. In the six floor cases are shown examples of birds and mammals which have been greatly reduced or exterminated over much of their former range or exterminated completely. These include the capercaillie, the kite, the marsh harrier, the hen harrier, the ruff, the passenger pigeon, dodo, great auk, as well as the European beaver, pine marten, wolverene, Japanese racoon-dog, aurochs, red deer, roe deer and wild boar. Around the walls are heads of various species of big game, all greatly reduced in numbers and in range by the activities of man. There is also a small wall case containing specimens of twelve kinds of British moths and butterflies which are at present receiving the attention of the Protection Committee of the Royal Entomological Society of London. Those represented in the case are the Clifton nonpareil, large blue, swallowtail, glanville, and heath fritillaries, Sussex emerald, Lewes wave, lunar double-strip, dark-bordered beauty, Blair's wainscot, rose plume and fiery clearwing. Most of the exhibits dealing with conservation are concerned with the national parks, game and wildfowl sanctuaries and other protected areas established in Holland, Denmark, United States, Canada, Africa and Malaya. The exhibition is one of the most comprehensive of its kind which has yet been arranged in Britain and deserves a visit from all those who are interested in wild life. A suitable handbook to illustrate the exhibition, which will be open until February 1952, is available from the Museum.

Quaternary Finds in Belgium

UNFORTUNATELY, no late palæolithic cave art has yet been discovered in Belgium. But at a number of localities small sculptures and engravings on pieces of stone and bone have been found associated with datable industries in the excavations. Such 'home' art is, of course, not an uncommon occurrence in France, and the Belgian examples are, by and large, similar to those already known which have been found in French Magdalenian sites. Representations of a number of different animals, including man, have been found among the Belgian examples, and details are collected in a publication by Prof. François Twiesselmann entitled "Les Représentations de l'Homme et des Animaux Quaternaires Découvertes en Belgique" (Memoire No. 113 de l'Institut Royal des Sciences Naturelles de Belgique. Pp. 28+10 plates. Brussels, 1951). They include *Bos primigenius*, reindeer, ibex, fish, birds and a beetle. Man is also figured, though never as well drawn as are many of the animals. This memoir, as a whole, is an important production; not that it contains much new material, but rather that it brings together in a convenient and well-illustrated form information heretofore only to be found scattered through a number of different publications, many of which are not very easily obtained. The memoir can be recommended to all students of late palæolithic art.

Census of Woodlands in Great Britain

THE first effort at making a systematic census of woodlands in Great Britain was carried out by the Forestry Commission, the results being published in 1928. Much of this survey was done by voluntary workers and was only partially satisfactory. The next census was planned during 1938–39, but had only been partially completed when war broke out. A new census, which would have inevitably been necessary owing to the heavy fellings during the War, was begun in 1947 and the field-work was completed by the middle of 1949 (Forestry Commission: Forest Record No. 3. London: H.M.S.O., 1951). The census had two main objectives: first, to map and classify all the woodlands of the country which are in blocks of five acres and more; and secondly, to obtain an estimate of the timber volume and increment of the woods remaining at the time of the survey—information which is essential for the purpose of regulating future felling, and without which, of course, no working plan could be drawn up. The government forest areas under the Forestry Commission were surveyed by members of the Commission staff, and private woodlands were surveyed by men and women specially recruited and trained for the purpose. This census showed a total area of actual and potential woodland in Great Britain (in blocks of five acres and more) of 3,448,362 acres and about 187,000 acres of small woods less than five acres in extent.

Forestry in Trinidad and Tobago

DURING the past twenty years, the annual reports of the Forest Department of Trinidad and Tobago have been fairly consistent and they have reported good work accomplished in the past; they have been hampered by the need for more roads to open up existing forests and by want of staff due to lack of facilities. The report for 1949 (Port-of-Spain, Trinidad) indicates that the Government has at last realized and sanctioned measures for improvement. Much greater progress may be looked forward to in future years. A reference to the local fauna is of interest. The local fauna of Trinidad and Tobago is largely nocturnal, and although varied and interesting, particularly the mammals and reptiles, are rarely seen by the general public. Hence there is considerable interest in the proposal for the establishment of a zoological garden. Government approval was given in 1947 for the use of a site in the Royal Botanic Gardens, and a Zoological Society was formed in 1947, but further development awaits the incorporation of the Society, which was still pending at the end of 1949. The interests of the local fauna are to a certain extent safeguarded by the Wild Animals and Birds (Protection) Ordinance, under which the conservator of forests is chief game warden; but it is becoming increasingly difficult to enforce the regulations and during 1949 poaching was widespread. This is an interesting report and must be a satisfaction to the conservator of forests, Mr. G. N. Sale, who is leaving the Colony on retirement.

Fish Collections from the Leeward and Line Islands

The George Vanderbilt Pacific Equatorial Expedition of 1951, which was jointly sponsored by the Academy of Natural Sciences of Philadelphia and the California Academy of Sciences, has recently completed a 3½-month cruise through the Hawaiian, Leeward and Line Islands, in which it obtained the largest fish collections as yet taken from the Leeward and Line Islands. The collections are being sorted at the California Academy of Sciences; reports on some of the groups will be made by Robert R. Harry, a graduate student in ichthyology of Stanford University, who was a member of the Expedition during the cruise through both sets of Islands, and other groups will be dealt with by Dr. Earl S. Herald, curator of aquatic biology, Steinhart Aquarium, California Academy of Sciences, who helped in the organization of the biological work and participated in the voyage through the Line Islands. Vernon E. Brock, director of the Hawaiian Division of Fish and Game, took part in the Leeward Islands cruise as the official observer of the territorial government. The Expedition was directed by George Vanderbilt.

German Hydrographic Institute, Hamburg: Report for 1950

The fifth annual report of the German Hydrographic Institute (pp. 70+11 plates; Hamburg, 11: the Institute, 1951) gives an account of its activities during 1950, and is furnished with an extensive appendix which gives very comprehensive details of the publications issued by the Institute and its constituent parts during the year. The Institute, having been rated a 'Federal Superior Authority', was transferred on July 1 of the year to the sole control of the Federal Ministry of Transport. Consequent upon the re-birth of the German merchant fleet, the Department of Nautical Publications and Nautical Notices, in common with the Chart-Producing Establishment, had to meet greatly increased demands, and the same was true of all the Divisions of the Institute directly concerned with shipping requirements—the Tidal Service, the Division of Nautical Astronomy, the Time Service and, in particular, the Department of Nautical Engineering. The Institute's new survey and research vessel *Gauss* was commissioned early in the year, and in summer and autumn she made three cruises in the North Sea devoted to oceanographical and geological-morphological investigations. Among further oceanographical research work were theoretical and laboratory studies of wind-stress effects upon water-level, and investigations of the effects of tidal streams on the structure of the water column and on climate (in the latter connexion a paper by Dr. G. Dietrich was published in *Nature*, 168, 8; 1951). Investigations into the chemistry and geology of the sea were devoted in part to problems of hydrobiology and coast erosion, and in part to problems facing the Ice Service of the Institute. The Geomagnetic Service was occupied with the design of geomagnetic charts to serve the needs of shipping, and with the elaboration of the numerous observations made at the Institute's magnetic observatory at Wingst.

Atomic Scientists Association

The September issue of the *Atomic Scientists News* contains, in addition to a report of the annual meeting of the Atomic Scientists Association, an extract from Sir John Cockcroft's lecture on nuclear power which he delivered at the Naturvidenskabelige Samfund in April and an article by Prof. R. E. Peierls, in which he directs attention to the necessity of not allowing the long-term interests of science and of the community to be neglected in favour of immediate needs. At the annual general meeting of the Association, held in the Clarendon Laboratory, Oxford, on June 30, the main discussion was on the policy to be adopted by the Association towards matters having political implications. Lord Cherwell urged that it should refrain altogether from expressing views on political matters; but Prof. N. F. Mott and several other speakers disagreed and considered it important that the Association should provide, in its *News*, a forum in which such matters could be openly discussed. No formal decision was made; but the president indicated that the newly elected council would take careful notice of the views expressed by both sides. At the meeting, the following were elected to hold office for 1951–52: *President*, Prof. M. H. L. Pryce; *Executive Vice-President*, Prof. Kathleen Lonsdale; *Treasurer*, Dr. L. E. J. Roberts; *Honorary General Secretary*, Dr. J. L. Michiels; and *Editor of the News*, Dr. H. R. Allen.

British Glaciological Society: Officers for 1952

The following have been elected officers for 1952 of the British Glaciological Society: *President*, G. Seligman; *Vice-Presidents*, J. M. Wordie, The Bishop of Portsmouth, Dr. K. Sandford and W. V. Lewis; *Honorary General Secretary*, A. H. Bolitho; *Honorary Assistant Secretary*, D. W. Humphries; *Honorary Meetings Secretary*, D. S. Brook; *Honorary Treasurer*, T. H. Best.

Announcements

The annual conference of the Geographical Association will be held in the Main (Old) Building and the New Building of the London School of Economics, Houghton Street, Aldwych, London, W.C.2, during January 1–4, 1952. In addition, the annual general meeting of the Association will take place at 3.30 p.m. on January 2. Further details can be obtained from the organizer of the conference, Dr. W. G. V. Balchin, Department of Geography, King's College, Strand, London, W.C.2.

J. C. Macrae has been appointed lecturer in gas chemistry in the Department of Coal, Gas and Fuel Industries, University of Leeds.

In the article in *Nature* of Dec. 1, p. 930, on the Royal Dublin Society meeting to mark the centenary of the birth of G. F. FitzGerald, it is stated that photostat copies of the FitzGerald–Heaviside correspondence had been presented to the Society by the Royal Institution. This is incorrect; these copies were presented by the Institution of Electrical Engineers.

RECENT ADVANCES IN ORGANIC FLUORINE CHEMISTRY

By Dr. R. N. HASZELDINE
University Chemical Laboratory, Cambridge

THE preparation of fluoroiodides has enabled many routes of interest in synthetic organic fluorine chemistry to be developed.

Perfluoro esters and lactones. A method for the preparation of fluoroiodides by the interaction of iodine and heavy metal salts of fluoro mono- and di-basic acids has been described in earlier communications[1,2]. Thus $CF_3[CF_2]_nCOOAg$ and $AgOOC[CF_2]_nCOOAg$ with halogens yield $CF_3[CF_2]_nX$ and $X[CF_2]_nX$ (X = Cl, Br, I). The compounds of general formula $X[CF_2]_nX$ (n even) can also be obtained via polymerization of tetrafluoroethylene with iodine (X = I) followed by reaction with bromine or chlorine (X = Br or Cl)[2]. Other products from these reactions are now being identified. Thus, the interaction of iodine and the silver salt of trifluoroacetic acid or of heptafluorobutyric acid can be made to yield small amounts of trifluoromethyl-trifluoroacetate CF_3COOCF_3, and heptafluoropropyl-heptafluorobutyrate $C_3F_7COOC_3F_7$. These compounds, the first completely fluorinated esters to be reported, are believed to arise by a free radical mechanism: for example,

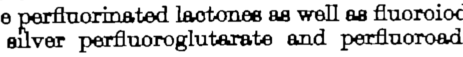
$$CF_3COOAg + I_2 \longrightarrow CF_3COOI + AgI$$
$$CF_3COOI \xrightarrow{\text{heat}} CF_3COO\cdot + \cdot I$$
$$CF_3COOI \xrightarrow{\text{heat}} CF_3\cdot + CO_2 + \cdot I$$
$$CF_3COO\cdot + CF_3\cdot \longrightarrow CF_3COOCF_3\,;$$

rather than by the simple ionic mechanism analogous to that which can be postulated to explain ester formation from hydrocarbon acids:

$$CH_3COOAg \xrightarrow{I_2} CH_3COOI \rightarrow CH_3I$$
$$CH_3COOAg + CH_3I \rightarrow CH_3COOCH_3 + AgI.$$

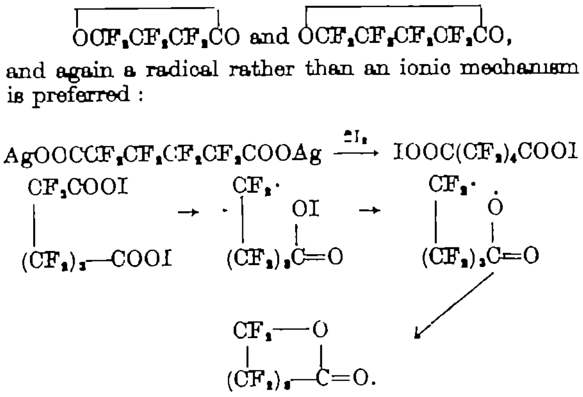
Heterolytic fission of the carbon–iodine bond in CF_3I under the conditions of the reaction is considered unlikely (cf. ref. 4). The properties of these volatile fluoro-esters, which have boiling points near those of the corresponding fluorocarbons, are being investigated.

The silver salts of dibasic acids react with iodine to give perfluorinated lactones as well as fluoroiodides. Thus silver perfluoroglutarate and perfluoroadipate yield



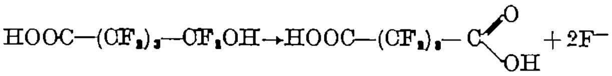
$OCF_2CF_2CF_2CO$ and $OCF_2CF_2CF_2CF_2CO$,

and again a radical rather than an ionic mechanism is preferred:

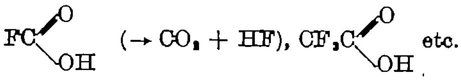


$$AgOOCCF_2CF_2CF_2CF_2COOAg \xrightarrow{2I_2} IOOC(CF_2)_4COOI$$

Although quite stable in a vacuum system, treatment of these lactones with aqueous reagents opens up the lactone rings to give transient compounds containing the $-CF_2OH$ group. These primary hydroxy fluorine compounds are unstable in aqueous media, and the quantitative loss of two fluorine atoms as fluoride ion can be demonstrated:



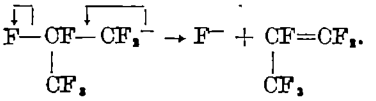
The dibasic fluoro-acid containing one less CF_2 group than the original acid is thus obtained. This indicates that the still unknown primary carbinols CF_3OH, C_2F_5OH, etc., would decompose in aqueous solution to give



The stability of such primary fluoro-carbinols in non-aqueous media is still a matter for conjecture, however, and it may be possible to prepare these compounds from the perfluorinated esters or lactones.

Perfluoro olefins. Sodium trifluoroacetate reacts with iodine on heating to give CF_3I[1]. Sodium heptafluorobutyrate, however, yields C_3F_7I in relatively poor yield and the main product is $CF_3CF{=}CF_2$, the formation of which can be visualized as proceeding by an elimination of the type:

$$CF_3CF_2CF_2COONa \rightarrow CF_3CF_2CF_2^- + CO_2 + Na^+$$



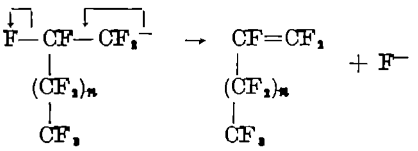
Heptafluoroiodopropane, prepared from CF_3I and tetrafluoroethylene or from C_3F_7COOAg, can be converted into $CF_3CF{=}CF_2$ by means of zinc, and the olefin can also be prepared by the thermal dehydrofluorination of the C_3F_7H obtained from C_3F_7COOH by decarboxylation. Oxidation of the fluoro-olefin gives the acid containing two fewer CF_2 groups than originally, so that one can descend the homologous fluoro-acid series as well as ascend it by fluoroiodide reactions[1,3].

Perfluoro alkyl Grignard reagents. As reported earlier[3], the fluoroiodides $CF_3[CF_2]_nI$ yield Grignard reagents $CF_3[CF_2]_nMgI$. The essential technique for the Grignard preparation is to carry out the reaction in a completely anhydrous solvent such as an ether of suitable boiling point, with a high solvent to fluoroiodide ratio, slight excess of magnesium and operating at a temperature below −30° C.; −50° to −80° C. has been found convenient once the reaction has been initiated at room temperature, or at −40° C. in the case of fluoroiodides with $n \geqslant 1$. Once Grignard formation has occurred, the temperature can be allowed to rise to 0° C. without appreciable decomposition and the compound to be treated can be added at some convenient temperature −60° to 0° C. Alternatively, the compound to be treated can be added after Grignard formation has been initiated and the temperature lowered, so that it is present during Grignard formation and reacts immediately. Yields of up to 65 per cent of the Grignard reagent have been obtained when $n > 1$.

The reactions so far investigated indicate that in the main the fluoro Grignard reagents react like hydrocarbon Grignard reagents. Compounds containing active hydrogen yield $CF_3[CF_2]_nH$; carbon dioxide yields $CF_3[CF_2]_nCOOH$, thus providing a simple method for fluoro-acid formation from longer-chain fluoroiodides (cf. ref. 1). The reactions of CF_3MgI, C_2F_5MgI and in certain instances C_3F_7MgI, with HCHO, CH_3CHO, CH_3COCH_3, C_6H_5CHO, $C_6H_5COC_6H_5$, CF_3COCH_3 and C_6H_5CHO have been found to proceed normally to give the carbinols; appreciable reduction occurs during these reactions, and the nature of the side reactions has not been completely determined. Ketones have been prepared by reaction with CH_3CN, CH_3COCl and C_6H_5COCl; the reactions with CF_3COCl or CF_3CN provide simple syntheses of perfluoro-ketones such as CF_3COCF_3, $CF_3COC_2F_5$ or $CF_3COC_3F_7$.

Elimination reactions of fluorine compounds. Decomposition of the Grignard reagent $CF_3[CF_2]_nMgI$, for example during its formation or on standing, yields $CF_3[CF_2]_nH$, $CF_3[CF_2]_{n-1}CF=CF_2$, MgF_2, MgI_2 and small amounts of the fluorocarbon $CF_3(CF_2)_{2n}CF_3$. The polymerization of the olefin, formed by the suggested elimination mechanism,

$$CF_3(CF_2)_{n-2}CF_2CF_2MgI \rightarrow CF_3(CF_2)_{n-2}CF_2CF_2^- + \overset{+}{Mg}I$$



$$F-\underset{\substack{|\\ (CF_2)_n \\ | \\ CF_3}}{CF}-CF_2^- \rightarrow \underset{\substack{|\\ (CF_2)_n \\ | \\ CF_3}}{CF}=CF_2 + F^-$$

would account for the formation of polymeric material isolated under non-optimum conditions of Grignard formation and reaction. The formation of $CF_3(CF_2)_nH$ could involve an ionic or free radical mechanism:

$$\begin{tikzcd}
CF_3(CF_2)_nMgI \arrow[r] \arrow[d] & CF_3(CF_2)_{n-2}CF_2CF_2^- \arrow[d, "solvent"] \\
CF_3(CF_2)_{n-2}CF_2CF_2\cdot \arrow[r, "solvent"] & CF_3(CF_2)_{n-2}CF_2CF_2H.
\end{tikzcd}$$

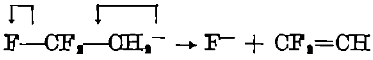
It is known that free perfluoroalkyl radicals will abstract hydrogen from solvents at room temperature[5]. The formation of the fluorocarbon $CF_3(CF_2)_{2n}CF_3$ thus probably occurs by a bimolecular reaction

$$CF_3(CF_2)_{n-2}CF_2CF_2MgI + CF_3(CF_2)_nI \rightarrow CF_3(CF_2)_{2n}CF_3 + MgI_2$$

rather than by combination of really 'free' radicals.

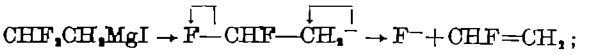
The observations in the literature[6,7] that the reactions of CF_3CH_2I or CHF_2CH_2I with magnesium in ether lead to olefin formation and not to Grignard formation may be reinterpreted on the above basis:

$$CF_3CH_2I \rightarrow CF_3CH_2MgI \rightarrow CF_3CH_2^- + \overset{+}{Mg}I$$



$$F-CF_2-CH_2^- \rightarrow F^- + CF_2=CH_2,$$

and similarly



$$CHF_2CH_2MgI \rightarrow F-CHF-CH_2^- \rightarrow F^- + CHF=CH_2;$$

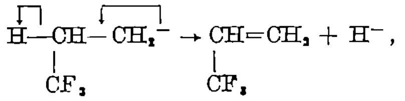
that is, Grignard formation does occur but is followed by decomposition under the unfavourable reaction conditions employed. The reaction of CHF_2CH_2Br with sodium or potassium[8] to give $CHF=CH_2$ can be similarly interpreted. There are indications that the application of the techniques used for the preparation of Grignard reagents from perfluoroalkyl iodides leads to the successful preparation of similar reagents from the dihydro fluoroalkyl halides CF_3CH_2I and CF_3CH_2Br. The carbon–iodine bond in CF_3CH_2I can be broken homolytically to give the $CF_3CH_2\cdot$ radical; the mercurial CH_3CH_2HgI has been prepared.

Application of the silver salt technique[1,2] to CF_3CH_2COOH, a compound prepared by the sequence

$$CF_3CH_2CH_2I \rightarrow CF_3CH_2CH_2OH \rightarrow CF_3CH_2COOH,$$

yields, by reaction with the appropriate halogen, CF_3CH_2I or CF_3CH_2Br.

It is noteworthy that olefin formation occurs only in fluorohalides which have a β-fluorine atom. Thus $CF_3CH_2CH_2I$[9] gives $CF_3CH_2CH_2MgI$, which reacts normally with many functional groups. Olefin formation from this Grignard is unlikely to involve

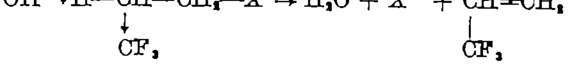


$$H-\underset{\substack{|\\ CF_3}}{CH}-CH_2^- \rightarrow \underset{\substack{|\\ CF_3}}{CH}=CH_2 + H^-,$$

and the $CF_3CH=CH_2$ obtained on heating the Grignard to 100° C. or during certain reactions, for example, with copper or with silver or cuprous halides to produce $CF_3(CH_2)_4CF_3$, is almost certainly formed by free radical disproportionation of two $CF_3CH_2CH_2$ radicals:

$$2CF_3CH_2CH_2\cdot \rightarrow CF_3CH_2CH_3 + CF_3CH=CH_2.$$

The presence of $CF_3CH_2CH_3$ can be demonstrated. Radical reactions to give olefin formation from, say, CF_3CH_2I or $CF_3(CF_2)_2MgI$ are unlikely, since they would involve homolytic fission of a C—F bond. Thus, it may well be that an important reaction of a fluorocarbanion will be to undergo an elimination reaction with expulsion of a β-fluorine atom as fluoride ion. Whereas olefin formation does not occur during Grignard formation from $CF_3CH_2CH_2I$, this fluoroiodide, like other fluoro-halo compounds containing the $CF_3(CF_2)_nCHCX$ unit, readily undergoes dehydrohalogenation with alcoholic alkali. The removal of β-hydrogen as a proton will clearly be facilitated by the electronegative β-$CF_3(CF_2)_n$ group tending to make the β-hydrogen atom relatively more acidic[10], for example,



$$OH^- \; H-\underset{\substack{\downarrow\\ CF_3}}{CH}-CH_2-X \rightarrow H_2O + X^- + \underset{\substack{|\\ CF_3}}{CH}=CH_2$$

Perfluoroalkyl nitroso and nitro compounds. Other reactions under investigation are designed to produce further perfluoro compounds containing functional groups. The synthesis of perfluoroalkyl nitroso and nitro compounds is reported for the first time. Representative members of perfluoroalkyl iodides and di-iodides have been converted into the monomeric blue nitroso compounds, for example, $CF_3(CF_2)_nNO$, and into the nitro compounds, for example, $CF_3(CF_2)_nNO_2$. The reduction of these compounds to the corresponding amines is being attempted.

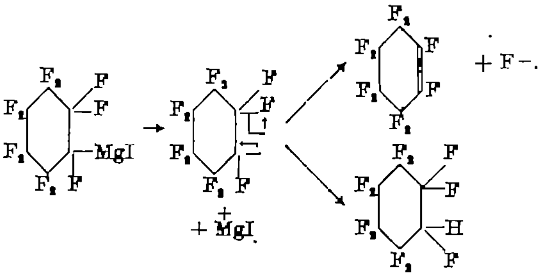
Perfluoro carbinols. The preparation of the carbinols $CF_3(CF_2)_nOH$, $[CF_3(CF_2)_n]_2CHOH$ and $[CF_3(CF_2)_n]_3COH$ by interaction of the perfluoroalkyl Grignard reagents with suitable reagents such as oxygen, perfluoroaldehydes (such as CF_3CHO), perfluoroketones (such as CF_3COCF_3), alkyl perfluoroacetates (such as CF_3COOEt), etc., is believed to have yielded, in specific examples, $(CF_3)_2CHOH$ and $(CF_3)_3COH$, the first completely fluorinated secondary and tertiary alcohols.

Zinc and cadmium perfluoroalkyls. Solutions of zinc and cadmium perfluoroalkyls have been prepared from the perfluoroalkyl iodides CF_3I and C_3F_7I, and as in the case of the Grignard reagents it is noticed that trifluoroiodomethane is the least reactive fluoroiodide. These new organometallic compounds also appear to react like their hydrocarbon analogues, though less readily, and may well prove advantageous (for example, in ketone preparation from acyl chlorides) in avoiding side-reactions found with the Grignard reagents.

Perfluoro acids. Application of the general method for the preparation of fluoro-acids from fluoroiodides has resulted in the synthesis of C_3F_7COOH[*], C_4F_9COOH, $C_5F_{11}COOH$, $C_6F_{13}COOH$, $C_7F_{15}COOH$, $C_8F_{17}COOH$, $C_9F_{19}COOH$ and $C_{11}F_{23}COOH$; derivatives and reactions of these long-chain acids have been examined. The use of the Grignard reagent provides a simpler method for converting fluoroiodides to fluoro-acids. Thus, while it is possible to apply the technique outlined earlier to perfluoroalkyl di-iodides $I[CF_2]_nI$ and hence obtain perfluoro dibasic acids $HOOC[CF_2]_nCOOH$, it is more convenient to prepare the di-Grignard reagent $IMg[CF_2]_nMgI$ ($n > 2$), since this reacts normally with carbon dioxide to give the required acid; reactions of the di-Grignard reagents with other functional groups are being investigated. Monohydro perfluoro acids of general formula $H(CF_2CF_2)_nCOOH$ have been prepared from the monohydro fluoroiodides $H(CF_2CF_2)_nI$ and also by the action of CH_3OH with C_2F_4 under free-radical conditions, isolation of the alcohols $H(CF_2CF_2)_nCH_2OH$, and oxidation of these to the acids.

The reaction of metallic sodium with ethyl trifluoroacetate in ethereal solution yields a mixture of products among which trifluoroacetoacetic ester and trifluoroethanol have been identified. The nature of high-boiling material formed during the reaction is being investigated. The expected diketone $CF_3COCOCF_3$, and the acyloin $CF_3CHOHCOCF_3$, are not formed under the conditions used, and the mechanism of this reaction is clearly of interest.

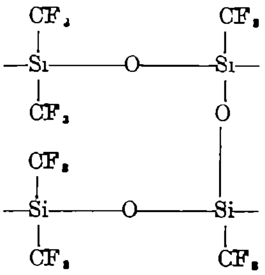
A perfluoro cyclic acid has been synthesized by the following route. The interaction of hexaiodobenzene and iodine pentafluoride yields, among other products, perfluoro cyclohexyl iodide $C_6F_{11}I$. This iodide yields a Grignard reagent $C_6F_{11}MgI$ which with carbon dioxide gives perfluoro cyclohexane carboxylic acid $C_6F_{11}COOH$ and perfluorocyclohexene C_6F_{10}, the latter arising by decomposition of the acid in aqueous media. It is of interest that the Grignard formation is again accompanied by olefin and by hydro-compound formation (see following reaction scheme). The acid may be converted into the chloride, bromide, or iodide by application of the silver salt reaction, while fluorination of the iodide yields perfluorocyclohexane. Preliminary examination indicates that $C_6F_{11}I$ shows many of the reactions associated with the perfluoroalkyl iodides. The perfluorocyclohexyl radical $C_6F_{11}\cdot$ is formed on heating or on exposure to ultra-violet radiation, and will add to unsaturated compounds. Acetylene, for example, yields $C_6F_{11}CH{=}CHI$, oxidation of which gives perfluorocyclohexene C_6F_{10} and only small yields of $C_6F_{11}COOH$. The oxidation product of perfluorocyclohexene, that is, perfluoro adipic acid, is also formed in substantial amount.



Infra-red spectra of fluorine compounds. The infra-red spectra of many compounds derived from fluoro-acids and fluoroiodides have been taken and will be published in full later. Wave-lengths 'characteristic' of functional groups in fluorine compounds are tentatively assigned in the accompanying table, and may need revision as more samples become available. R_F denotes CF_3, C_2F_5 . . . etc., or C_6F_{11}; the third column of the table gives the values for corresponding hydrocarbons.

R_FCOOH	5·60–5·65	5·85
R_FCOOEt R_FCOOMe	5·6	5·7–5·8
R_FCOONa R_FCOOK	5·9	6·15–6·4
R_FCOOAg	6·15–6·20	
R_FCONH_2	5·70–5·85 6·10–6·15	two bands 6·0–6·2
R_FCOCH_2—	5·65	5·9–6·0
R_FCOR_F	5·55	5·9–6·0
$\begin{matrix}R_FCO\\R_FCO\end{matrix}\!>\!O$	5·2, 5·5	5·30–5·48 5·6–5·7
R_FCHO	5·6–5·7	5·8–5·9
R_FCOF	5·3	
R_FCOCl	5·4–5·5	5·52–5·54
R_FCN	4·45	4·3–5·3
$R_FC{\equiv}CH$	4·6–4·7 for C≡C 3·01 for C—H	4·6–4·7 2·95
R_FCH_2OH	2·99 for OH	c. 3·0
$R_FCH(OH)_2$	3·03 for OH	
R_FI	c. 13·5–14·5	
R_FBr	c. 13·0–13·5	
R_FCl	c. 12·8	
$R_FCH{=}CH_2$	5·99 10·2, 10·4	6·08 10·1, 11·0
$R_FCH{=}CHCl$	6·06 10·7	
$R_FCH{=}CHBr$	6·08 10·7	
$R_FCH{=}CHI$	6·15–6·20 10·55–10·65	
$R_FCBr{=}CH_2$	6·1 10·7, 11·9	6·1 11·2
$R_FCH{=}CHCH_3$ *trans*	5·90 10·4	6·0 10·36
$R_FCH{=}CHCF_3$ *trans*	10·4	10·36
$R_FCH{=}CHCF_3$ *cis*	5·95	6·02
$R_FCH{=}CHCOOH$ *trans*	5·85 6·00 10·28	5·85 6·05 10·30
C_6F_{10} cyclic	5·76	
$R_FCF{=}CF_2$	5·57	
$R_FCF{=}CFR$	5·78	

Perfluoroalkyl silicon compounds. It would clearly be of interest if the stability and inertness of fluorocarbons could be combined with the valuable properties of silicones, that is, if fluoro-silicones could be produced. From what is now known of perfluoroalkyl organo-metallic and -metalloidal compounds, it is not at all certain that perfluoro silicones will be resistant to hydrolysis. Two routes have been followed to prepare perfluoro-silicon compounds for examination. In the first, the perfluoroalkyl Grignard reagents have been found to react with $SiCl_4$ to yield a mixture of products from which $(CF_3)_2SiCl_2$, for example, has been isolated; other compounds such as $Si(CF_3)_4$, CF_3SiCl_3, etc., are undoubtedly present. In the second instance, the interaction of fluoroiodides and silicon–copper has been found to yield fluoroalkyl silicon compounds together with disproportionation products. From such compounds it may well be possible to prepare silicones of the type



Even if such polymeric compounds cannot be obtained or should they prove unstable, perfluoro silicon compounds of a different and more suitable type might become possible. Furthermore, it should be emphasized that although fluoroiodides have been used for much of the work described in this and earlier communications, it is distinctly possible that fluorobromo compounds might undergo many similar reactions. There are indications that perfluoroalkyl bromides yield Grignard reagents $CF_3(CF_2)_nMgBr$, and that they can undergo free-radical reactions involving addition to olefins[11].

As the chemistry of fluorine and its organic compounds progresses, it becomes increasingly evident that a vast new field of study is being opened up, a field of chemistry that will eventually considerably supplement the more established field based on hydrocarbon chemistry. [Aug. 24.

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[1] Haszeldine, *Nature*, 166, 192 (1950).

[2] Haszeldine, *J. Chem. Soc.*, 584 (1951).

[3] Haszeldine, *Nature*, 167, 139 (1951)

[4] Banus, Emeléus and Haszeldine, *J. Chem. Soc.*, 60 (1951).

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[8] Haszeldine, *J. Chem. Soc.*, 2856 (1949).

[9] Haszeldine, *J. Chem. Soc.*, 2789 (1950)

[10] Haszeldine, *J. Chem. Soc.*, 2495 (1951)

[11] Steele and Haszeldine (unpublished)

LECTOTYPES IN MYCOLOGY: A TAXONOMIC PROPOSAL

By E. J. H. CORNER

Botany School, Cambridge

I WISH to direct the attention of taxonomists to a procedure which is becoming common, at least in the nomenclature of Basidiomycetes. It is the method of proposing types (lectotypes) for genera of more than one species. Such typification is, of course, the goal of generic nomenclature, and the need for it in Basidiomycetes is great, where many highly artificial, untypified assemblages must be combed into homogeneous genera. Typification by a lectotype, however, amounts to generic emendation, inasmuch as species which do not qualify with the lectotype must be excluded. Emendation implies generic and specific revision, comprehensive enough to satisfy modern standards of classification. The scientific approach would be first to revise the genus and its allies, so as to obtain a clear insight into the relationships of the species, and then, in the resultant monograph, to consider lectotypes with the utmost caution in view of the facts that knowledge is always imperfect and that a lectotype once accepted cannot be changed. Unfortunately, the procedure of which I complain proposes the lectotypes first by reference to early (and, scientifically, elementary) publications, without basic revision, without re-definition of genera, even without personal acquaintance with the organisms concerned, and leaves to posterity the real task of evaluating the proposals by study of the species[1-5]. The cart is put before the horse, and, to change the metaphor, the botanist is left in the dark, because fundamental knowledge of the structure of these fungi, on which better classification depends, is so dim. As it is easier to consult libraries than it is to become personally acquainted in microscopic detail with a large number of species, this procedure is becoming a popular expedient to the detriment of mycology. Genera, of course, are not dictated, but are discerned from the study of species.

I will give two examples of the disconcerting consequences of this procedure. They are drawn from the Clavariaceæ and result from the publication of my monograph, which was reviewed in *Nature*[6]. Many more could be cited, especially from the Polyporaceæ. In fact, there must be so many instances of this procedure among cryptogams generally that I hope my proposal will call for approval at the next International Botanical Congress.

Lachnocladium Lév. was described with seven species, none designated as the type. By 1940, it had 113 specific names and was clearly heterogeneous. *L. furcellatum* (Fr.) Lév., as one of the seven, was then proposed as the lectotype, without anything more being known about it than was published in 1830: indeed, none of the original species had been re-described; scarcely any of the whole genus had been described with any exactitude, and there was no attempt to revise the tropical 'clavarias' which are the content of the genus[1,2,4]. In the meantime, I was working on my monograph of the whole family, for the express purpose of modernizing descriptions and discovering generic limits. I interpreted *Lachnocladium* on *L. brasiliense* Lév., another of the seven, because it represented the largest tropical group of species that required generic differentiation, while conforming with the original diagnosis, and because type-material was available in Kew and Paris. In consequence, the genus became the most distinctive and, taxonomically, the most important among all the clavarioid fungi, instead of being the nondescript receptacle for all 'tough' clavarias from the tropics. I deliberately avoided *L. furcellatum* because it was based on three collections (Brazil, Guinea, Bourbon), which were then as inaccessible to me as they had been to others. Now, six years later, through the kindness of Dr. Seth Lundell, of the Institute of Systematic Botany at Uppsala, I have been able to examine the only original collection of *L. furcellatum* that there is in the Friesian herbarium, namely, the Brazilian collection of Beyrich's. It does not belong to *Lachnocladium* emend. Corner; but it is *Lentaria surculus* (B.) Corner [= *Lachnocladium compressum* (B.) Lév.]; and the genus *Lentaria* contains only four of the 113 specific names of *Lachnocladium*, two referring to north temperate species. But what, or where, the Guinea and Bourbon collections of *L. furcellatum* may be is not known, and no mycologist would now assume their identity with the Brazilian merely because the pocket-lens had put them together 120 years ago.

Thus, by reference to 'literature' only, and by putting the cart before the horse, nomenclaturists have advocated as the lectotype of this important tropical genus a species which cannot yet be resolved, which may never be resolved, which may be a mixture of more than one genus, or, if uniform, which represents only 4 per cent of the genus: and this part is not characteristically tropical as the original diagnosis implied. In detail, we do not know whether *Lentaria* is to become a synonym of *Lachnocladium*, in which case *Stelligera* Heim ex Doty takes the place of *Lachnocladium* emend. Corner, or my classification, based on a world monograph, is to be upheld: about fifty species, several of them common, are affected. But, further, if *Lachnocladium* should take over from *Lentaria*, then *Lachnocladium* may easily become a synonym of *Ramaria* or take the place of *Clavariella*, for *Lentaria* is not nearly so clear-cut a genus as *Lachnocladium* emend. Corner. If *Ramaria* should take over *Lachnocladium*, this well-known name of long standing (a hundred years) for tropical species will disappear; if *Lachnocladium* should take over from *Clavariella*, then the names of a hundred more species of temperate and tropical countries will have to be changed, and some of these are the best known of all clavarias. Such doubts, problems and consequences should have been resolved by research into the organisms themselves before the lectotype was proposed, as I did in my monograph before I emended *Lachnocladium* by carefully considering its relations with all other species of the family: no such absurdity as this can enter into my classification. Yet, this blind man's buff, as is the procedure of which I complain, passes as scientific nomenclatorial procedure and may, by reason only of priority, as in this instance, nullify fundamental research, which research would then be used for further nomenclatorial juggling with generic names. The procedure is not merely detrimental to mycology but also contrary to scientific thought, which must exact stability of nomenclature from taxonomy.

The second example is the choice of *P. quisquiliaris* as lectotype of *Pistillaria*, again without monographic revision. My researches showed that the effect of this lectotype was to merge the two large foundation-genera *Pistillaria* and *Typhula* into one and to place a later name, *Cnazonaria*, that has never been current, where *Pistillaria* can readily be maintained, as I have done in my monograph in accordance with Recommendation VI, Art. 18, of the International Rules of Nomenclature (6, 98, 99). Thus, this blind man's buff may also bowl over foundation-genera.

For the sake of scientific research, for mycology, and for botany, which demand stability of nomenclature, I propose to international taxonomists the following principles:

(1) That typification of genera by lectotypes implies generic emendation, which in turn implies revision of the genus and its allies so that the full consequence of the proposed lectotype can be seen; (2) that any such typification without the necessary revision should be rejected.

The proposal is an amplification of paragraph 4 of Appendix 1 to the International Rules of Botanical Nomenclature, as adopted at the seventh International Botanical Congress[7]. It emphasizes what is so often overlooked, especially in connexion with lower plants, that many of the nomenclatorial problems are caused by lack of knowledge of the organisms, which no amount of static typification will improve. In the case of Basidiomycetes, such revision means full hyphal analysis, as explained in the introduction to my monograph, the absence of this analysis being the main source of errors of present-day classifications, whether concerned with lectotypes or not. Thus, if my proposal is adopted, the making of lectotypes will be the outcome of fundamental research, slow but sure, in accordance with the great importance attached to the concept of the generic type. If the proposal is not adopted, there will be so many more of the confusions that I have instanced that many current generic names will become unserviceable in a multiplicity of interpretations, while others will be lost and unfamiliar ones put in their stead.

[Nov. 10.

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ACCIDENT PRONENESS

IN a contribution to the eleventh issue of "New Biology"* Dr. R. MacKeith suggests that the idea or hypothesis of accident proneness may turn out to be as important for saving lives as sulphonamides and the antibiotics like penicillin have been.

In Britain there are 1,000 fatal and 350,000 other accidents a year in factories; 5,000 deaths from accidents in the home, and 3,000 deaths and 250,000 injuries on the roads. This can be examined from various aspects. The medical care is expensive. It is wasteful of labour that might be productive. It is the cause of suffering to those bereaved, to the surviving injured and especially to those who are mutilated and scarred. That such a high accident-rate is tolerated appears to indicate that the benefits of having buses, motor-cars and lorries are worth more than are several thousand lives and a quarter of a million injuries a year. Can these accidents be prevented?

In 1919, Greenwood and Woods, working for the Industrial Fatigue Research Board, observed that in a group of workers studied over a period, accidents did not occur uniformly throughout the group, some of the workers had repeated accidents, so that 80 per cent of the accidents happened to 20 per cent of the workers. This ratio has been confirmed by a number of studies of industrial accidents and of road accidents. Such an uneven distribution might arise from a simple chance distribution; but that is not an adequate explanation of the repeated observations. It might be because having one accident makes a person liable to suffer further accidents, or it might be because individuals differ in their liability to accident, even with the same degree of risk.

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* New Biology, 11. Edited by M. L. Johnson and Michael Abercrombie. Pp. 128+16 plates. (Harmondsworth: Penguin Books, 1951.) 2s.

Thus, in children, the peak age for road accidents is four to six years; children of this age-group have special characteristics, physical, mental and emotional, and these may be responsible for the high accident-rate. Children are active, progressing usually by running rather than walking, and just acquiring the grace in movement which implies full control. They may see a motor-car thirty yards away and not appreciate that it is moving rapidly towards them. They believe that grown-ups are all-powerful and so they may well believe the car could be stopped if necessary. These small children are impulsive and act suddenly and may be moved to action by fantasies or strongly felt emotions. In brief, their high accident-rate may be from their relative physical, intellectual or emotional defects compared with the children of 7–9 who have fewer accidents.

The same possibilities arise when accident-prone adults are studied. An American insurance company's analysis of a series of industrial accidents suggested that "mechanical hazards caused less than 9 per cent, physical and mental defects about 3 per cent, lack of skill less than 8 per cent", leaving personality defects to account for 80 per cent of the accidents.

The idea of accident proneness of psychological origin was first put forward by Farmer and Chambers in a Medical Research Council report published in 1926, and also by Marbe in the same year. Attempts were made to correlate accident proneness with the 'reaction time'. ('Reaction time' is the time between receiving a stimulus and acting upon this perception.) There is little correlation, and though there is a higher correlation with elaborate tests demanding a close co-ordination of stimulus and action, it was not high enough to justify selection of workers on such tests. In dealing with motor-car drivers it was found that failure to do certain psychological tests was reflected in a higher accident-rate. Farmer and Chambers also found that liability to accident is a stable characteristic. Bus drivers with a high number of accidents in their first year of work tended to go on having an excessive number. Inexperience in itself does give a rather increased rate of accidents; but, after the first year, further experience does not reduce the accident-rate. These authors suggested that by taking the results of certain tests and the reports of the accident incidence in the first years of driving, some accident-prone drivers could be detected and perhaps diverted to other occupations.

In the United States Dr. Flanders Durban has made a special study of accident-prone patients, and her work showed that, first, most (80 per cent) of those who have had one serious accident tend to have others, and have a particular kind of personality. The other 20 per cent do not tend to have more accidents and do not have special personality features. Secondly, people with a history of minor accidents are more likely to have serious accidents. If a group of fracture patients is compared with a group of patients with heart disease, 76 per cent of the total illness period in their previous medical history was the result of accidents for the fracture patients, and 2 per cent for the heart patients. Thirdly, accident-prone persons have unusually good health records; they have not been off work much and are especially free of colds and indigestion. Fourthly, they are not clumsy or dull; they are quick-minded "men of action not deliberation', but inarticulate about expressing their feelings. Fifthly, there are various types of accident-prone persons. The most usual type are happy-go-lucky, impulsive, casual people "who divorce and remarry easily". From the psychological point of view they are hostile to authority, but evade this feeling. That is, they are not openly hostile to parents or employers, but take up fatalistic 'don't care' attitudes towards others.

Accident-prone children have pent-up aggression and resentment which is shown by restlessness, stealing, lying or truancy. Fabian and Bendor, studying children of 1–15 years with severe head injuries, found that 38 per cent of them had had previous major accidents, 83 per cent of the children had inadequate parents—sometimes heavy drinkers, sometimes a domineering, abusive father and an over-protective mother. These children are like delinquents; but where one breaks laws, the other breaks bones. The guilty feelings of some of the fracture patients were revealed by remarks such as "It serves me right". Accidents appear to happen when children are doing forbidden things; and it is suggested that some children may be reckless in order to bring punishment upon themselves because they cannot bear the feelings they have of guilt.

Data about accidents in the home are difficult to get. One study suggested that two-thirds of these are due to carelessness of one sort or another. Accidents do happen to the tired and irritable, so that personal rather than structural factors are the main cause of accidents in the home. "But it is clear that there are most injuries where housewives live in overcrowded and ill-equipped homes; they are distracted by the difficulties of keeping an eye on the children while trying to get through the day's work without confusion and disorder. A long story of fighting against the heavy odds of environment often lies behind expressions such as thoughtlessness, carelessness or negligence."

Accident proneness certainly exists in some people. It is not the only factor in the causation of accidents. "Dangerous machines in factories still must be shielded; we must try to improve our roads, and make our homes safer. We must help children to learn safe behaviour. Does the idea of accident proneness offer us any further ways in which accidents might be reduced?"

A transport company transferred their drivers who had most accidents to other jobs and so reduced accidents to one-fifth of what they had been. The ex drivers still suffered injuries, but only to themselves. Most of the fatal road accidents in Great Britain involve public-service vehicles such as buses and lorries, and so it should be possible to know the incidence of accidents, to recognize the accident-prone drivers and persuade them to change to other jobs. This is a field in which trade unions and employers should co-operate, for it may be difficult to work out how such a scheme is to be administered. More should be known about the tests devised for reaction time and the psychological tests which might be used. This would cost money, but not much in comparison with the immense sums proposed for road improvements "to make roads safer". It is unlikely that such expensive schemes will be possible for a long time, and "however much external conditions were improved, with a view to reducing the general accident rate, those specially prone would still have a higher accident rate under all conditions than those with a relatively low accident proneness". If legislation is to be introduced involving limitations on the liberty of the subject, the case for such limitations will have to be very strong before it is acceptable to Parliament.

These would be measures to deal with a situation that has arisen and has been discovered. On a longer-term policy the abnormal reaction to authority shown by the accident-prone should not arise. A child who has repeated accidents should be regarded as having a behaviour problem which needs treatment, and the environment in which the accident-prone personality develops should be removed or altered.

LONDON TO BIRMINGHAM TELEVISION LINK

AT a meeting of the Institution of Electrical Engineers on November 8, a paper entitled "The London–Birmingham Television-Cable System" was presented by T. Kilvington, F. J. M. Laver and H. Stanesby, members of the Post Office Engineering Department. This paper described the cable system which provides channels for relaying television signals simultaneously in both directions between the television broadcasting stations at Alexandra Palace and Sutton Coldfield. The corresponding radio link between these two stations was described in a paper read before the Institution last session under the title "The London–Birmingham Television Radio-Relay Link", by R. J. Clayton, D. C. Espley, G. W. S. Griffith and J. M. C. Pinkham, of the Research Laboratories of the General Electric Co., Ltd., and since published in the *Proceedings* (98, Part 1).

The radio link provides a connexion between the Museum Telephone Exchange in London and Telephone House in Birmingham, with four intermediate repeater stations. Among the conditions of the overall electrical performance, specified by the Post Office, was the requirement that all terminal and repeater stations should work unattended. This feature necessitated the provision of an elaborate supervisory and monitoring system, and the installation of a complete range of standby equipment in all the signal and power circuits of the stations. The frequencies used for transmission in one direction between London and Birmingham alternate at the successive repeater stations between 917 and 937 Mc./s., and the corresponding frequencies used in the other direction are 870 and 890 Mc./s. The aerial system for either transmitter or receiver consists of a dipole with a passive reflector mounted in the aperture of a paraboloidal mirror, 14 ft. in diameter. The gain of such a system is 27·5 db. over a half-wave dipole, and it is shown in the paper that a transmitter power of 6 W. provides a satisfactory signal/noise ratio over the longest links, two of which are slightly less than forty miles. The terminal equipments and their associated circuits were designed to pass television signals over a band 3 Mc./s. wide, with very uniform characteristics of attenuation and phase over this frequency range, while the build-up time of the signal and the overshoot beyond the steady-state response were both required to be very small.

For some time after the opening of the Sutton Coldfield Station in December 1949, this radio link was used for programme transmission between London and Birmingham, and valuable experience was gained on its reliability and operational characteristics. The faults that occurred in a total operating time of four thousand hours arose mainly from electricity-supply failures, from the complexity of the control and monitoring systems, and from the accidental operation of certain keys. From the lessons which are being learned from the installation under service conditions, it seems likely that some simplification of control and monitoring facilities could be introduced into future link-systems for television and telephony.

Reverting to the more recent paper describing the complementary system of connecting by cable the London and Birmingham television stations, the authors explain that the design of the system was largely influenced by the report of the Hankey Committee published in 1945, which looked forward to the time when provision might be necessary for the transmission of very-high-definition colour pictures. Accordingly, it was decided to design the system so that, although initially the limit of the vision-frequency band to be transmitted would be 3 Mc./s., the system could be adapted to a much greater band width without difficulty. The cable route is about 140 miles in length, including the connexions between Alexandra Palace and Sutton Coldfield to the appropriate Post Office exchanges in London and Birmingham, respectively. Provision has been made for repeater stations at approximately three-mile intervals along the route, although at present, with the limited band-width requirement already explained, it has sufficed to equip and use only one in four of these, at a maximum spacing of less than twelve miles.

The vision-frequency signals modulate a carrier of 6·12 Mc./s. at the sending-end, the lower side-band, the carrier and part of the upper side-band being transmitted over the cable. The transmission paths are provided by a pair of coaxial cables approximately one inch in diameter, and, with the repeaters at approximately twelve-mile intervals, the gain and phase delay are substantially constant from 3 to 7 Mc./s. In the event of repeater failure, change-over from working to standby equipment is effected automatically, and power for some of the intermediate repeater stations is supplied over the coaxial cables themselves. The main cable contains four other coaxial cables for telephone channels, and a number of others of the balanced-pair type, several of which are used for supervisory functions. The overall vision-frequency characteristics of the Alexandra Palace to Sutton Coldfield connexion show a total variation in gain of 0·8 db., and in phase delay of 0·04 μsec. for frequencies up to 3 Mc./s. Above this frequency the cut-off is rapid. The performance in respect of linearity, signal/noise ratio and time response is adequate, a fact which is supported by the reproduction in the paper of photographs showing a television test pattern before and after transmission from Alexandra Palace to Birmingham and back, that is, over twice the length of cable normally used in the exchange of programmes between these stations.

It is becoming clear that, in the development of television and telephone systems, large national networks are likely to use both radio links and cables in a mixed cascade arrangement. This association of a trunk radio link with a cable installation in Great Britain will provide valuable experience towards the future planning and development of national and international networks in which both the radio and cable systems will play their appropriate parts.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

1,000-Curie Cobalt-60 Units for Radiation Therapy

TELETHERAPY units using radium are limited in usefulness by the low radiation intensities produced by the small amounts of radium which can be used. To secure an adequate dosage-rate, the distance between the source and the tumour cannot be more than a few centimetres, and therefore the dose delivered to the skin lying between the source and the tumour is much higher than that delivered to the tumour. The dose-rate below the surface, expressed as a percentage of the dose-rate at the skin, decreases very rapidly with increasing depth. Thus the percentage depth-dose is influenced primarily by the inverse square law, and one of the chief advantages of high-energy radiation, namely, its small attenuation by the tissue between the source and the tumour, is not realized.

Any attempt to obtain an improvement in the depth-dose by increasing the amount of radium, and correspondingly improving the ratio between the source-to-tumour distance and the source-to-skin distance, is limited by the high cost of radium, and by the required increase in the volume of the source. If the diameter of the source is increased, it is harder to get a well-defined beam; if the thickness is increased, much of the radiation is lost by absorption within the source.

With the high density of neutron flux of the Canadian nuclear reactor at Chalk River, sources of cobalt-60 having specific activities of 20–60 curies per gm. can be prepared. One gram of this isotope will give about the same radiation output as 32–96 gm. of radium. The gamma-rays from cobalt-60 have energies of 1·17 and 1·33 MeV.; thus the average energy is about the same as that of the gamma-rays from a sealed radium source.

Two identical sources of cobalt-60 were made available by the Atomic Energy Project of the National Research Council of Canada in the summer of 1951 for experimental and clinical use. Each source is 1 in. in diameter and half an inch thick, and has an effective strength of 1,000 curies. Two quite different units have been designed to use these sources for radiation therapy.

One of the units, designed by two of us (H. E. J., L. M. B.) for the Saskatchewan Cancer Commission, was installed in the University Hospital, Saskatoon, in August 1951. This unit consists of a steel-encased lead cylinder, with rounded ends, 20 in. in diameter and 22 in. in length, and weighs about 2,000 lb. The source is mounted on the circumference of a wheel near the centre of a head, so that by rotating the wheel it can be brought opposite an opening in one end of the head through which the radiation can emerge. The head is suspended from an overhead carriage. It can be moved in a horizontal direction, raised and lowered, and rotated through 120° in a vertical plane. A rotating circular platform, flush with the floor, is provided for rotational therapy. A variety of treatment fields can be obtained by the use of interchangeable lead diaphragms. Light stainless-steel cones, attached to each of these, indicate the size of the field and fix the treatment distance. Circular fields and rectangular fields up to 20 cm. × 20 cm., at 80 cm. source-to-skin distance, can be obtained.

With the source rotated to the 'off' position, the dosage level 1 ft. from the head is less than 7 mr./hr. With the machine turned on, dosage-levels outside the treatment room, for the severest scattering conditions, are less than 5 mr./hr. Other measurements on this unit were carried out by members of the Saskatchewan group, and details of these will be found elsewhere[1].

The second unit, designed by R. F. Errington and D. T. Green, of the Development Division of Eldorado Mining and Refining (1944), Ltd., is installed in the clinic of the Ontario Cancer Foundation in the Victoria Hospital in London, Ontario. This unit consists of a head pivoted between the arms of a horizontal 'Y', so that it can be rotated downward in one plane through about 105°, that is, from a few degrees above the horizontal to a few degrees beyond the vertical. The horizontal arm can be moved up and down a vertical column by a motor-driven screw mechanism. The vertical column is supported from the floor by a base extending forward under the head.

The radiation beam emerges through a conical opening in the head. When the beam is 'off', this opening is filled with mercury. When the beam is turned on, an air compressor built into the horizontal arm is started, and air pressure forces the mercury up into a reservoir. If the beam is turned off, or if there is a power failure, the reservoir valve opens and the mercury returns, under gravity, to cut off the beam.

Field sizes are varied by means of diaphragms in front of the opening in the head. Four lead blocks at right angles to each other can be adjusted by levers on the outside of the head to yield square or rectangular fields between 4 cm. × 4 cm. and 20 cm. × 20 cm., at 100 cm. from the source. The diaphragm system can be moved along the axis of the beam so that any source-to-skin distance between 70 cm. and 100 cm. can be utilized. In any position, the end of the diaphragm system is 13 cm. or more from the patient. A beam of light from a source at the same distance from the patient as the radiation source, and limited by the diaphragm in the same way as the radiation beam, is used as a field localizer. A detailed discussion of the unit, and of the depth-dose measurements made on it at the Radiology Laboratory of the National Research Council by some of us (National Research Council group), will be found elsewhere[1].

Depth-dose measurements were carried out in Saskatoon and in Ottawa, using D.C. amplifiers with small ionization chambers and water phantoms. The results were in excellent agreement. A summary of the percentage depth-dose data is given in the accompanying table. The maximum dose occurs 5–6 mm. below the surface of the phantom. The surface dose and the dose at any given depth depend on the size of the field. A distance of at least 15 cm. should be used between the limiting diaphragm and the surface of the phantom to reduce the electron content of the gamma-ray beam.

In the first two columns of the table, depth-dose data for the cobalt-60 units, using a 100 cm.^{2} field at 100 cm. source-to-skin distance, is compared with data obtained by Miller[2] for a 2-MeV. Van de Graaff type X-ray unit. In the last two columns a comparison is presented between the cobalt data and measurements obtained by Trump[3] for a 3-MeV. Van de Graaff type X-ray machine, for 100 cm.^{2} fields and for a source-to-skin distance of 70 cm. It is

Depth (cm.)	Field, 100 cm.^{2}. Distance, 100 cm.		Field, 100 cm.^{2}. Distance, 70 cm.	
	Cobalt-60	2 MeV. (ref. 2)	Cobalt-60	3 MeV. (ref. 3)
0·5	100	100	100	100
1·0	99	98	98	98
5·0	80	79	77	76
10·0	58	54	54	53
15·0	41	37	37	36
20·0	29	25	26	25

apparent that the percentage depth-doses for the cobalt are considerably higher than for 2-MeV. X-rays, and slightly higher than for 3-MeV. radiation. This indicates that the average energy of the photons from a 2-MeV., or even a 3-MeV., X-ray generator is lower than the average photon energy of a cobalt-60 source.

The cobalt units are flexible, simple to operate, and should require little servicing. They may prove to be very convenient sources of high-energy radiation for therapy.

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Oct. 26.

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The Impossibility of Determining the Sun's General Magnetic Field by Zeeman Effect Measurements

Thiessen[1], v. Klüber[2], and Kiepenheuer[3] have recently achieved a very high accuracy in measuring the Zeeman effect of the Fraunhofer lines. Their results agree that, outside sunspots and other disturbed regions, the Zeeman effect is very small, corresponding to a few gauss or less. From this it is usually concluded that the sun's general magnetic field is less than a few gauss. This conclusion would be legitimate only if there were no turbulence in the photosphere.

Suppose that we observe a certain mass $\int dm$ of the photosphere. The absorption of a spectral line in a mass element dm is proportioned to a function $\beta\,(T)$ which depends mainly on the temperature T. Zeeman-effect measurements in the direction of a z-axis give an *apparent* field H_z:

$$H_z = \frac{\int H \cos\gamma \,.\, \beta\,(T)\, dm}{\int \beta\,(T)\, dm}, \qquad (1)$$

where H is the real field which makes an angle γ with the z-axis.

The field H is the vector sum of the sun's general field H_0 and a turbulent field H_t. From the granulation it can be concluded[4,5] that, in general, $H_t \gg H_0$. As the electric conductivity is so high that the magnetic lines of force are 'frozen in', an adiabatic change of the gas density ρ will, on the average. be accompanied by a change in $H \sim \rho^{2/3}$. As the temperature also changes as $\rho^{2/3}$, H is proportional to T. Hence, if ϑ is the angle between H_0 and H_t, we have:

$$T = \alpha H = \alpha\,(H_0^2 + H_t^2 - 2H_0H_t \cos\vartheta)^{1/2}, \qquad (2)$$

where α is a constant.

Even if β is known, we can evaluate the relation between H_z and H_0 only if we know the turbulence spectrum. Until we do so, no conclusion about H_0 can be drawn from measurements of H_z.

In order to show this by a simple example, suppose that the turbulent field is isotropic, with H_t constant, that $\beta \neq 0$ only for a certain temperature $T = T_a$, and that H_0 is parallel to the z-axis.

The mean temperature T_m is:

$$T_m = \alpha \int_0^\pi (H_0^2 + H_t^2 - 2H_0H \cos\vartheta)^{1/2} \,.\, \tfrac{1}{2} \sin\vartheta d\vartheta.$$

For $H_0 < H_t$ we obtain

$$T_m = \alpha\,(H_t + H_0^2/3\,H_t), \qquad (3)$$

which gives, with $H = T_a/\alpha$:

$$H = (T_a/T_m)\,[H_t + H_0^2/3\,H_t]. \qquad (4)$$

Introducing (4) and $\cos\gamma = (H^2 + H_0^2 - H_t^2)/2H\,H_0$ into (1) we obtain

$$H_z = \frac{H_0}{2}\left[1 + \frac{2}{3}\left(\frac{T_a}{T_m}\right)^2\right] - \frac{H_t^2}{2H_0}\left[1 - \left(\frac{T_a}{T_m}\right)^2\right].$$

For $T_a = 0{\cdot}9\ T_m$ and the $H_t = 3H_0$, we have $H_z/H_0 = -\,0{\cdot}1$.

Although this is a special case, it indicates that we cannot always be sure that Zeeman effect measurements give even the right sign of a weak field.

As $H_t \gg H_0$ does not hold for sunspot fields, there is no serious objection to making measurements of the Zeeman effect of such fields.

From the rate of progression of the sunspot zone, the magneto-hydrodynamic theory of sunspots shows the value of the general magnetic field to be:

$$37 > H_0 > 9 \text{ gauss}.$$

There seems at present to be no valid argument against a dipole field of this order.

I wish to thank Dr. Öhman for stimulating discussions.

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Stockholm.
Sept. 10.

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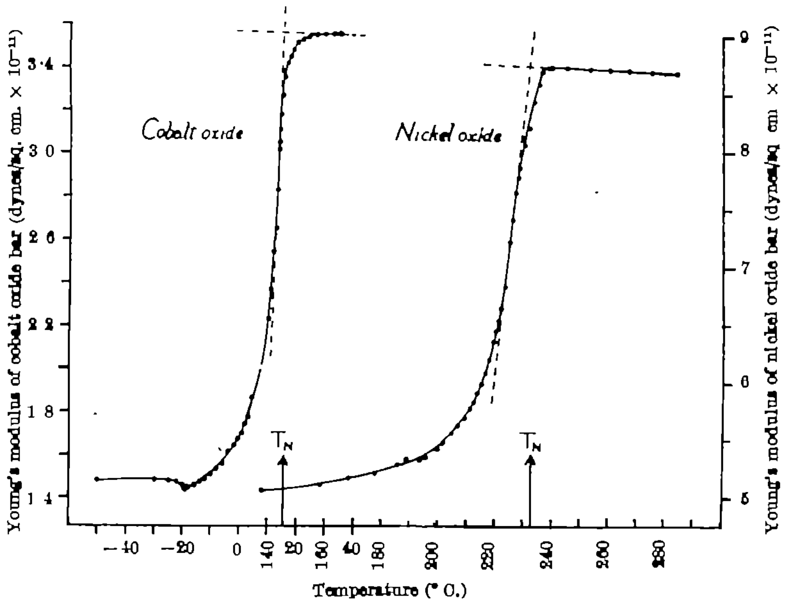
Anomalous Variation of Young's Modulus of Antiferromagnetics at the Néel Point

MEASUREMENTS have been made on the variation of Young's modulus of two antiferromagnetic materials, nickel oxide and cobalt oxide, over ranges of temperature which include their Néel temperatures (the Néel temperature of an antiferromagnetic is that temperature below which antiparallel alignment of the spin vectors of the ions takes place). The specimens of the oxides were in the form of rods of square



cross-section, and measurements of Young's modulus were made by a dynamic method similar to that described by Zacharias[1]. A quartz crystal, cemented to the oxide bars, was used as a generator of longitudinal oscillations.

The measured values of Young's modulus of both bars of oxide as a function of temperature are shown in the accompanying graph. The curves show that for these materials there is a large increase in the value of Young's modulus as the temperature of the specimen is increased through the Néel point. The observed changes of Young's modulus, expressed as a percentage of the lower-temperature values, are about 75 and 150 per cent for nickel oxide and cobalt oxide respectively. An indication of the Néel temperature in each case can be obtained from the point of intersection of the tangent at the point of inflexion with the line drawn through the higher-temperature values of Young's modulus, produced backwards. (This construction is similar to that sometimes employed in the determination of the Curie temperature of a ferromagnetic material from the observed variation of its spontaneous magnetization as a function of temperature.) The values of the Néel temperatures determined in the present work and by other workers using different methods are summarized in the table.

Author	Method	Néel temperature, T_N (° C.)	
		CoO	NiO
Foex (ref 2)	Dilatation	19	250
Trombe (ref. 3)	Susceptibility	19	220–370*
Present work	Young's modulus	16	234

* The form of the susceptibility-temperature curve from which these results are derived is such that an accurate value for the Néel temperature cannot be obtained.

During the course of the measurements, qualitative observations of the decrement of longitudinal oscillations of the oxide bars were made. It was found that for nickel oxide the decrement was relatively high in the range from room temperature to about 160° C., at which point a rapid decrease of the decrement occurred. The decrement remained small from 160° to 300° C., the highest temperature at which measurements were made on this material. Corresponding results for cobalt oxide have not yet been completed.

Two possible explanations of the anomalous variation of Young's modulus through the Néel temperature offer themselves immediately. First, the observed change of Young's modulus may possibly be due to a modification of the shape of the curve of total binding energy of the ions as a function of the inter-ionic distance, due to the additional contribution of the super-exchange energy which appears below the Néel point. However, considering that the super-exchange energy is about 0·03 eV. and 0·05 eV. for cobalt oxide and nickel oxide respectively, compared with the total binding energy of about 2 eV., this explanation appears unlikely. Secondly, the change in Young's modulus may be due to the influence of an applied stress on the preferred orientations of the spin vectors in the antiferromagnetic domains. Experiments designed to test the latter hypothesis are now being carried out in this laboratory, and it is hoped to publish further details at a later date.

Our thanks are due to Dr. G. L. Miller, of Murex, Ltd., who manufactured the oxide bars, to Dr. J. H. Mitchell, of Ericsson Telephones, Ltd., for the quartz crystals, and to Imperial Chemical Industries, Ltd., for the provision of a primary frequency standard.

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Charge-Renormalization accompanying Radiative Corrections

THE usual formalism of quantum electrodynamics[1,2] consists in the elimination from the Schrodinger equation of the free particle Hamiltonian H_0 and of the particle interaction Hamiltonian H^i. The resulting Schrödinger equation gives the corrections to the motion of the interacting particles due to their presence in an external field Hamiltonian H^e.

In some cases one is able to introduce a 'bound interaction representation' by eliminating H_0 and H^e. The resulting Schrodinger equation gives the correction to the motion of non-interacting particles in the external field due to their interactions. In this representation operators and commutators depend on the external field[3,4]. The vacuum expectation value of the current-operator $[j_\mu]_0$ represents the vacuum polarization by the external field[4,5].

If $[j_\mu]_0$ is zero, Dyson's graphs[1] are to be used; but the graphs of scattering of an electron by an external field do not exist in the 'bound interaction representation'. One can then infer that only mass-renormalizations and photon self-energy regularizations are to be performed[1-4]. This is the case of a free particle and of an electron in a homogeneous and constant magnetic field. This result explains the absence of charge renormalizations in various works on the magnetic radiative corrections developed in the 'bound interaction representation'[5,7-9].

If $[j_\mu]_0$ is not zero (Coulomb field, variable magnetic field), the 'bound interaction representation' cannot avoid charge renormalizations, for, in addition to the Dyson graphs, one must consider similar terms containing $[j_\mu]_0$. These terms of vacuum polarization introduce again charge infinities.

The 'bound interaction representation' indicates the connexion between charge infinities and vacuum polarizations in quantum electrodynamics. In meson theory, since the meson self-energy must not be regularized to zero, the situation is different.

Another advantage of this representation consists in the fact that one is no longer obliged to develop radiative corrections in powers of the external field.

The case of a homogeneous and constant magnetic field can be treated completely, since the operators and anti-commutators are known exactly for such a field[10,11]. The self-energy in the square of the coupling constant gives a mass renormalization term and a term which is the total magnetic radiative correction. For an electron this term is finite. The development in powers of the magnetic field converges very rapidly. The ratio of the magnetic polarizability to the magnetic moment is of the order 10^{-14}. This result has already been obtained by Gupta[8].

For nucleons with pseudoscalar coupling the terms are finite and converge more rapidly. The ratio of the magnetic polarizability to the magnetic moment is of the order of 10^{-21}. The perturbation method with the external field is thus correct.

Similar calculations for self-energies in the fourth power of the coupling constant are being made. The results mentioned above will be published in detail elsewhere.

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June 27.

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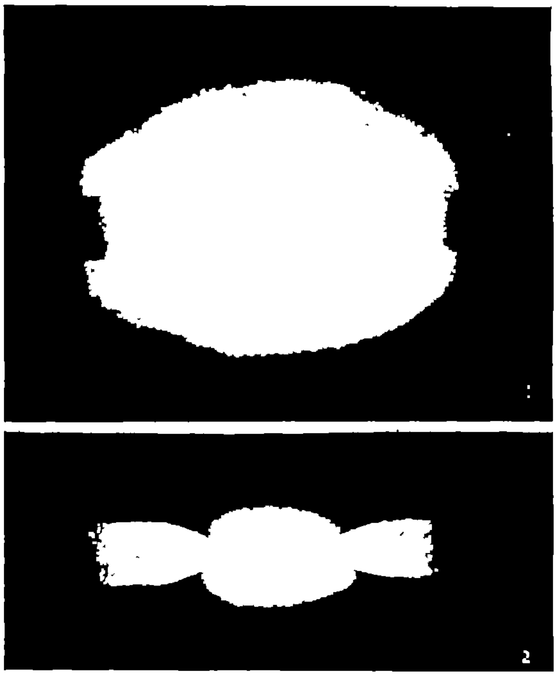
A Discharge Illuminant for Optical Systems capable of either Continuous or Flash Operation

It is sometimes desired to illuminate an object in an optical system at one level for general examination and at a momentarily higher level for photographic recording. The development of a combined flash and continuous source lamp offers a novel method for doing this. The high-pressure mercury-vapour compact-source lamp, the characteristic high brightness of which is well known, has successfully been used under pulse conditions to provide high levels of illumination for high-speed ciné photography[1,2]; this type of lamp has also been used as a condenser flash-discharge source to give high-intensity short-duration flashes of light. Recently a small xenon discharge lamp has been developed which provides a useful amount of light for such purposes as photomicrography, and can, in addition, be switched at will from the steady arc to a condenser flash-discharge with a flash duration of less than 50 microsec. The xenon discharge gives excellent colour rendering under both conditions of operation.



Arc discharge of type *F.A.5* lamp at 150 W. steady rating

In an experimental form, the arc tube is a cylinder of hard glass with an electrode sealed into each end, to form an arc gap of several millimetres. The tube contains xenon at a pressure of about 1 atmosphere, and when operating continuously at 150 watts the light source is 4–5 mm. long and 2·5 mm. wide with a maximum brightness of about 1,000 stilb.

The lamp is designed to discharge 200 joules from a condenser at intervals of about 5 sec., and from Fig. 1 it will be seen that the source size is then larger than the continuous burning source (Fig. 2); but due to the very high current density in the flash (several thousand amperes) its peak brightness is extremely high.

The lamp operates as a steady light source from the normal 200/250 V. A.C. supply with a series choke. For flashes, a condenser charged to between 2 and 2·5 kV. is used, and the lamp is triggered by applying a pulse of 5–8 kV. to a spiral grid placed outside the tube; this also initiates the continuous arc.

Apart from the simple method of control, and the ease of aligning a flash discharge source by the continuous operation of an arc between the same electrodes in an optical system, this lamp provides an electrical means of changing from one type of light source to another in place of the mechanical turret-head system. This type of lamp has also been used as a high-speed compact stroboscopic source, with a mean rating of 125 watts and a repetition frequency exceeding 160 flashes per second.

We are indebted to Mr. L. J. Davies, director of research, British Thomson-Houston Co., Ltd., Rugby, for permission to publish this letter.

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Theoretical Determination of Electron Density in Organic Molecules

A recent communication under the above title[1] prompts us to put on record some recent results which we have obtained.

(1) One of us (N. H. M.[2]) has made detailed calculations of the actual electronic density in benzene at points in the molecular plane and in a parallel plane chosen to exhibit the influence of the π-electrons as much as possible. It appears that, except for certain small regions just above and below the carbon atoms, the contribution from the σ-electrons exceeds that from the π-electrons everywhere, and often by a large factor. It appears almost correct, therefore, to describe the π-electrons as imbedded in a denser 'sea' of σ-electrons. These calculations used both conventional molecular-orbital functions and a new solution of the Thomas–Fermi equation. Theoretical discussions of the density exclusively in terms of π-electrons, and without due recognition of the σ-electrons, are likely to lead to quite false conclusions. This is in keeping with recent work of Dr. S. L. Altmann[3] at King's College, who shows that $\sigma - \pi$ resonance is important even in the ground-state of aromatic molecules.

(2) Another of us (P. W. H.[4]) has studied the effect of molecular vibration on the peak densities likely to be recorded by X-ray analysis. The charge-cloud for a non-vibrating atom can be computed wave-mechanically. If we suppose, as a first approximation, that the atom carries this charge with it as it vibrates, then a 'smearing-out' occurs. The peak density in the vibrating molecule is drastically reduced below its value in the non-vibrating molecule. Thus it is highly dangerous to compare the observed (that is, vibrating) density with that calculated (usually non-vibrating). This is also true, though in a reduced manner, for the bridge values of the density in the centres of the various C—C bonds. In addition to this, X-ray measurements are made on a crystal, and it appears that translation and libration of the molecule as a whole significantly change the density distribution in each unit cell. Theoretical analysis of the observed distribution shows that these latter motions are much more important than the internal vibrations in affecting the charge density.

(3) In conclusion, it seems desirable to point out that present X-ray observations, such as those of Abrahams, Robertson and White[5], give the density only at points in the molecular plane. Here, on account of their nodal plane, the π-electrons contribute nothing at all to the density except as a result of fairly large molecular vibrations. It appears from Dr. Klement's letter[1] that he has studied only the π-electrons. If that be so, then what he calls the exchange density in a bond may be shown to be closely related to the conventional π-bond order. Direct check with observation (other than with bond-lengths[6]) cannot be made until Prof. J. M. Robertson uses his X-ray measurements to calculate the density in a parallel plane. Even then, as shown above, the π-electron distribution will be confused by that from the σ-electrons.

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A New Type of Organo-Iron Compound

Numerous investigators have studied the reaction of Grignard reagents with anhydrous ferric chloride, but have failed to isolate any organo-iron compounds or to produce any definite evidence for their formation in such reactions.

The statements by Job and Reich[1] and by Champetier[2], that they have obtained stable ethereal solutions of compounds of the type RFeI by reaction of ferrous iodide with organo-zinc halides, are based solely on the formation of ferrous hydroxide on hydrolysis, and may be accounted for by the difference in solubility between ferrous and zinc hydroxides. Indeed, the evidence of Champetier's own experiments with Grignard reagents[2] suggests that such intermediates may be formed at low temperature, but are quite unstable above – 40° C. The normal reaction leads to reduction of the ferric salt and, with excess Grignard reagent, results in the formation of metallic iron according to the equation :

$$6\,R\text{MgBr} + 2\,\text{FeCl}_3 \rightarrow 3\,R_2 + 2\,\text{Fe} + 3\,\text{MgBr}_2 + 3\,\text{MgCl}_2.$$

This reaction is of preparative value and has been shown to yield diphenyl from phenylmagnesium bromide in almost quantitative yield[3].

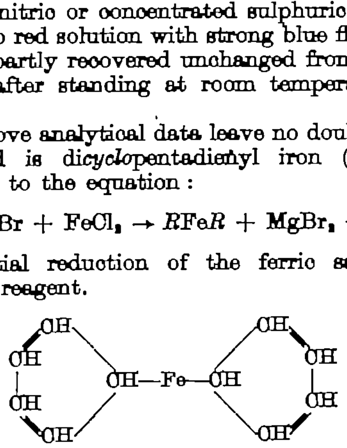
As a possible route to 'fulvalene'[4], we attempted to apply this reaction to *cyclo*pentadienylmagnesium bromide. To a solution of this Grignard reagent (from 18 gm. ethyl bromide and 4 gm. magnesium in benzene with 11 gm. *cyclo*pentadiene) was added an equivalent amount (9·05 gm.) of ferric chloride dissolved in anhydrous ether. After allowing the mixture to stand at room temperature overnight, it was refluxed (1 hr.) to ensure complete reaction, cooled and decomposed with ice-cold ammonium chloride solution in the usual manner. Evaporation of the dried organic layer yielded an orange solid (3·5 gm.). This was moderately soluble in ether, readily soluble in benzene and crystallized from methanol in large needles of melting point 173–174° C. (found : C, 64·6 ; H, 5·6 ; Fe, 30·1 per cent ; molecular weight, by cryoscopic determination in benzene, 186·5. $C_{10}H_{10}Fe$ requires : C, 64·6 ; H, 5·4 ; Fe, 30·0 per cent ; molecular weight, 186·0). Iron was determined gravimetrically as Fe_2O_3 after heating the compound with concentrated nitric acid under a reflux condenser.

The substance sublimes readily above 100° C. It is insoluble in, and apparently unattacked by, water, 10 per cent caustic soda and concentrated hydrochloric acid even at the boiling point. It dissolves in dilute nitric or concentrated sulphuric acid forming a deep red solution with strong blue fluorescence, but was partly recovered unchanged from the latter solution after standing at room temperature overnight.

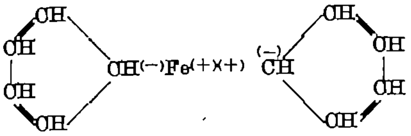
The above analytical data leave no doubt that this compound is di*cyclo*pentadienyl iron (I), formed according to the equation:

$$2\,R\text{MgBr} + \text{FeCl}_3 \rightarrow R\text{Fe}R + \text{MgBr}_2 + \text{MgCl}_2,$$

after initial reduction of the ferric salt by the Grignard reagent.



I



II

The remarkable stability of this substance is, of course, in sharp contrast to the failures of earlier workers to prepare similar compounds and must be attributed to the tendency of the *cyclo*pentadienyl group to become 'aromatic' by acquisition of a negative charge, resulting in important contributions from the resonance form (II) and intermediate forms.

Our studies of this reaction and of other approaches to fulvalene are continuing.

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Activated Adsorption of Hydrogen on Nickel Catalysts

The thermodynamics and kinetics of the chemisorption of hydrogen on metals are of considerable importance for the elucidation of the mechanism of hydrogenation reactions catalysed by these metals. Although extensively studied, the process still remains rather obscure because the evidence is in many respects conflicting. O. Beeck *et al.*[1] and E. K. Rideal and B. M. W. Trapnell[2], for example, report that, working with metal films such as nickel, the adsorption velocity is immeasurably rapid. Only a small amount of the hydrogen adsorbed shows a measurable rate of adsorption. Increasing the temperature of adsorption causes a considerable decrease in total adsorption, which is ascribed to the combined effects of desorption and sintering. However, the amount of hydrogen slowly adsorbed remains about the same. They consider the slow process to be a solution of the hydrogen in the nickel structure.

On the other hand, experiments performed on reduced nickel compounds show a different result, as reported for the first time by A. F. Benton and T. A. White[3] and since then confirmed by numerous authors, for example, quite recently by H. Sadek and H. S. Taylor[4]. Although a certain part of the adsorption is again very rapid, quite a considerable amount is adsorbed slowly. The remarkable effect is observed that the amount of adsorbed hydrogen increases with increasing temperature, which has led H. S. Taylor to the supposition that the adsorption is 'activated'. The transition from rapid to slow adsorption was explained by assuming heterogeneity of the surface. It may be remarked in this connexion that the tendency to sinter in many of the preparations tested was less pronounced than in the case of the films; hence a process may here be observed which remains unobservable in the films as a result of sintering.

Studying these phenomena on a catalyst consisting of 100 parts of nickel to 29 parts of silica (by weight), obtained by co-precipitation from nickel nitrate, sodium carbonate and sodium silicate solutions and subsequent reduction, we were able to reproduce both types of behaviour. The all-important parameter in this connexion proved to be the temperature of reduction. After reduction at a temperature lower than 400° C. the sample obtained was comparable in behaviour to those described by the second group of workers. If, however, the temperature was higher than 500° C., the ensuing sample closely resembled the films, with the difference that the tendency to sinter was very much reduced.

For this type of nickel – silica catalyst, reduction is incomplete below 400° C., but substantially complete above 500° C. The obvious inference is therefore that the oxygen content of the metal obtained is responsible for the activated adsorption, presumably because part of the surface is covered by oxygen, a suggestion first put forward by J. K. Roberts[5]. An attempt was therefore made to prove this point by careful adsorption of oxygen on the surface of a well-reduced catalyst. The oxygen was adsorbed at − 196° C., the oxygen-covered sample slowly heated to a higher temperature and thereafter the adsorption of hydrogen determined. The results confirmed Roberts's hypothesis. With increasing amounts of oxygen coverage, the amount of rapidly adsorbed hydrogen decreased while the total adsorption remained more or less constant.

A very interesting phenomenon was, moreover, revealed by these experiments. The decrease of rapidly adsorbed hydrogen with the oxygen coverage was linear, but *two* relationships were found, depending on the temperature of preheating of the oxidized sample. If this temperature was 400° C.:

$$V_{\mathrm{I,H_2}} = C - V_{\mathrm{O_2}};$$

if it was 100° C.:

$$V_{\mathrm{I,H_2}} = C - \tfrac{1}{2}V_{\mathrm{O_2}},$$

where $V_{\mathrm{I,H_2}}$ is amount of hydrogen rapidly adsorbed (cm.^{3}); $V_{\mathrm{O_2}}$ is amount of oxygen presorbed (cm.^{3}); C is a constant.

Assuming hydrogen to be adsorbed as atoms, one might explain these relations by the supposition that oxygen is chemisorbed as molecules at low temperatures, but dissociates to adsorbed atoms at high temperatures.

It may be remarked that the total hydrogen adsorption remains practically the same in both cases.

Any procedure which results in heating a reduced catalyst sample at high temperatures (~ 400° C.) without hydrogen being present, for example, heating under nitrogen or even prolonged high-vacuum pumping at these temperatures, causes the rapid adsorption to decrease while at the same time some sintering is observed. Renewed reduction restores the rapid adsorption. Consequently, some process of surface oxidation occurs during this heat treatment. It may be that a diffusion of oxygen atoms from the interior of the metal to the surface occurs; but it is more probable that the silica carrier releases water which reacts with the metal:

$$Ni + H_2O \rightarrow NiO + H_2,$$

either on the surface or in bulk or both.

To our mind the experiments described here fully confirm Roberts's hypothesis on the nature of the activated adsorption. Activated adsorption as defined by H. S. Taylor accordingly is adsorption on that part of a metal surface which is covered by oxygen atoms or molecules. The phenomenon hence cannot be considered as evidence for the heterogeneity of a pure *metal* surface.

The experiments reported here will be published in full in the *Recueil des Travaux Chimiques des Pays-Bas*.

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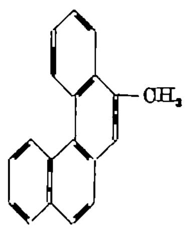
A Novel Synthesis of 2-Methyl-3 : 4-Benzphenanthrene

It has been observed that 2-methyl-3 . 4-benzphenanthrene[1,2] is a potent carcinogenic hydrocarbon[3]. Although this hydrocarbon was synthesized previously by Hewett[1] and by Newman[2], their methods are rather laborious and involve numerous steps, and eventually make this hydrocarbon less accessible to synthetic chemists. However, the method developed in this laboratory for synthesis of polycyclics[4,5] was extended to the synthesis of the above hydrocarbon. The synthesis of 9-methyl-phenanthrene[6] served as a model for this synthesis, which gave 2-methyl-3 : 4-benzphenanthrene in excellent over-all yield in four steps starting from 2-allyl-1-tetralone.



α-Tetralone was formylated to 2-formyl-1-tetralone (boiling point 136–138°/5 mm., lit.[7] boiling point 154°/10 mm.) following the conditions of Birch and Mukherji[8]. Allylation of this compound was effected with allyl iodide in presence of dry sodium ethoxide in benzene to give 2-allyl-2-formyl-1-tetralone (boiling point 134–138°/1 mm.). This substance was hydrolysed to 2-allyl-1-tetralone (boiling point 144–150°/5 mm.; semicarbazone, melting point 174–175°) by mechanical stirring with 5 per cent sodium hydroxide at 50–55° C. for 3 hr.[8]. 2-Allyl-1-tetralone was then subjected to aluminium chloride-catalysed reaction[4,5] with benzene, when 2-(β-methyl-β-phenylethyl)-1-tetralone (boiling point 200–208°/4–5 mm.) was obtained in satisfactory yield. Reduction of this substance with aluminium *iso*propoxide and *iso*propyl alcohol gave the corresponding carbinol (boiling point 205–210°/4–5 mm.) in almost quantitative yield. This carbinol was cyclized with concentrated sulphuric acid[10]. (1·84) to 2-methyl-1 : 2 . 9 : 10 : 11 : 12-hexahydro-3 : 4-benzphenanthrene, which distilled at 2 mm. from a bath at 195° C. This hexahydro derivative was smoothly dehydrogenated with palladium-charcoal (30 per cent) at 300–320° C. for 4 hr. to give 2-methyl-3 : 4-benzphenanthrene, as a pale yellow viscous oil, which crystallized from acetone-alcohol in small, almost colourless needles (melting point 71–72° C.; calc. for $C_{19}H_{14}$: C, 94·2; H, 5·8; found: C, 94·07; H, 5·9 per cent; lit.[1], leaflets, melting point 69·5–70° C.; lit.[2], almost colourless needles, melting point 70·4–71° C.).

The hydrocarbon gave a vermilion picrate which crystallized from alcohol in needles (melting point 135–136° C.; lit.[1], melting point 132·5–133·5° C.; (calc. for $C_{19}H_{14}C_6H_3O_7N_3$: C, 63·7; H, 3·6; N, 8·91; found: C, 63 13; H, 3·51; N, 8·75 per cent).

The microanalyses were carried out by Drs. G. Weiler and F. B. Strauss (Oxford).

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Colour Reagents for the Paper Chromatography of Di- and Tri-hydroxy Phenols

Various colour-producing spraying reagents have been developed for the detection of di- and tri-hydroxy phenols on paper chromatograms. Excellent results are obtainable with the diazotized sulphanilic acid of Evans, Parr and Evans[1] and the phosphomolybdic acid reagent of Riley[2]. Bate-Smith[3,4] applied Partridge's[5] ammoniacal silver nitrate reagent for furnishing diagnostic evidence regarding the position and number of hydroxy groups and also used ultra-violet light, both in the presence and absence of ammonia vapour, to obtain useful information. The majority of the above class of C_6 compounds give characteristic coloured spots with a 2 per cent aqueous ferric chloride spray[3,4], although meta- and para-hydroxy phenols (for example, orcinol, phloroglucinol, resorcinol and hydroquinone) show ill-defined greyish spots.

In the present communication a new spray reagent, developed during a comparison of the complex phenolic mixtures formed by the alkaline degradation of the extracts of the bark of *Acacia mollissima* Willd. (black wattle tannin), *A. decurrens* Willd. (green wattle tannin) and *A. dealbata* Link. (silver wattle tannin), is described. Numerous phenols have been used for the identification[6,7,8] and estimation[9] of sugars; but the reverse, that is, the use of sugars for the identification of phenols, appears to have found little application, except in the case of a fructose – hydrochloric acid reagent for the identification of resorcinol[5].

Sucrose (2·0 gm.) was therefore shaken with a mixture of concentrated hydrochloric acid (10 ml.) and absolute ethanol (90 ml.). Complete solution was not achieved, but the resulting mixture, when lightly sprayed on to paper chromatograms of di- and tri-hydroxy phenols and heated for 40–60 sec. at 85–95° C., gave the colorations shown in the accompanying table in ordinary and ultra-violet light.

Phenol	Visible light	Ultra-violet light
Catechol	Violet	Blue-violet
Pyrogallol	Dark-pink	Violet
Resorcinol	Light-pink	Weak yellow fluorescence
Phloroglucinol	Brown-pink	Maroon
Orcinol	Light pink fading to yellow in 1–2 hr.	Light blue fluorescence
Hydroquinone	Grey	Violet

Variations in concentration produce slightly different shades of colour. Of the above, catechol and hydroquinone require slightly longer heating periods (about 60 sec.) before their characteristic colours appear. The hydrochloric acid – sucrose – ethanol reagent affects the paper only to a slight degree, as very light spraying and short heating times are necessary. Phosphoric acid, while not affecting the paper[9] when used to replace the hydrochloric acid, gives similar but weaker colorations. Orcinol spots when sprayed with sucrose – phosphoric acid – ethanol show more intense light-blue fluorescence under ultra-violet light.

Fructose may be used in place of sucrose in these reagents, since both give the same colorations when sprayed with resorcinol or naphthoresorcinol in the presence of hydrochloric acid[6] or phosphoric acid[9]. A cheap and easily made reagent capable of giving clearly defined characteristic colours with various polyhydroxy phenols is thus available.

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Chromatographic Detection of Pyruvic, Dimethylpyruvic and α-Ketoglutaric Acids in Cultures of *Aspergillus niger* on Various Substrates

Ramachandran and Walker[1] have shown that, in Hida's medium of inorganic salts[2], preformed felts of *Aspergillus niger* produce pyruvic and dimethylpyruvic acids from xylose or from glycerol, and that addition of sodium acetate to the glycerol medium enhances considerably the yield of both these keto-acids.

We have now found that when preformed felts of *A. niger* are allowed to float upon a sterile solution of potassium arsenite (0·01 *M*) in 0·1 *M* phosphate buffer (*p*H 8·0) at 30° for 12 hr., the mould produces from its reserve material, substances which yield derivatives with 2 : 4-dinitrophenylhydrazine. Examination of these products by paper chromatography according to the procedure of Cavallini, Frontali and Toschi[3] has shown that the metabolism solution contains pyruvic acid, dimethylpyruvic acid, α-ketoglutaric acid, a fourth keto-acid which is neither acetoacetic acid nor α-ketobutyric acid, and a non-acidic carbonyl-containing substance. Krebs and Eggleston[4] demonstrated the formation of α-ketoglutaric acid in pigeon's breast muscle in the presence of arsenite, and the conversion of glucose to the same acid by *Pseudomonas fluorescens* was described by Lockwood and Stodola[5]. α-Ketoglutaric acid has also been obtained by the action of *A. oryzae* on glutamic acid as reported by Uemura[6], and, hitherto, this has been the sole mention of the production of this keto-acid by mycological activity. The spot on the chromatogram which represents the 2 : 4-dinitrophenylhydrazone of the unknown keto-acid lies between the positions occupied by the respective derivatives of pyruvic and dimethylpyruvic acids. The different R_F values found by us for authentic 2 : 4-dinitrophenylhydrazones of keto-acids and for the several 2 : 4-dinitrophenylhydrazones obtained from the metabolism solution of the mould are shown in the accompanying table.

SOLVENT: BUTANOL SATURATED WITH 3 PER CENT AMMONIA (V/V). WHATMAN NO. 1 FILTER PAPER

R_F values of 2 : 4-dinitrophenylhydrazones obtained from buffer-arsenite metabolism solutions		R_F values of authentic 2 : 4-dinitrophenylhydrazones of:	
	0 049	α-Ketoglutaric acid	0 049
	0·32	Pyruvic acid	0 33
Unknown keto-acid	0·50		
	0 68	Dimethylpyruvic acid	0 68
Non-acidic carbonyl compound	0·93		

When preformed felts of the same strain of *A. niger* were placed on sterile solutions of glucose (0·1 *M*) in 0·1 *M* phosphate buffer (*p*H 8 0), to which potassium arsenite had been added to give a concentration of 0·01 *M*, the same four keto-acids had again accumulated after several days at 30°. The total weight of precipitate obtained, however, on addition of 2 : 4-dinitrophenylhydrazine hydrochloride reagent to aliquots of the metabolism solution was greater than in the former experiment, in which glucose was absent from the medium.

The presence of the same unidentified keto-acid has been detected, moreover, in the culture fluid containing pyruvic and dimethylpyruvic acids obtained by allowing preformed felts of *A. niger* to li on solutions of glycerol and also of glycerol and acetate in Hida's salt solution.

We have observed that when felts of the same mould are placed on Hida's[2] salt solution to which ethyl acetoacetate (1 per cent w/v) has been added, this solution after about eight days at 30° contains pyruvic acid, dimethylpyruvic acid, α-ketoglutaric acid and again the same unidentified keto-acid encountered in the other experiments. In all instances the presence of these products was established chromatographically and was verified in repeated experiments. Work with the object of isolating the different products in the form of crystalline derivatives is now in progress in these laboratories.

The strain of *A. niger* employed in these experiments is one that gives only small yields of citric acid from glucose (10–15 per cent of the glucose utilized); and, in view of this, our results would seem to indicate that citrate accumulates in sugar cultures of those strains of *A. niger* in which the enzyme system metabolizing citric acid is either deficient or weak, and that in other strains of this mould any citric acid produced is afterwards transformed, in part at least, by way of the tricarboxylic acid cycle.

Our detection of dimethylpyruvic acid and of α-ketoglutaric acid in the mixture of products arising from both carbohydrate and ethyl acetoacetate may be an indication that the mechanisms by which the mould converts glucose to citric acid, and to the 4-carbon dicarboxylic acids common to the Szent-Györgyi systems in equilibrium and the Krebs cycle, are linked closely to those which give rise to certain acidic products and derivatives of the same which are all built on the isoprene skeleton.

During the progress of these studies, we learned from Dr. D. J. D. Hockenhull, a former colleague at Manchester, that work on parallel lines was being undertaken by Glaxo Laboratories, Ltd. This led to our consultation and an exchange of views on matters of mutual interest, and it is a pleasure to acknowledge this friendly collaboration. We desire to thank Prof. H. A. Krebs for the gift of a specimen of the 2 : 4-dinitrophenylhydrazone of α-ketoglutaric acid which we have used for purposes of comparison.

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Production of Ketoglutarate by *Penicillium chrysogenum*

Krebs and Eggleston[1] have isolated ketoglutaric acid (I) during a study of arsenite-inhibited pyruvate utilization by pigeon's breast muscle. Lockwood and Stodola[2] have isolated substantial yields of the same compound from a *Pseudomonas fluorescens* fermentation of glucose. From moulds its isolation has been reported only by Uemura[3], who obtained it on deamination of glutamic acid by *Aspergillus oryzae*.

When washed, starved mycelial suspensions from *P. chrysogenum* Q176 var. *brevisterigma*[4], originally grown in submerged culture, had been shaken aerobically with lactate in presence of arsenite, substantial amounts of keto-acids could be isolated; we determined their nature after filter-paper chromatography (Cavallini *et al.*[5]), using water-saturated *sec.* butanol. Substantial yields, consisting almost exclusively of ketoglutaric acid, were frequently obtained.

In presence of 0·01 *M* sodium arsenite at *p*H 7·3, we obtained 400 mgm. of the crude 2 : 4-dinitrophenylhydrazone of ketoglutarate from 2·8 gm. potassium lactate. After crystallization from ethyl acetate, light petroleum (boiling point 40–60°) and ethanol, it melted at 217–218° (authentic phenylhydrazone, melting point 219°, and a mixture, 218–219°: C, 40·87; H, 3·23; N, 16·90 per cent; authentic phenylhydrazone required C, 40·50; H, 3·07; N, 17·18 per cent).

It was later found that, at *p*H 5·0 as opposed to the original *p*H 7·3, inhibitor was not necessary for the production of keto-acids.

From 1·0 gm. of potassium lactate we obtained 0·80 gm. of the phenylhydrazone contaminated with material having an R_F between those of the derivatives of pyruvate and dimethyl pyruvate. By chromatography on alumina a large fraction of the nearly pure phenylhydrazone, weighing about 550 mgm., was isolated; it was recrystallized from ethyl acetate – light petroleum to give a product that melted at 218–219° and did not depress the melting point of authentic 2 : 4-dinitrophenylhydrazone of ketoglutarate.

A fuller account of this work is being submitted for publication elsewhere. We are happy to acknowledge a friendly interchange of views and collaboration with Dr. T. K. Walker and his colleagues at Manchester, who have been working on parallel lines[7].

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Inositol, a Major Constituent of the Seminal Vesicle Secretion of the Boar

In the course of the recent isolation of ergothioneine from boar's vesicular secretion[1], an alcohol-precipitable fraction was separated which did not contain nitrogen or sulphur; upon further purification of this fraction, crystalline material was obtained which tasted distinctly sweet, was optically inactive and non-reducing, and which gave a strongly positive Scherer reaction[2,3] characteristic of inositol. After recrystallization, first from ethanol and next from water, 18 gm. of pure meso-inositol was obtained from 1 litre of the vesicular secretion. The substance had a melting point of 225° C., and was found to contain 40·28 per cent C and 6·79 per cent H as against 40·11 per cent C and 6·66 per cent H expected theoretically; on oxidation with periodic acid[4] it showed a titration curve identical with that of pure meso-inositol. The concentration of inositol in the boar's seminal vesicle secretion exceeds considerably the amounts hitherto recorded for material of either plant or animal origin. The dry matter of 1 litre of vesicular secretion is about 150 gm., one-third of which is dialysable; of this no less than 18 gm. or 40 per cent is free inositol.

The physiological function of inositol has been mostly linked with its role as vitamin, lipotropic and growth factor[4]; its deficiency has also been reported to cause some disturbance in animal reproduction[5]. It is interesting to note that in the boar, in any event, inositol is secreted by the same accessory gland as fructose[7] and citric acid[8]; in this connexion fœtal blood may be mentioned as another example of the simultaneous occurrence of inositol and fructose[9,10]. The distribution of seminal inositol in other species, the place it occupies in sperm metabolism and its relation to the other constituents of semen are under investigation.

This study was carried out on behalf of the Agricultural Research Council. The analyses for carbon and hydrogen are by Drs. Weiler and Strauss. I am indebted for valuable help to Prof. D. Keilin, Dr. D. J. Bell and Mr. R. W. Pomeroy.

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Chromatography of Adrenotropic Hormone on Ion-exchange Columns

During the past year there have been several observations which have indicated that adrenotropic hormone (ACTH), as measured by the ascorbic acid depletion test[1], might be a basic substance. Payne, Raben and Astwood[2] observed that its activity could be adsorbed on powdered cellulose from dilute acetic acid solution and eluted again by 0·1 *N* hydrochloric acid, and these experiments agreed with results from preliminary trials in this laboratory on the behaviour of adrenotropic hormone when subjected to solvent partition (some of these initial experiments were carried out in collaboration with Dr. H. G. Khorana, of the Department of Chemistry, University of Cambridge) and preparative electrophoresis. Astwood, Raben, Payne and Grady[3] have since utilized a single-step adsorption of adrenotropic hormone activity on oxycellulose (10·4 per cent COOH). We have concurrently been exploring its behaviour on columns of 'Amberlite *IRC*-50', which have previously been found to permit effective chromatographic purification of low-molecular weight basic proteins, such as ribonuclease[4] and lysozyme[5].

ACTH 'protein hormone' was prepared from pig pituitaries by the method of Fishman[6], with omission of exposure to strong ammonia. When this protein preparation (activity = approximately 1 × Armour Standard preparation *La*-1-*A*) was chromatographed on the synthetic carboxylic acid resin *IRC*-50 (*XE*-64)[4], the curve given in Fig. 1 was obtained. The results in Fig. 2 were obtained with 'crude corticotropin' (activity = 1–2 × *La*-1-*A*) prepared by the method of Astwood and his colleagues[2]. The position of the active peak on the effluent curve is a function of *p*H. The active material moves rapidly with the main proteins at *p*H 7, the degree of retardation increasing as the *p*H is reduced below 6·6.

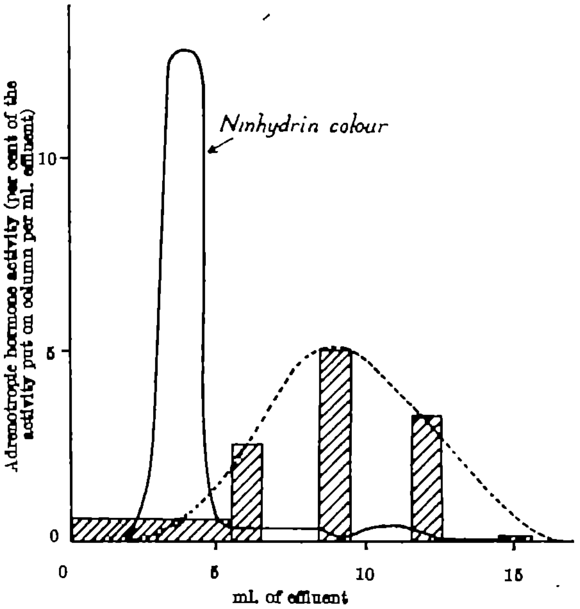

Fig. 1. Chromatography of ACTH 'protein hormone' on 'Amberlite *IRC*-50' with sodium phosphate buffer of *p*H 6·8 (0·2 *M* in phosphate). 10 mgm. of the protein was put on a 1 cm. × 10 cm. column

The results indicate that the active material in preparations of adrenotropic hormone can be satisfactorily chromatographed on ion exchange columns of fair resolving power under the mild conditions of neutral *p*H and room temperature. With the 'protein hormone', 50–100 per cent of the biological activity was recovered in fractions containing less than 5 per cent of the ninhydrin-positive[7] material. It is important to note that the major protein component

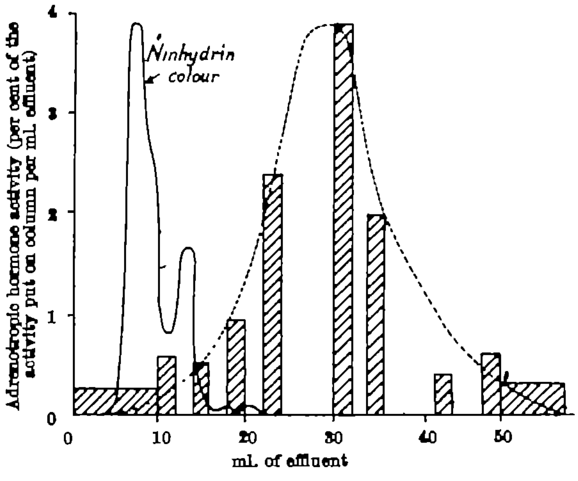

Fig. 2. Chromatography of 'crude corticotropin' (ref. 2) on 'Amberlite *IRC*-50' with sodium phosphate buffer of *p*H 6·65 (± 0·02) (0·2 *M* in phosphate). 100 mgm. of crude corticotropin was extracted with 2·6 ml. of the buffer and 1·6 ml. of the solution put on a 1 cm. × 85 cm. column

is essentially inactive. With 'crude corticotropin', 50–100 per cent of the activity was recovered in fractions which corresponded to 2–5 per cent of the starting solution on a ninhydrin colour basis. Although removal of the sodium phosphates by ion exchange to yield a salt-free powder leads to some loss of activity, we find that the active fractions contain less than 1 per cent of the weight of the starting material, and their potency may be as much as a hundred times that of the starting material. These highly active preparations are unstable in dilute solution even in acid media; but we have found that the addition of 0·2 per cent of phenol together with 0·2–0·5 per cent of the anti-oxidant thiodiglycol ($S(CH_2CH_2OH)_2$) to all solutions, including those used for dilution of samples before bioassay, eliminated the major losses.

The chromatographic results help to clarify our understanding of adrenotropic hormone. In line with the earlier observations[2,3], the evidence indicates that the ascorbic acid – depleting factor is a highly active basic substance, readily separable under non-hydrolytic conditions from the proteins which have been the major constituents of the early preparations of the hormone.

We wish to express our thanks to the Nuffield Foundation for generous support of this research, and to the Armour Laboratories, Ltd., for the gift of standardized preparations. One of us (H. B. F. D.) is grateful to the Medical Research Council of Ireland for a studentship held while much of this research was carried out.

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Effect of Certain Nucleic Acid Constituents on the Growth of Some Higher Fungi

ALTHOUGH the nucleic acid purines are known to be essential growth-factors for several bacteria, they have not been found to produce any positive effect on the growth of fungi, except in four cases, namely, *Phycomyces blakesleeanus*[1], *Lenzites betulina*, *Polyporus abietinus* and *Polyporus annosus*[2]. The last two, where a strong effect of adenine was noted, have now been more thoroughly investigated.

In an earlier study[3], almost optimal growth of these two species had been obtained in a purely synthetic medium with vitamin B_1 as the only growth-factor added, and the fact that the strains responding to adenine had been in culture for fourteen and seven years, respectively, gave rise to the suspicion that their unexpected behaviour was correlated with ageing. New naturally occurring strains reacted, however, in the same way (Table 1), and the reaction seems therefore to be a physiological character of the two species, or at least a character occurring in certain wild strains.

Table 1. GROWTH OF SEVEN SPECIES OF HYMENOMYCETES IN LIQUID CULTURE WITH AND WITHOUT ADENINE

Each culture flask with 25 ml. nutrient solution M3 (see ref. 4) + 1 μgm. vitamin B_1. Average values, ± standard errors, taken from six or eight cultures. Temperature 25° C.

Species and year of isolation	Incubation time (days)	Dry weight of mycelium (mgm. per flask)	
		No further addition	1 mgm. adenine per flask
Polyporus abietinus (1937)	10	2·7 ± 0·2	4·9 ± 0·6
,, ,, ,,	15	18·7 ± 0·3	49·2 ± 5·8
,, ,, ,,	20	47·0 ± 2·9	83·3 ± 9·4
,, ,, (1951)	15	42·2 ± 2·9	60·8 ± 1·8
Polyporus annosus (1944)	15	4·9 ± 0·4	12·5 ± 0·7
,, ,, ,,	20	25·8 ± 2·5	53·7 ± 5·8
,, ,, (1951)	15	2·2 ± 0·1	3·0 ± 0·1
Mycena flavo-alba (1948)	25	1·6 ± 0	12·8 ± 0·3
Mycena rubromarginata (1948)	25	2·4 ± 0·4	13·1 ± 1·6
Mycena metata (1948)	25	15·0 ± 0·8	20·6 ± 1·3
Mycena zephirus (1948)	25	14·2 ± 1·2	21·8 ± 0·9

The effect of adenine was also studied in seventeen other species of wood- and litter-inhabiting Hymenomycetes. A strong positive response was found in some species of *Mycena*, particularly in *M. flavo-alba* and *M. rubromarginata* (Table 1), which in addition are partially tyrosine-deficient[4].

Growth-curves showed that the effect consisted mainly in a shortening of the lag-phase, the mycelial production in the control cultures catching up with the purine series at the end of the experiment (in *Polyporus abietinus* and *P. annosus* after thirty days). The lowest active concentration was found to be c. 100 μgm./litre.

In *M. rubromarginata*, all other purine derivatives tested, except adenosine, were inactive; in *M. flavo-alba*, hypoxanthine, and in the two *Polyporus* species hypoxanthine, guanine and guanosine also produced a growth-promoting effect, although it was somewhat weaker than that due to adenine.

It is suggested that these responses are due to deficiencies in the biosynthesis of purines in the fungi in question. An investigation of a greater number of wood- and litter-inhabiting fungi would probably reveal further cases of purine deficiency. A comparative biochemical study of all these cases may contribute to the picture of the biosynthesis of purines in fungi, which now is based chiefly on investigations

Table 2. EFFECT OF ADENINE AND TRYPTOPHANE ON THE GROWTH OF FOUR SPECIES OF HYMENOMYCETES

Nutrient solution, etc., as in Table 1

Species	Incubation time (days)	Dry weight of mycelium (mgm. per flask)			
		No further addition	1 mgm. adenine per flask	1 mgm. tryptophane per flask	1 mgm. adenine + 1 mgm. tryptophane per flask
Lentinus lepideus	20	57·0 ± 3·2	57·0 ± 2·2	19·9 ± 2·1	44·8 ± 3·4
,, ,,	25	100·0 ± 2·5	—	85·3 ± 5·7	105·5 ± 7·0
Trametes heteromorpha	30	26·4 ± 5·3	20·5 ± 5·2	7·5 ± 0·7	24·8 ± 5·3
Polyporus annosus	15	7·6 ± 0·6	11·8 ± 0·9	3·4 ± 0·5	9·1 ± 0·6
Pemophora fraxinea	15	14·1 ± 3·0	11·1 ± 1·3	9·3 ± 1·3	22·7 ± 2·6

of artificially produced purine-deficient mutants of Ascomycetes.

In this connexion it may be mentioned, however, that in certain circumstances a growth-promoting action can also be obtained in several species, besides those mentioned above. If the amino-acid tryptophane is included in the nutrient solution, the growth of many fungi is inhibited[5], this inhibition in several cases being totally or partially overcome by a simultaneous addition of adenine (Table 2). In *Lentinus lepideus* various concentrations of the two substances were tested. When the ratio of adenine to tryptophane was 0·3, the inhibition was released to the extent of about 50 per cent; when the ratio of these substances was greater than or equal to 1. the inhibition was removed completely. This effect, however, varied to a certain degree with time.

The real nature of this interaction is still obscure. A parallel can perhaps be found in the recent observation of Schopfer[6] that an excess of vitamin K induces a requirement for nicotinic acid (or related substances) in *Phycomyces*. Even if the mechanism of these phenomena should prove to be quite different, they indicate the possibility that an excess production of one metabolite—caused by mutation or by unusual cultural conditions—may be made apparent by the appearance of a requirement for another metabolite.

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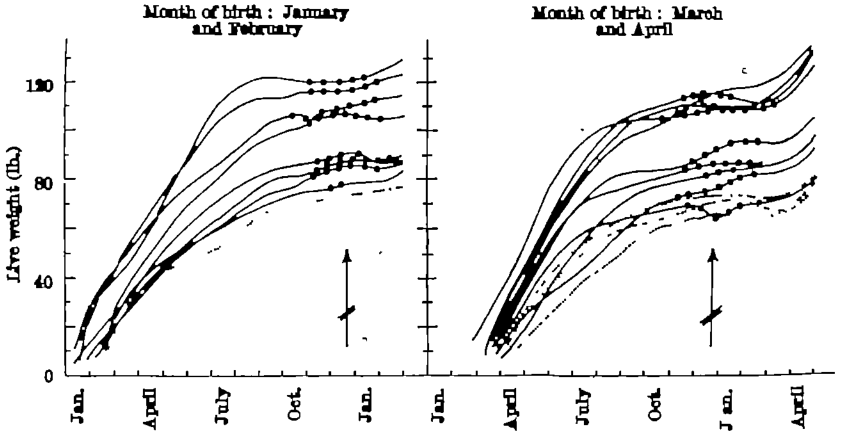
Sexual Season in Ewe Lambs

THE sexual season of ewe lambs lasts only a quarter to a third as long as that of adults[1]. In ewe lambs, sexual activity starts during November and December in Cambridge (N°)[2], while it starts during June in New Zealand (S°)[3]; and consequently the sexual season coincides with the shortest days of the year irrespective of the hemisphere. Their sexual season, which varies with the breed, is not spread evenly about the shortest day as it is with adults[4]. The onset of the sexual season in ewe lambs varies with the month of birth[2,5]; data regarding the cessation or extension of the sexual season are notably lacking.



—●—, Œstrus; —○—, silent heat; . . . . , ewe lambs did not show heats. Shortest day marked by arrow

Œstrous performance in relation to growth-rates in Suffolk ewe lambs

Two groups of grade Suffolk ewe lambs were available, one born in January and February and the other born in March and April. They were weighed regularly from birth and were put after weaning with active vasectomized ram lambs for one year. The ram lambs were ochred, and observations for œstrus were made daily. Results concerning the sexual season of both groups are shown in the accompanying table.

The proportion of ewe lambs which did not show any œstrus during the first autumn was 11 per cent and 20 per cent in early- and late-born lambs respectively. The average date of onset and cessation of the sexual season was 3½ weeks earlier in the early-born ewe lambs than that of the late-born. The average duration of the sexual season was 66 days in both groups. Early-born lambs experienced on an average more heat periods per ewe per season than late-born ones. Silent heat occurred more frequently in the late-born animals, and the number of silent heats expressed to the possible total number of heats was 7 per cent and 14 per cent in early- and late-ewe lambs respectively.

The live weight at the onset of the sexual season (first heat) ranged from 66 to 121 lb. with no significant difference between the two groups. Meanwhile, ewe lambs with retarded growth (both early- and late-born) either did not show œstrus in their first autumn or experienced few œstrous cycles (see diagram). In both groups ewe lambs with higher growth-rates showed more œstrous cycles and fewer silent heats. The growth was checked during the sexual season, this being due not to their attaining sexual maturity but to seasonal variation in the nutritive value of pasture.

It is concluded that œstrous performance in ewe lambs is controlled by a complex factor: the daylight environment and the growth-rate. Maximum sexual activity coincides with the shortest days, presumably the peak period of the activity of the

Month of birth	January and February		March and April	
	Range	Mean ± S.E.	Range	Mean ± S.E.
Date of onset	Oct. 15–Nov. 23	311 ± 6·2*	Oct. 27–Dec. 18	333 ± 5·1*
Date of cessation	Dec. 10–Feb. 6	12 ± 5·8*	Dec. 9–Mar. 12	34 ± 6·3*
No. of heats per ewe lamb per season	0–7	4·2 ± 0·4	0–8	3·6 ± 0·6
No. of silent heats per ewe lamb per season	0–2	0·4 ± 0·1	0–3	0·8 ± 0·2

* The period elapsed from December 31.

pituitary gland. Once the sexual season has started, œstrus is experienced at regular intervals (cycle-length 16·51 ± 0·18 days) provided that the daylight environment is favourable. Ewe lambs which show their first œstrus after the shortest day have consequently the shortest sexual season. It is suggested that, for the manifestation of œstrus in ewe lambs, certain thresholds of live weight, in the same way as the hormonal thresholds, are required. In the Suffolk (see diagram) the thresholds which play a part during the favourable daylight environment are classified as follows: (I) above 100 lb., high œstrous performance (maximum); (II) 75–100 lb., heat periods interspersed by silent heats; (III) less than 75 lb., low œstrous activity or no activity at all (minimum).

This work was financed by the Agricultural Research Council and was carried out in the Animal Research Station, Cambridge, during study leave from Fouad I University, Egypt. Thanks are due to Dr. John Hammond for continuous advice and encouragement.

E. S. E. Hafez

School of Agriculture,
University of Cambridge.
June 28.

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[1] Hafez, E. S. E., *Nature*, 166, 822 (1950).

[2] Hammond, jun., J., *J. Agric. Sci.*, 34, 97 (1944).

[3] Walker, D. E., "The Breeding Season, Œstrus and the Œstrous Cycle in the New Zealand Ewes", Univ. of N. Zealand thesis for M.Sc. degree (1943).

[4] Hafez, E. S. E., *J. Agric. Sci.* (in preparation).

[5] Watson, R. H. (personal communication, 1950).

A New Platyctenid Ctenophore from Jamaica

Platyctenid Ctenophores have now been discovered along the shores of Jamaica. This is the first record of these interesting forms from the West Indies, although related forms have been recorded from the coast of Florida[1].

In May 1950 five transparent, colourless Platyctenids were noticed adhering to the sides of a tank containing the black solitary tunicate, *Ascidia nigra* Savigny, which had been collected from mangroves on the previous day. Similar Ctenophores were afterwards found in the natural habitat actually creeping on these ascidians, presumably as commensals.

In the following July, more than a hundred specimens were found on the cœnosarcs of Dynamenid hydroids from the same locality. These forms were pale pink or pale green in colour, but appeared to have the same basic structure. All these specimens closely resembled the genus *Cœloplana*, but also showed certain extremely interesting and well-marked features which are indicative of at least a new species and possibly of a new genus. Two of these features may be mentioned here, namely, (1) the presence of oral grooves with well-marked edges which curve round to end on the aboral surface in continuity with the openings of the tentacular sheaths, and (2) the presence of marked oral lappets which become produced laterally as the edges of the oral grooves.

A full description of the distinctive characteristics, habits and microscopical anatomy of these new Platyctenids is in the course of preparation and will be published shortly.

Jessie J. Rankin

Department of Zoology,
University College of the West Indies,
Mona, St. Andrew,
Jamaica, B.W.I.
July 2.

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[1] Smith, F. G. Walton, *Science*, 101, 17 (1945).

History of Science and Technology in India and South-East Asia

Dr. Joseph Needham has very ably reviewed in *Nature* of July 14, p. 64, the series of papers that were read at the symposium on the "History of Sciences in South Asia", and has drawn some pertinent conclusions therefrom. He has, however, not been able to gauge the spirit in which the symposium was held, or expatiate on the new lights that were thrown on the subject. He has, on the other hand, omitted to mention certain salient facts about the organization of the symposium, and the review gives by omission the erroneous impression that it was solely the work of the Unesco Science Co-operation Office for South Asia. As chairman of the symposium, and now president of the National Institute of Sciences of India, I wish to put on record the part played by the National Institute in the symposium.

The idea of holding a symposium on the history of sciences in South Asia was first mooted by Dr. D. S. Kothari, one of the secretaries of the Institute, which received the support and co-operation of the Unesco Science Co-operation Office in Delhi. Accordingly, the symposium was held under the auspices of the National Institute of Sciences of India, in collaboration with the Unesco Science Co-operation Office, in Delhi, during November 5–7, 1950. Facilities for holding the meetings and accommodation for the visiting delegates were generously provided by the University of Delhi. A number of scientific men, historians and oriental scholars from India and abroad attended the symposium and took part in its deliberations. From the mimeographed copies of the papers that had been circulated in advance, it was clear at the very outset that considerable controversy was bound to arise about the dating of the most important texts, and to overcome this difficulty a Chronology Committee, consisting of historians and scientific men, was appointed at the business meeting prior to the symposium. This Committee felt that it was very difficult to ascertain with accuracy the dates of Indian literary works supposed to belong to the pre-Christian era. But after discussing the matter at length, it recommended that the chronological table given below might be taken as a working hypothesis in connexion with the discussion of papers of the symposium. The table is based on the standard work "History of Indian Literature" by Winternitz.

The authors of papers were then asked to revise their papers according to the dates given in the table for various texts. Owing to very divergent views, however, it was not intended to have all the papers published in full. In reviewing that motley of papers, which were not authorized for publication, and stating that mimeographed copies are available at the Unesco Science Co-operation Office in Delhi, Dr. Needham has unwittingly done an

CHRONOLOGICAL TABLE

Age of the Rigveda	2000 B.C. to 1500 B.C.
Age of Samhitas and Brahmanas	1500 B.C. to 800 B.C.
Age of old Upanishads	900 B.C. to 599 B.C.
Charaka	A.D. 100
Charaka Samhita—kernel of	A.D. 100, but enlarged in later times
Susruta Samhita	A.D. 200 to A.D. 500
Vedanga Jyotisha—present text	500 B.C.
Sulbha Sutras	500 B.C. and later
Dharmasutra	600 B.C. to 200 B.C.
Mahabharata Manusmriti Ramayana	200 B.C. to A.D. 200

injustice to the National Institute of Sciences of India and to the organizers of the symposium. A summary of the proceedings of the symposium is in preparation for publication by the Institute.

The great difficulty with which a scientific worker is faced in a study of the history of science in India lies in the fact that the available ancient materials and documents are written either in Pali or Sanskrit languages, with which he is generally not familiar. He has, therefore, to depend upon oriental scholars for interpretations and commentaries of texts for dating ancient literature. There is, however, a lack of scientific knowledge among historians and orientalists, and this makes it difficult for them to appreciate and evaluate the scientific thought of ancient India. In the case of fixing the dates of various texts, there is no unanimity among historians. Hence the participants in the symposium came to a decision that in future scientific workers dealing with the history of science in India should give original texts, and the names of the source books for reference by the historians and orientalists.

The scientific men in India, as elsewhere, are well qualified by experience to sift and analyse their data before arriving at any definite conclusions. For example, my own contributions on fishery legislation, based on "Arthasastra" and the Asoka Pillar Edict, were read by many eminent oriental scholars, who have expressed agreement with the interpretations suggested by me. Nevertheless, whenever a 'conservative view on any matter is challenged, adverse comments are likely to result. It is therefore the duty of the scientific workers to make a correct approach to and appraisal of the scientific knowledge of ancient India, notwithstanding prejudices that may exist already about the history of India's cultural heritage and scientific thought. "The study of the history of science in India," as remarked by Dr. Needham, "remains enthralling."

S. L. HORA
(President)

National Institute of Sciences of India,
Mathura Road,
New Delhi 1.
Oct. 5.

I HAVE read Dr. Hora's communication with interest and sympathy. It was a great disappointment to me that I was not able to accept the invitation to participate personally in the Conference, but after the publication of my review in *Nature* I became aware of the work of the Chronology Committee through the report published by Dr. Hora at the conclusion of Dr. Wolsky's review in *Archives Internationales d'Histoire des Sciences*, 4, 579 (1951), and I was pleased to find so much concordance of view. My chief object in acceding to the request of the Editors of *Nature* that I should review the conference papers sent to them, which neither the Editors nor I knew were in any sense unauthorized, was to encourage interest in the history of Indian contributions to science.

JOSEPH NEEDHAM

Physics of Social Equilibrium

IN his review of my paper of this title, read to Section A (Physics) of the British Association at Edinburgh, Prof. T. S. Simey raises certain criticisms which, I think, are mainly due to some misunderstandings. As my paper has so far not appeared in print, I wish to set out briefly the main points of my argument.

In theoretical physics use is made of simplified models for representing groups of phenomena. The limitations of such models are clearly understood, and their purpose is to facilitate the understanding of observed facts and to provide a heuristic principle for the discovery of new relationships. It seems quite legitimate to use physical models for the representation of non-physical phenomena, for example, of social phenomena, for this express purpose.

I pointed out the inadequacy of two such models which are frequently used. The first represents a human society by a mechanical system which is subject to the classical laws of dynamics, like a mechanical machine. The second model regards such a society as a 'loose statistical assembly' with practically no interaction between its members, like the assemblies of particles which in the kinetic theory of gases represent a rarefied material substance, and assumes that the social phenomena are ruled by the statistical laws of games of chance which can be derived from the probability calculus under the condition of mutual independence of the individual events.

I suggested the use of a more adequate model incorporating both the causal and the chance aspects of the phenomena involved, namely, a so-called 'close assembly' of particles with strong mutual interaction, like a liquid or a solid. The physical behaviour of such a model is governed by the laws of statistical mechanics, and its characteristic feature is that the individual fate of a member of the assembly is neither strictly determined, as in the first of the rejected models, nor strictly undetermined, as in the second one; the probabilities for the various possible events in the future are not fixed, but depend on the present state of the whole assembly. This gives rise to the so-called 'co-operative phenomena' in physics which are characteristic of dense material substances. I discussed a few examples of such co-operative phenomena, like ferromagnetism, phase transitions in crystals and strength of solids, and directed attention to the striking similarity between these and certain social phenomena. I therefore pleaded for the use of this sort of model as a heuristic principle for the guiding and shaping of human societies.

I thought I had made it perfectly clear that I neither intended to get to "an understanding of the very purpose of human life", nor to discredit the application of statistical methods in sociology. I only criticized some inadequate physical models of society and proposed a less inadequate one the very essence of which is its statistical nature. It was the indiscriminate application of the calculus of probability, as used in the statistics of games of chance, which I argued against, and I cannot see that by doing so I have "over-stated my case".

The analogy I drew between the behaviour of human societies and close physical assemblies, like crystals (not, as Prof. Simey writes, "communities of crystals"), was meant solely to demonstrate that the co-operative phenomena working in both these cases are of a similar nature. For the fundamental assumption made is only that a strong 'interaction' of some sort or another is taking place; whether this interaction is of a conscious or an unconscious nature is not essential for the characteristic features of a co-operative phenomenon.

If the proposed model is indeed a reasonable representation of human society, various measures, introduced in the past for strengthening social communities, appear to be founded on unsound principles and are bound to produce the opposite effect. It was in this connexion that I mentioned the political stability of the United Kingdom; but I never intended more than to make a very modest contribution towards the understanding of this stability.

I quite agree with Prof. Simey that the value of statistical mechanics for the social sciences will have to be established by extensive experiments, although I am not sure whether such communities as a factory working group or a housing estate are sufficiently large assemblies to justify the proper use of the theory of co-operative phenomena. I should be quite satisfied if my paper induces social scientists to undertake such experiments.

R. FÜRTH

Birkbeck College,
University of London.

I AM much reassured by what Dr. Fürth has said, since he has made it clear that his intention was to object to the 'indiscriminate' application of statistical methods to social problems, rather than to suggest that the use of those methods was necessarily misleading. I do not, in fact, see much evidence of misuse of statistics in this way by my academic colleagues; but I agree that less-sophisticated people are often led into errors of this kind, and it is useful to point it out.

Dr. Fürth has performed a valuable service in directing attention to a mathematical 'model' which has not so far been made use of in the interpretation of social phenomena. But I can only reassert my view that it would be a retrograde step if we were to allow ourselves to argue by analogy, and to conclude as a result that "various methods, introduced in the past for strengthening social communities, appear to be founded on unsound principles and are bound to produce the contrary effect".

The value of these suggestions needs to be tested by experiment and observation; but the possibility of doing so appears to be somewhat remote when doubt is cast on the value of using the working population of a factory or the inhabitants of a housing estate as the material of an experiment, on the ground that their numbers are not sufficiently large. Dr. Fürth must tell us more about the minimum numbers which would be significant for this purpose, and throw more light on the methods which might be used to achieve it.

T. S. SIMEY

Department of Social Science,
University of Liverpool.

Non-adaptive or Neutral Characters in Evolution

SEWALL WRIGHT[1] has shown that, given certain ecological conditions, drift will occur and produce an apparently random pattern of variation. Some authors have thereupon employed genetic drift, in the same way as adaptive neutrality was formerly employed, to explain every example of variation which in their opinion is random. This procedure is wrong. They have not proved drift to be acting, but have failed to prove that selection is acting, and have invoked drift to cover the failure. An explanation which depends for its success on the failure of the investigator cannot be regarded as satisfactory.

I do not claim, as Carter[2] states, that we must now accept that there is no evolution of non-adaptive—or neutral—characters in Nature. Such a claim would be as difficult to maintain as the claim that genetic drift is common and important. Probably drift does occur, to some extent. But every example of it so far adduced either rests on the logical fallacy pointed out above and in a previous communication[3], or remains uninvestigated, or has been disproved on further investigation. The more the interactions between genes and their environments are studied, the less likely does it become that genes controlling definite characters can possess, except perhaps for very short periods, the very low selective coefficients necessary for extensive drift.

It seems, therefore, that in view of the complexity of living systems and their environments, the investigator should be cautious and not use drift or selective neutrality as an explanation for all unanalysed cases. As Carter[2] points out, what is wanted is more investigation; but it is doubtful whether any example of variation in Nature can be so completely analysed that, after selective effects have been estimated, the residual variation can be ascribed with confidence to genetic drift. There is always the possibility, indeed the likelihood, that the analysis of selective effects was not complete.

A. J. CAIN

Department of Zoology and
Comparative Anatomy,
University of Oxford.

[1] Wright, S., *Genetics*, 16, 97 (1931); "The New Systematics", 161 (London, 1940); *Evolution*, 2, 279 (1948).

[2] Carter, G. S., *Nature*, 168, 700 (1951).

[3] Cain, A. J., *Nature*, 168, 424 (1951).

I AM glad that Cain admits that genetic drift may be a real factor in evolution, even though he may not be willing to admit that its effect is significant. Since I have not wished to express an opinion on the relative importance of selection and drift, it seems that the only point at issue between us is that I do not accept the present evidence as being so strongly against drift that we should not, when dealing with some types of evolutionary change—especially trivial changes in micro-evolution—regard it and selection as equally possible explanations when neither is proved. If we do so regard them, it seems as much a fallacy to assume selection alone where there is no disproof of drift, as to assume drift wherever there is no proof of selection. If in any case analysis of selective effects is incomplete, this fact cannot be used as evidence against drift as the efficient cause.

G. S. CARTER

Zoological Laboratory,
University, Cambridge.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, December 17

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. E. C. Cherry : "What Practical Benefits can Communication Engineers expect from the Modern Information Theory ?"

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Rt. Hon. the Earl of Verulam, Mr. J. Houston Angus and Mr. Stephen Chaplin : "Geography of Power".

Tuesday, December 18

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Dr. D. L. Gunn : "The Red Locust".

Institute of Fuel (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. J. W. R. Rayner : "Gasification by the Moving-Burden Technique".*

Tuesday, December 18—Wednesday, December 19

Association of University Teachers (in the Eugenics Theatre, University College, Gower Street, London, W.C.1).

Physical Society (in the Physics Department, University College, Southampton).—Autumn Provincial Meeting.

Tuesday, December 18

At 2 p.m.—1st Session. "Optics of Metals".

Wednesday, December 19

At 9.30 a.m.—2nd Session : "Thermal Properties and Growth of Crystals", at 2 p.m.—3rd Session : "Complex Spectra and Nuclear Structure".

Wednesday, December 19

Society of Chemical Industry, London Section (joint meeting with the London and South-Eastern Counties Section of the Royal Institute of Chemistry, at the Waldorf Hotel, Aldwych, London, W.C.2), at 4 p.m.—Symposium on "Radio-chemistry" (Speakers. Sir John Cockcroft, F.R.S., Dr. J. E. Johnson and Mr. J. Smith).

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Scientific Papers.

Institution of Electrical Engineers, Supply Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. W. R. Stoker and Mr. C. N. Thompson : "Inhibited Transformer Oil" ; Mr. P. W. L. Gosling and Mr. L. H. Welch : "The Stability of Oil in Transformers".

Manchester Literary and Philosophical Society, Social Philosophy Section (at the Portico Library, Mosley Street, Manchester), at 5.30 p.m.—Lady Simon of Wythenshawe : "Leadership—Can We Educate for It ?"

Royal Microscopical Society (in the Department of Human Anatomy, Oxford), at 5.30 p.m.—Dr. R. Barer : "A Vector Theory of Phase-Contrast and Interference-Contrast".

Thursday, December 20

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. H. D. Ursell : "Prime Ends".

Royal Aeronautical Society (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Mr. H. G. Broadbent and Mr. W. T. Kirkby : "Control Surface Flutter".

British Institute of Radiology (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8 p.m.—Contributions on "The Diagnostic Use of P32 in Neurosurgery" (Speakers : Mr. T. P. Morley and Dr. C. W. Gilbert).

Friday, December 21

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Lieut.-Comdr. P. G. Satow : "Meteorology and Navigation".

British Institute of Radiology (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 6.30 p.m.—Dr. W. K. Sinclair : "The Use of P32 incorporated in a Plastic for Superficial Beta Therapy" ; Mr. H. F. Freundlich : "The Use of Fission Products in Surface Applicators".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned :

Senior Lecturer in Physics at the Frontier College for Women, Peshawar—The High Commissioner for Pakistan, 35 Lowndes Square, London, S.W.1 (December 20).

Principal Biochemist in the Clinical Laboratories—The House Governor, London Hospital, Whitechapel, London, E.1 (December 21).

Biochemist for full-time research on fundamental problems related to the nervous system, at the Neuro-Psychiatric Research Centre, Whitchurch Hospital—The Secretary, Welsh Regional Hospital Board, Temple of Peace and Health, Cathays Park, Cardiff (December 22).

Junior Chemists (with Inter.B.Sc., or equivalent) in the Central Laboratory, Chiswick—The Staff Officer (F/EV/197), London Transport, 55 Broadway, London, S.W.1 (December 22).

Principal of the Technical Institute—The Director of Education, Town Hall, Wallasey (December 22).

Scientist, Grade I, or Senior Scientist (with high academic scientific qualifications ; sound all-round knowledge of fuel technology and some research experience are desirable) as Chief Coal Survey Officer in the Scottish Division—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/403 (December 22).

Scientist, Grade II (with an honours degree in science, or the equivalent, and several years industrial experience) in the No. 2 (Wigan) Area Laboratory at Ince Moss Colliery, Wigan ; a Scientist, Grade II (with an honours degree in science, or the equivalent, and several years industrial experience) in the No. 4 (Burnley) Area Laboratory at Altham Coke Works, Altham, Accrington ; and a Scientist, Grade III (graduate with a first- or second-class honours degree in chemistry) at the Central Laboratory, Shade House, Swinton—The Divisional Establishment Officer, National Coal Board, North-Western Division, 40 Portland Street, Manchester 1 (December 22).

Assistant (Grade A) in Chemistry, to teach organic or inorganic chemistry to an advanced level, and general chemistry to intermediate level—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex.

Assistant Executive Engineer in the Public Works Department, Sarawak—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/113.

Chemist (with some experience in research) for training in methods of dyeing research—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

Chemists and Metallurgists (Scientific Officer grade) at a Ministry of Supply research establishment in Berkshire : Physical Metallurgist (Ref. F.886/51A) with sound knowledge of modern metallurgical theory ; experience in metallography or in the determination of thermal and physical properties essential, and a Physical or Inorganic Chemist (Ref. F. 887/51A) preferably with some experience of radioactive chemistry—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

Curator (with an honours degree in archæology with some anthropological training) in the Department of Museums, Malaya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27410/1/51. Appts.

Electronic Engineer or Physicist by the Division of Atomic Energy (Production), to take charge of a group concerned with the maintenance and modification of electronic instruments at Windscale Works, Sellafield, Cumberland—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 279

Graduate Assistant in the Biochemical Department—The Secretary, Hospital Management Committee, Dudley Road Hospital, Birmingham 18.

Head of the Department of Chemical Technology, Indian Institute of Science, Bangalore—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting A.12/1/31 B.

Health Physics and Safety Group Manager (with either an honours degree in physics or chemistry, associateship of the R.I.C. or the Institute of Physics, or equivalent qualifications) at Windscale Works, Sellafield, Cumberland—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting No. 269.

Lecturer (medically qualified, with some experience of physiological teaching and research) in Physiology—Prof. D. S. Torrens, School of Physic, Trinity College, Dublin.

Lecturer in Mechanical Engineering, to teach applied mechanics, strength and properties of materials, and some thermodynamics—The Principal, Technical College, Darnley Road, Gravesend, Kent.

Lecturer in Physiology and Pharmacology—The Registrar, College of Technology, Bristol 1.

Lecturer in Rubber Chemistry—The Clerk, National College of Rubber Technology, Northern Polytechnic, Holloway, London, N.7.

Officer-in-Charge of Camden Park Experimental Station (Agricultural), Windward Islands—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting *Nature* and M.23443.G.

Physicist (with electronic experience) for basic research on ultrasonics—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

Principal Scientific Officer—Physicist (Ref. A. 367/51A) to work on the improvement of existing techniques and investigation of new methods of photographic recording of experiments, including the use of long-focus lenses, and of colour photography ; and a Senior Scientific Officer—Electrical Engineer or Physicist (Ref. A.368/51A) for experimental work in the development of magnetic recorders and associated electronic circuits, in the Instrumentation Department of the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

Research Assistants (with relevant academic qualification, and practical experience in either mechanical engineering design or research, or in electronics and instrumentation) for work covering a wide field of hydraulic engineering—The Director, British Hydromechanics Research Association, Harlow, Essex.

Science Graduates : (*a*) a Physical Chemist to develop methods of test in the field of adhesives, and (*b*) a Chemist for laboratory dealing with day-to-day production problems arising in the industry—The Printing, Packaging and Allied Trades Research Association, Patra House, Randalls Road, Leatherhead, Surrey.

Senior Scientific Officer or Scientific Officer (with a first- or second-class honours degree in chemistry, metallurgy or physics, or equivalent qualification, at least three years' post-graduate research experience, and a good knowledge of German or Russian) in the Information Section at the Atomic Energy Research Establishment, Harwell—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting F.897/51A.

the vitality of free institutions and on the strengthening and fostering of all that makes for positive achievement.

What matters is that the lessons to be learnt from the experience in the United States described so vividly by Mr. Barth should be applied to prevent like mistakes in Great Britain and elsewhere. The recent episode of the withdrawal of the passport of Dr. E. H. S. Burhop, a lecturer in the University of London, suggests that necessary regulations in Britain are neither always framed with imagination and understanding of the real issues nor invariably interpreted with common sense and administered with courtesy. The case was parallel with the obtuseness to human issues which is one of the worst features of American loyalty investigations. There may well be room, as Dr. Burhop reasonably suggested, for some further investigation of the question of travel rights, and the bearing of such rights on scientific work might engage the attention of the Society for Freedom in Science.

Too great caution cannot be observed in regard to any such infringement of academic freedom or of the civil liberties of scientific workers. Recently some attention has been directed to a position which has developed in Australia, apparently in consequence of a similar dependence upon the State or upon private benefactors for support of the universities to that of American colleges and universities noted by Mr. Barth. The Vice-Chancellor of the University of Adelaide, Dr. A. P. Rowe, has pointed out that the statute barring professors (and only professors) from becoming members of Parliament or members of political associations is as old as the University itself; knowledge of its existence came as a surprise to him and most of his colleagues, and it appears to be in desuetude. The Registrar of the University of Western Australia has stated that a corresponding clause in that University's general regulations, which applied also to lecturers, was dropped last year. Dr. Rowe himself believes that the Council of the University of Adelaide would be willing to remove the statute in question if any feeling on the matter existed among the staff.

Adelaide and Melbourne are the only two out of Australia's eight universities whose statutes include such a clause, although the University of Sydney requires a professor to resign on being elected to Parliament, and a clause requiring resignation on election to Parliament is being included in the contracts of all members of its academic staff by the new Australian National University at Canberra. The statute in the constitution of the University of Melbourne was enacted in 1859 in the face of vigorous opposition by the professorial staff, and the clause was presumably copied into the statutes of the University of Adelaide when that University was founded in 1874. The matter was brought to notice by Prof. J. B. Cragg's recent withdrawal of his acceptance of his appointment to the chair of zoology at Adelaide. That Prof. Cragg is right in holding this statute to be a serious infringement of the rights of the individual is sufficiently demonstrated by the reported statement of the Vice-Chancellor of the University of Melbourne, that the restriction is necessary for a university largely dependent on the State, and that for an independent university it would be entirely different. It is not suggested that the clause has hitherto been administered illiberally, and Prof. Cragg was prepared to state that he would resign his professorship if elected to Parliament. Nevertheless, in unscrupulous hands the restraint, particularly against membership of a political association, could be used to do much damage to academic freedom; and misgivings regarding operation of the clause will be encouraged by the disclosure that the Council of the University of Melbourne is considering new rules to control political discussion.

This is, of course, primarily an Australian matter and has already provoked outspoken comment in the *Melbourne Argus* and protests by students. It is well, however, that it should be known that there is no sympathy in Great Britain for such inroads into academic freedom. As the Vice-Chancellor of the University of Melbourne has revealed, what is involved is a general attitude of mind, and it is against this rather than one particular statute that Prof. Cragg made his stand. It is wrong to deny to a professor the ordinary rights of a citizen, and university authorities betray the traditions of scholarship when they fail to recognize the differences between a professor pronouncing *ex cathedra* on his own subject and the same professor deciding to support one political party rather than another outside the walls of his university.

Beyond this, it is plain that some politicians and business men in Australia are attempting to enforce orthodoxy and eliminate thoughts they regard as dangerous by withholding university funds. No true university can tolerate such interference without losing its soul. It is to be hoped that university teachers in Australia will show something of the turbulence of the old medieval universities when academic privileges and rights were invaded. If they do, they can be assured of the firm support of their colleagues elsewhere in the Commonwealth; scientific men and technologists, who to-day are rightly held as particularly responsible for maintaining the freedom of the studium or campus against outside interference, have already shown by their concern over the new status of the Australian Commonwealth Organization for Scientific and Industrial Research an appreciation of the importance for full freedom for scientific advance.

A CLASSIC IN PHYSICS REVISED

A History of the Theories of Aether and Electricity
The Classical Theories. By Sir Edmund Whittaker. Revised and enlarged edition. Pp. xiv+434. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1951.) 32s. 6d. net.

THIS is a revised edition of the well-known book published in 1910 under the title "A History of the Theories of Æther and Electricity from the Age of Descartes to the Close of the Nineteenth Century". The only reason the earlier book is not even better known to the present generation of scientific workers than it is, is that it has been out of print for so many years. Indeed, many of the present generation who recognize its author as one of the very foremost of living mathematicians and almost certainly the most versatile, and also as one who in recent years has earned an additional reputation as an authority upon the philosophy of physical science, may scarcely realize that he had so long ago established himself also as the leading historian of the theories here considered.

These are the theories that, historically, led to the development of relativity and quantum theory during the present century. It has been no secret that Sir Edmund Whittaker has for many years contemplated not only a revision of his earlier book but also a second volume dealing with these subsequent developments. His retirement from the chair at Edinburgh and the consequent leisure required for this formidable undertaking were delayed by the Second World War. Also, most will appreciate that the 'leisure' of retirement in post-war conditions is far from being of the sort to which he must have looked forward. Rarely can a self-imposed obligation have been more resolutely pursued and eventually so faithfully fulfilled. It is assuredly a very rare event for the author of a major work himself to prepare a revision forty-one years after its original publication.

Sir Edmund states, "The volume of 1910 has been to a considerable extent re-written, with the incorporation of much additional material". The re-writing is most extensive in Chapter 1, in Chapter 12 on "Classical Radiation-Theory", which is entirely new, and in Chapter 13, which corresponds to the original Chapter 12. This last now includes, for example, an account of Whittaker's own demonstration in 1904 that a general electromagnetic field may be described by two scalar-potentials instead of a scalar- and a vector-potential, and a fuller account than before of the Zeeman effect, while it omits the previously given introduction to special relativity, which is now naturally deferred to the second volume. Elsewhere, the text of the earlier book is largely preserved, though with the insertion of fresh paragraphs and footnotes. The fact that, besides mentioning other works that have appeared since 1910, these contain many new references to original sources—thus considerably lengthening the already awe-inspiring earlier "Index of Authors Cited"—demonstrates the thoroughness with which Sir Edmund has reviewed all that he had previously written.

As is very well known, it was not until the work of Maxwell and his immediate successors in the second half of the nineteenth century that the electromagnetic nature of light came to be established. But if, anticipating this development, the theory of radiation is included, the history of the theories of æther and electricity can be given in a coherent and adequately self-contained fashion. This is what Sir Edmund does. It is, of course, the story of fundamental physical science, and it could easily expand itself into the whole history of physical science. But he is brilliantly successful in keeping the emphasis upon his main themes, while at the same time making the reader aware of important concurrent developments bearing upon them or affected by them.

Descartes "was the first to bring the æther into science", and the book effectively begins with the exposition of his ideas and then, in the first chapter, reviews the theory of the æther up to and including Newton's concepts and his work on light. The next two chapters trace the history of electricity and magnetism up to Green's introduction of the electrostatic and magnetostatic potentials and to Ohm's work on electric currents. Then the history of the æther is taken up again in a chapter on the period from Bradley to Fresnel, and another on theories of the æther as an elastic solid. The history of electricity and magnetism is resumed in a chapter devoted principally to the discoveries of Faraday, followed by three (with one on "Models of the Æther" interposed) mainly about the mathematical developments leading up to the work of Maxwell, about that work itself, and about the work of his followers. The experimental work after Faraday up to Thomson's discovery of the electron is then described. Chapter 12, already mentioned, is effectively a description of the empirical work on spectral series and the empirical and theoretical work on black-body radiation that later led to the discovery of quantum phenomena. The final chapter centres round the Lorentz electron-theory of optical phenomena and of electric and thermal conduction.

Besides giving a clear statement of the experimental discoveries, upon which the theories were founded, and a most penetrating account of the physical concepts employed, Sir Edmund in his book actually re-derives in outline the mathematics of these theories. Thereby he not only provides a much more precise account than would otherwise have been possible, but also he is able to display the general forward march of the achievements far more clearly and to demonstrate the relations between various contributions far more concisely. In this way, too, he succeeds in showing the importance of work such as Weber's, which played an essential part in the historical development without itself remaining as a permanent feature of accepted theory.

Sir Edmund Whittaker has recorded a monumental amount of scholarly information. But what he has above all succeeded in doing, possibly more than any other historian of science, is to impart a comprehensive and authentic impression of that wherein the great pioneers were truly great. He enables us to see their work, with its lack of precedents, against the background of strangely assorted experimental data and of contemporary conflicting general physical concepts, and to see how they yet contributed each his share to what we are bound to recognize as permanent progress. No better factual account exists to show how hardly won that progress has been.

W. H. McCrea

GENETICS AND ANTHROPOLOGY

Genetics and the Races of Man

An Introduction to Modern Physical Anthropology. By Prof. William C. Boyd. Pp. xvii+453. (Oxford: Blackwell Scientific Publications, Ltd., 1950.) 30s. net.

In the present state of development of physical anthropology, this book must be accounted of particular interest. It is not the guide to the whole field of modern physical anthropology which the subtitle may suggest; nevertheless, it provides a thoroughgoing introduction to that large section of the subject which at the present time is undergoing rapid progress, that is to say, the analysis, through genetics, of human diversification, evolutionary and racial. The book fully justifies Prof. W. C. Boyd in his claim that human genetics has advanced to the point where it has rendered totally inadequate the hitherto accepted classification by superficial phenotypic or 'morphological' criteria, an approach which for the most part leaves unspecifiable the degree of innate relationship between human groups.

This exposition by Prof. Boyd will do much to ensure henceforth the primacy in racial anthropology of genetic method. For this approach provides, through the enumeration of the frequency of identifiable genes in different populations, an entirely objective assessment of genetic relationship. Moreover, it allows some insight into the likely mechanisms at work in human differentiation, taking into account the operation of such factors as population size, systems of mating, isolation and selection. Thus the origins of modern racial groups, the rate and extent of admixture, and the significance of 'clineal' and other modes of geographical distribution can all be understood as dynamic and historical processes. By the older method, despite statistical refinement, the analysis of these phenomena cannot rise above the descriptive level. The basis of these new advances lies, of course, in the comparatively recent discovery of new blood-group systems, the elucidation of their hereditary mechanism, and the application of the evolutionary principles formulated by Haldane, Fisher, Wright and Huxley. All these topics, both in their genetic and mathematical aspects, are dealt with satisfyingly by Prof. Boyd. Some readers, however, may find the chapter on the elements of genetics too skimped; there is, for example, insufficient discussion of multiple factor inheritance.

Prof. Boyd has found it possible to demarcate six human groups as racial or sub-specific entities on a strictly genetic basis without reference to any of the older criteria such as hair shape or skin colour. This alone shows that a complete re-orientation in physical anthropology has been effected. But is Prof. Boyd doing the subject a service in the castigation he metes out to some of the older workers who have been somewhat slow to appreciate that their concepts are becoming outmoded ? Much of his criticism seems unnecessary in order to establish the scientific superiority of the genetic approach. The new reader in this introduction is likely to obtain a distorted impression of past work in racial physical anthropology. He will certainly fail to appreciate, for example, the great contribution represented by the statistical biometry of the Pearson School, even if one admits the weaknesses to which Prof. Boyd directs attention. It is only fair, also, to insist that in the past reasonably good use was made of the only information which human genetics could offer until quite recently, namely, that derived from the *ABO* blood-group system. Prof. Boyd does not really make it plain enough that, while data using identifiable genes such as the blood-group genes have become a *sine qua non* of anthropological field-work, there are many good reasons why information on other characters of imperfectly known or even unknown genetic constitution should continue to be collected. The hereditary basis of some of these is bound in time to be clarified, as has happened recently to some extent in the case of a polygenetic feature such as body build. In any event there are many other legitimate uses in anthropology to which such data can be put.

This lack of perspective is a blemish in an otherwise excellent book. It invites the further comment that Prof. Boyd, like some of those he severely criticizes, does not quite avoid a tendency which should be guarded against in physical anthropology—the undue preoccupation with racial classification as such, which carries with it the danger of making taxonomy an ultimate aim of the subject. There are signs that physical anthropology to-day is slowly freeing itself from this long-standing obsession and is taking as its task the whole biology of man in its social and natural context. Racial and genetic constitution is a very important aspect, but yet only a part, of the variability and adaptability which, in relation to the activity and efficiency of human groups, it is the task of physical anthropology to elucidate.

J. S. Weiner

EDUCATION FOR MARRIAGE

Marriage

A Book for the Married and the About to be Married. By Kenneth Walker. (Published for the British Social Biology Council.) Pp. xii+136. (London: Secker and Warburg, Ltd., 1951.) 8*s*. 6*d*. net.

THE author, who is a distinguished genito-urinary surgeon and is also well known for contributions of a more philosophical kind to the field of biology, has taken the model of a guidebook for those about to be married and has transformed it into something much more rich and interesting. Prejudices on the subject of human sexual behaviour are so strong that it must be the greatest temptation to avoid controversial issues when writing a book meant to be read by all and sundry. Mr. Walker evades none of the difficult points, deals with them with frankness and courage, and does not gloss over his personal views, however unconventional he may feel them to be. When discussing pre-marital continence, for example, he points out that in Western societies the average age at marriage has been steadily pushed back until it is now about thirty. "This means that for at least a dozen years young people are compelled to suppress an instinct which is only second in intensity to that of self-preservation."

No reversal of this tendency to postponement can be expected. Every individual must find his own answer to the problem he is set in this way. It is one thing to be restrained from pre-marital sexual relations by genuine convictions; but quite another to be held back by mere fears, fears of women and sexuality in general, fear of scandal, fear of being found incompetent, fear of going too far. "It is these youths, outwardly continent and inwardly unchaste, who are likely to develop a neurosis in the course of their struggles."

The author points out that in his treatment of this and other difficult topics in the course of the book he does not speak for its sponsors, the British Social Biology Council, but for himself alone.

From the first chapter, on marriage and the family, including their biological and social justifications, to the last, the wider aspects of the theme are tackled with vigour and from a strongly personal point of view. The result is a book which is marked by the personality of the author, is stimulating and refreshing to read, and will surely compel the intelligent reader to do some thinking on his own account. The more purely factual matter—the anatomical and physiological discussion of sexual function—is, of course, expert and accurate. On territory which is factually less safe, there will certainly be readers who will be provoked to differences of opinion, not only on religious but also on anthropological and sociological grounds.

Eliot Slater

Remington's Practice of Pharmacy

A Treatise on the Preparing, Standardizing and Dispensing of Official, Unofficial and Extemporaneous Pharmaceutical Products, with Descriptions of Medicinal Substances, their Properties, Uses and Doses. Tenth edition, by Dr. E. Fullerton Cook and Dr. Eric W. Martin. Pp. xii+1616. (Easton, Pa.: Mack Publishing Co., 1951.) n.p.

THIS is a new edition of a standard work, one of the editors being Dr. Fullerton Cook, who was chairman of the Committee of Revision of the Pharmacopeia of the United States for thirty years. It deals with the whole art and science of pharmacy, as it is practised in the United States. After a general section on such themes as history and ethics, it describes the technical operations used in the laboratory and the factory. About eight hundred pages are devoted to descriptions of the substances and preparations used as drugs, including all those which are official in the United States and many unofficial ones. This edition includes valuable sections on the uses of drugs contributed by Prof. L. S. Goodman, of Salt Lake City.

The field covered is reasonably up to date, but it is curious to note how American practice differs in details from British practice; for example, the list of antihistamines contains more than fifty preparations, but promethazine does not appear to be mentioned even under the guise of some other name. The section on testing and analysis contains an interesting article on statistics by Lila F. Knudsen. There are sections on the laws governing pharmacy, on professional details such as furniture, first aid and contraceptives, on business methods, on the art of perfumery and the treatment of poisoning.

This bulky book appears to contain almost all that the American pharmacist needs to know. Ten editions have appeared at irregular intervals during sixty-five years, and the last interval was only three years. The book evidently continues to serve a useful function after all this time.

J. H. G.

Physical Chemistry, Experimental and Theoretical

An Introductory Text-book. By Dr. G. Van Praagh. Pp. xiv+295. (Cambridge: At the University Press, 1950.) 15*s*. net.

ALTHOUGH called experimental and theoretical, this book is mainly a laboratory manual of physical chemistry. A certain amount of theoretical matter, discussing and integrating the principles illustrated, is adroitly blended with the groups of experiments. This is a good practice and helps to promote a mastery of the subject.

In selecting his experiments, Dr. G. Van Praagh has carefully kept in mind the limits of time and apparatus usually found in schools. Moreover, he has tried out the whole of the two hundred experiments described. These cover the states of matter (including the colloidal state), atoms and molecules, solutions, adsorption, chemical change, mass action, ionic dissociation, phase reactions, and electrochemistry. The informative value of the experiments chosen, the good distribution over various topics, and the balance kept between the easy and difficult, all combine to make this an excellent book for use in colleges and the advanced forms of schools.

My only adverse criticism is not of the method or contents but of the author's attitude to his indebtedness for information. He does not state why he only occasionally mentions the originator of an experiment; for many of his experiments are taken from other instructional books, and in some of these books they are described for the first time. Yet Dr. Van Praagh makes no mention of permission in the preface or acknowledgment in the text.

G. FOWLES.

Cumacés

Par Prof. Louis Fage. (Faune de France, 54. Fédération française des Sociétés de Sciences naturelles: Office central de faunistique.) Pp. iii+136. (Paris: Paul Lechevalier, 1951.) 1200 francs.

THE latest publication in the well-known "Faune de France" series, No. 54, is by Prof. Louis Fage and deals with the crustacean order Cumacea. The name Cumacea, given by Krøyer in 1846, was based on the genus *Cuma* established by Milne-Edwards in 1829 for *C. audouini*; but the name is preoccupied by *Cuma* for a mollusc given by Humphrey in 1797. In spite of suggestion by Stebbing in 1900 that the order should be renamed Sympoda, it is still more general, as in the present work, for the older name to be used. For forty-three years *C. audouini* remained the only species of the order known from France; but the present work deals with sixty-seven valid species from France after excluding doubtful records, and, as the author suggests, more of these small forms are likely to be added as time goes on.

The first twenty-two pages provide an account of the structure, biology and other general matters; the remainder is devoted to systematics. The latter includes useful keys of the descending categories down to species and a full, diagnostic description of each species. The brochure is illustrated with 109 text-figures, many of which contain a number of individual drawings. While not incorrect under the International Rules, the reviewer considers it preferable to follow the general practice of writing the trivial name with a small initial letter when it is derived from the name of a person.

Die botanische Buchillustration

Ihre Geschichte und Bibliographie. Von Claus Nissen. Band 1: Geschichte, Lieferung 2. Pp. 81–160. Band 2: Bibliographie, Lieferung 2. Pp. 81–160. (Stuttgart: Hiersemann Verlagsgesellschaft m.b.H., 1951.) n.p.

THE second parts of the two volumes follow the lines of the earlier parts. The author and publishers are to be congratulated on their speedy appearance, and the hope may be expressed that publication will soon be completed. This part of the first volume, dealing with the history of botanical book illustration, completes the chapter on what is termed the baroque period and then passes on to the modern period which, starting with Robert Morison, ends with issues of King Penguins and Pelicans. Pride of place is given in this period to British publications, although some of the best botanical artists whose work is discussed were not of British birth, as, for example, Ehret and the Bauer brothers. The second part of the second volume, dealing with bibliography in alphabetical order, carries on from *He* to *Sa*. As in the first part, one notes some surprising omissions. For example, under Prain there is no reference to the fine work by Prain and Burkill on the genus *Dioscorea* in the East, published in the *Annals* of the Royal Botanic Garden, Calcutta, 1936, while Vol. 2, "Monocotyledons" (1934), of J. Hutchinson's "Families of Flowering Plants" is also omitted.

W. B. T.

WEATHER AND THE MOVEMENTS OF LOCUST SWARMS: A NEW HYPOTHESIS

By Dr. R. C. RAINEY
Desert Locust Survey Headquarters, Nairobi

MIGRATING locust swarms have attracted attention since the earliest times, and recent evidence has fully established the spectacular nature of some of these movements. Thus, following the heavy locust breeding experienced on the Red Sea coast of Saudi Arabia between February and April 1950, the first wave of desert locust (*Schistocerca gregaria* Forsk.) swarms to reach the Nile valley during the present plague appeared near Atbara on May 17, 1950, and were reported in Darfur, some seven hundred miles away to the west-south-west, fifteen days later. A detailed examination of the evidence leaves little doubt that these swarms had, in fact, originated on the Arabian coast, and that it was some of the same swarms which afterwards reached the Ouaddai area of French Equatorial Africa in mid-June, representing a total net displacement of some 1,300 miles in about a month. An illustration of the distance which may at times be covered in a single flight is provided by two well-documented records of numbers of desert locusts coming on board ships in the Atlantic some 1,200 miles from the nearest land[1,2].

The importance of the wind in the dispersal of air-borne insects in general has often been stressed (ref. 3, etc.), and the part played by the wind in such swarm movements as those mentioned is indicated by the off-shore wind, which reached gale force at times, associated with the only one of these ocean records for which adequate weather data are available[4], and by the fact that certainly the greater part and probably the whole of the movement across the Sudan during May–June 1950 took place down the north-east monsoon. Moreover, while prolonged flight has been regarded[5,6] as characteristic of the behaviour of gregarious adult locusts, field[7,8] and laboratory[9,10] determinations of the air-speed of flying locusts over a considerable range of conditions have given mean values ranging from 7 to 11 m.p.h., which at once set very modest upper limits to the wind-speeds against which swarms may be expected to be capable of making headway.

Furthermore, while there are a number of records of locusts landing into the wind, and turning out of winds in excess of flying speed (probably both optomotor reactions[6]), and of taking off into wind (probably involving the aerodynamic sense-organ[7,11]), field observations have so far failed to find any fixed and consistent orientation of flying locusts to potential orientating factors such as wind and sun. Thus, in winds of less than the probable air-speed of the locusts, up-wind, down-wind and cross-wind orientations are all observed[6,7,12]. Moreover, a swarm failing to maintain any persistent orientation, either circling (a form of swarm movement not infrequently seen), or even changing course sufficiently frequently at random, would also be displaced down-wind. On this evidence, swarm movements in directions other than down-wind would appear likely to be of limited extent, of the order of a few miles a day, and to occur only in areas and seasons of light winds.

This is in general agreement with most of the regular major seasonal movements of swarms so far described in, for example, the Indo-Pakistan area[13] and eastern Africa[5], which take place down the corresponding prevailing winds, and change direction with them. Furthermore, certainly some of the exceptions to this generalization, and possibly all, may well represent movements down non-prevailing winds. Thus perhaps the most striking of these exceptions is the northward movement of swarms in spring to the countries of North Africa and the Middle East[6,14,15], against the direction of the corresponding prevailing northerly winds. At this season, however, all the territories concerned, from Morocco to Baluchistan, are intermittently affected by depressions, moving eastwards and characterized by the temporary interruption of the northerlies by warmer winds from a southerly quarter[16], the subsequent re-establishment of the cooler northerlies often taking place at a well-marked cold front[17,18,19]. An association between the arrival of swarms in Egypt and the passage of depressions has long been recognized[20], and an example of a similar association was provided by the heavy invasion of Tripolitania in early 1951; the main wave of swarms arrived during January 29–30, with the strong south-westerly winds that developed ahead of the primary cold front of one of the deepest and most active depressions of the winter. Rao[21] has similarly attributed northerly and north-easterly swarm movements in spring in Baluchistan to down-wind displacement in the warm sectors of passing depressions. The higher temperatures associated with the southerly winds in the warm sectors of such depressions thus appear to operate as a 'rectifying factor'[6], favouring displacement in a northerly direction. A further example of a frequently recorded swarm movement which probably takes place down a non-prevailing wind is provided by the swarms landing on the north coast of the Somali peninsula during the south-west monsoon. Such swarms have been shown[22] to be probably mainly of local origin, returning with the well-marked afternoon sea-breeze characteristic of this area and season, after having been swept out to sea by the strong morning monsoon.

It has accordingly been found useful to examine some of the meteorological implications of down-wind movement. A synoptic chart, recording simultaneous observations of weather over a wide area, demonstrates areas of convergence, across the boundaries of which surface winds show a net excess of inflowing air over outflow, and within which the overall vertical motion of the air is one of ascent; and areas of divergence, across the boundaries of which outflow exceeds inflow, and within which the overall vertical motion of the air is one of descent. Convergence is an essential factor in the production of widespread heavy precipitation, while divergence is generally associated with fair weather; and the recognition and characterization of such areas is accordingly an essential step in the process of weather forecasting. Examples of areas of convergence affecting regions invaded by the desert locust are the Inter-tropical Convergence Zone (refs. 23, 24, etc.), between trade-wind and monsoon currents originating on

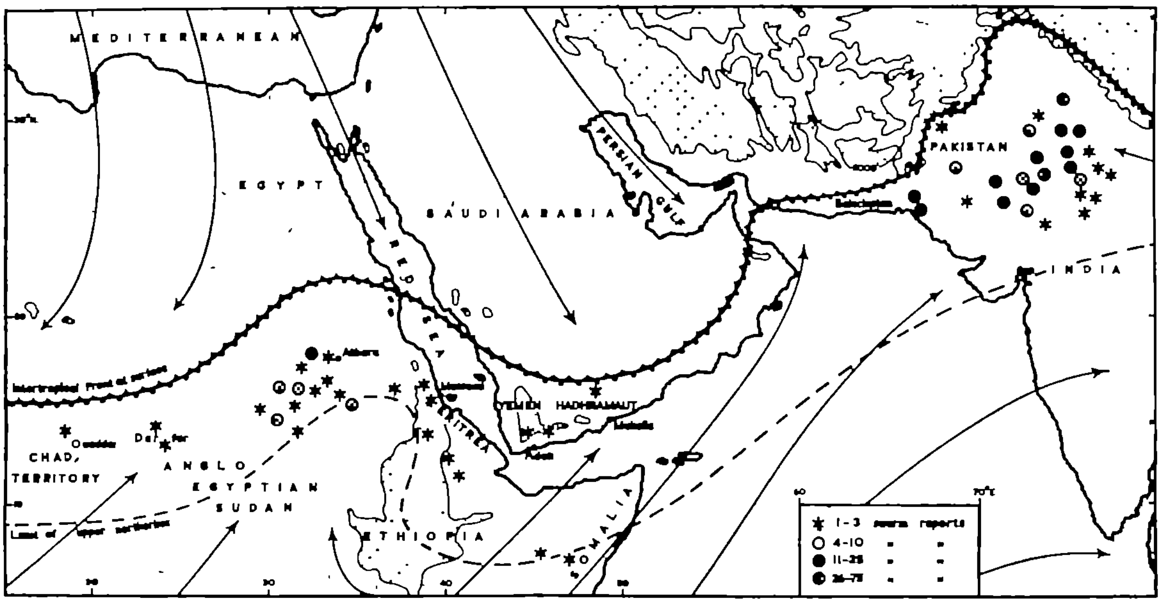

Fig. 1. The Intertropical Convergence Zone and the distribution of desert locust swarms, July 12–31, 1950

opposite sides of the equator, associated with the 'short', 'long' and 'monsoon' rains of most of Africa and India; the westerly depressions already mentioned which give the winter and spring rains of the Mediterranean and Persian Gulf (ref. 16, etc.); and the semi-permanent front, between north-westerly and south-easterly winds, associated with the winter rains of the central and southern Red Sea (refs. 17, 25). Now, in general, winds within a few thousand feet of the earth's surface may be regarded ultimately as blowing from areas of divergence to areas of convergence; and displacement down-wind may therefore be expected to result in movement sooner or later into areas of convergence. It is therefore suggested that the major displacements of locust swarms take place towards areas of convergence, and that swarms may in general be expected to collect in the vicinity of such areas.

This hypothesis may readily be tested by a comparison of swarm records with the corresponding current synoptic charts. In dealing with records from thinly peopled regions, such a comparison is most conveniently made over a period of a number of days during which the synoptic situation is showing little change, in order to be able to consider a number of swarm reports sufficiently large to be representative of the current swarm distribution. The first such period examined was July 12–31, 1950, when the Intertropical Convergence Zone remained relatively stationary in the position indicated in Fig. 1, which also gives the distribution of all desert locust swarms reported during this period, together with an indication of the corresponding surface winds. It will be noted that all the swarms reported were in the vicinity of the Intertropical Convergence Zone, from Chad Territory in the west, through the Anglo-Egyptian Sudan, Eritrea, Ethiopia, Yemen, the Somalilands, the Aden Protectorates and Pakistan to northern India. Practically all recorded swarms were, in fact, between the position of the air-mass boundary at the surface (the Intertropical Front) and the southern limit of the over-running upper northerlies (the 'limit of deep monsoon air'[26], or 'nose of the Intertropical Front'[26]), which at this season is usually closer to the main zone of precipitation than is the surface Intertropical Front[25,26,27]. During this particular season, both the Intertropical Convergence Zone and locust breeding were incidentally recorded as extending considerably farther north than usual in the Anglo-Egyptian Sudan, and the Intertropical Convergence Zone was, as indicated in Fig. 1, probably also farther north than usual over Arabia.

Such evidence of an association of swarm distribution with the Intertropical Convergence Zone encouraged the hope that the movements of the latter might prove to be associated with some of the corresponding swarm movements. The first opportunity of investigating this possibility was provided by the swarm movements in eastern Africa during September and October, 1950, including the first invasion of the British East African territories during the present plague (Fig. 2).

During most of September, 1950, the only desert locust swarms reported south of the Gulf of Aden were in the western end of the Somaliland Protectorate, with the adjacent parts of Ethiopia, where breeding had occurred during the previous month, and near Erigavo in north-eastern Somaliland, where swarms had been present since early August.

During the fourth week of September the Intertropical Convergence Zone began to move southwards from the Gulf of Aden across the Somalilands, with surface north-easterlies established for the greater part of each day at Djibouti from September 22, at Berbera from September 23, and at Hargeisa from September 26; on September 27 a large swarm was reported in south-eastern Somaliland at Las Anod, where 2 in. of rain had been recorded the previous day. On September 29 and 30 rain was recorded in the neighbouring parts of Somalia and of the Ogaden; and on October 1 immature swarms were seen in this area, near Gardo. Away to the west, swarms were reported on September 30 to have left Durdur, where breeding had been particularly heavy, in a southerly direction; and on October 1 a swarm was seen near

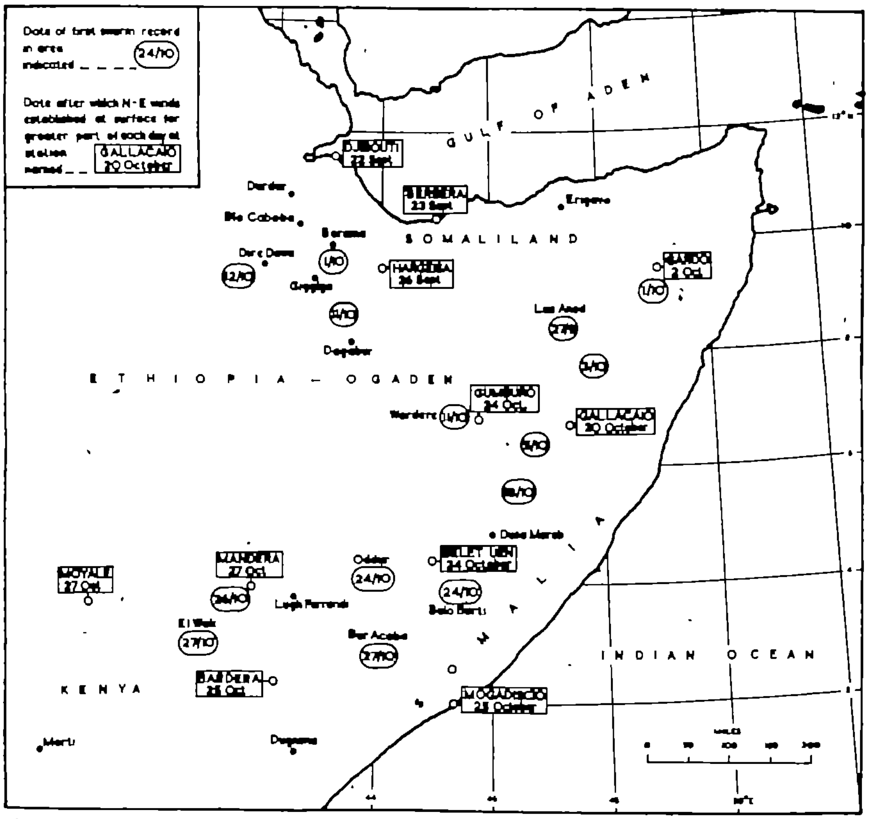
Date of first swarm record in area indicated
24/10
Date after which N-E winds established at surface for greater part of each day at station named
GALLACAIO 20 October
GULF OF ADEN
DJIBOUTI 22 Sept.
BERBERA 23 Sept.
Erigavo
Dardar
Bio Caboba
Borama
Dire Dawa
12/10
1/10
Giggiga
HARGEISA 26 Sept.
SOMALILAND
GARDO 2 Oct.
1/10
Las Anod
Dagabur
ETHIOPIA – OGADEN
GUMBURO 24 Oct.
Wardere
11/10
GALLACAIO 20 October
Dusa Mareb
MOYALE 27 Oct.
MANDERA 27 Oct.
26/10
Lugh Ferrandi
Oddur
24/10
BELET UEN 24 October
24/10
Bulo Burti
El Wak
27/10
Bur Acaba
27/10
BARDERA 25 Oct.
KENYA
MOGADISCIO 25 October
INDIAN OCEAN
Merti
Dugiuma
MILES

Fig. 2. Advance of the Intertropical Front and the movement of desert locust swarms in eastern Africa during September and October 1950

Giggiga, to the south of the Borama-Bio Caboba area, in which a number of young swarms had been reported during the latter half of September. By October 2 northerlies were established at Gardo, and for the next few days the Intertropical Front remained between this station and Gallacaio, still in south-westerlies. On October 3 an immature swarm was seen and heavy rains fell between Gardo and Gallacaio; there was further rain at Gallacaio on October 4; and on October 6, following freshening north-easterlies at Gardo and Hargeisa, swarms were seen to the south-west of Gallacaio.

Following a temporary recession of the Intertropical Front, with south-westerlies re-established at Gardo between October 7 and 11 and at Hargeisa between October 8 and 10, its southward movement was resumed, with surface north-easterlies on the afternoon of October 11, with gusts up to 20 knots at Gardo and reaching 15 knots at Hargeisa. On this date flying locusts were seen from an aircraft at 4,500 ft. over Wardere, and an immature swarm was reported between Giggiga and Dagabur; on October 12 there were two further reports of immature swarms, south and south-west respectively of Dire Dawa.

The south-westerlies receded from Gallacaio and Gumburo (I am indebted to the Sinclair Petroleum Co. for the Gumburo records) after October 18 and from Belet Uen after October 19; easterlies were established at Gallacaio on October 20, with rain, continuing on October 21, when showers were also recorded at Belet Uen. Easterlies were temporarily established at Gumburo during October 19–21, with 2·2 in. of rain on October 20. On October 18 a heavy invasion of mature swarms began in the Dusa Mareb area, between Gallacaio and Belet Uen, and during October 20–25 widespread egg-laying took place in this area, where heavy rains also fell at about this period.

The Intertropical Convergence Zone continued to move southwards, with the establishment of northerlies at Belet Uen and of north-easterlies at Gumburo on October 24, and of north-easterlies at Mogadiscio and easterlies at Bardera by October 25; on October 24 flying swarms were reported at Oddur, between Belet Uen and Bardera, and near Bulo Burti, between Belet Uen and Mogadiscio.

On the night of October 25–26, scattered locusts flew over Lugh Ferrandi; on October 26 there were the strongest north-easterlies of the month at Belet Uen and Mogadiscio, widespread showers occurred in Kenya, and swarms arrived at three points in the Mandera area. On October 27, easterlies had become established at Mandera, and swarms were reported near El Wak and at Bur Acaba, again very close to the limit of the surface north-easterlies in these areas.

The Intertropical Convergence Zone became relatively stationary and generally inactive during most of November, with no further sustained southward movement until early December. There were signs of increased activity during mid-November, with rains on November 11 and 12 in south-central Somalia and north-east Kenya; and on these dates swarms reached the Merti (Kenya) and Dugiuma (Somalia) areas, the most southerly points known to have been attained by this generation; both areas were in the immediate vicinity of the Intertropical Front at the time.

The north-easterlies usually over-run the retreating south-west monsoon in East Africa[24], as elsewhere in the region under consideration[25-28], and were, for example, established at 7,000 ft. above sea-level over Kenya as far south as the equator when they had only reached 5° N. in Somalia at the surface. Plateau-level north-easterlies and rains were, in fact, experienced at times well in advance of the southern limit of the surface north-easterlies of the lowlands. The leading swarms, however, remained in the immediate vicinity of this latter limit (the Intertropical Front) throughout the migration; the beginning of the southerly swarm movement from Somaliland, for example, and the arrival of the first swarms in Kenya, five hundred miles away and a month later, both appear to have taken place within a day of the passage of the Intertropical Front across the areas concerned. Over this period the speed as well as the general direction of displacement of the leading swarms thus appear to have been determined by the movement of the Front.

The hypothesis that major swarm movements take place towards, and with, zones of convergence thus appears to merit further consideration as a potentially useful means of supplementing the present essentially historical method of forecasting swarm movements, since forecasts of the movements of the Intertropical Convergence Zone over central Africa, for example, based on the pressure distribution to the north and south of the continent, are issued by the East African Meteorological Department up to a week ahead. The hypothesis may well indicate a need for further information on limiting conditions for flight, which are likely to be important, for example, in determining the speed of swarm displacements approaching zones of convergence from a distance. It may, in addition, help to provide a background against which the finer effects of behaviour on displacement may be more effectively studied, by enabling appropriate allowance first to be made for the part played by the purely transporting effect of the wind in particular recorded swarm displacements.

Convergence also provides a mechanism for the frequently recorded association of exceptional rains with the arrival of locusts; during November–December 1949, to quote a single example, the first swarm record anywhere in Arabia after a lapse of four months, at Mukalla, with the first full-scale gregarious breeding in the Hadhramaut during the present plague, followed a rainfall of 7 in. in 36 hr. at this station, for which the mean annual rainfall, over the whole nine years for which records are now available, is 2·5 in. A similar effect (I am indebted to Mr. P. R. Stephenson for this suggestion) may perhaps also contribute at times to the process of gregarization, by producing a measure of 'real concentration'[29] of adult *solitaria* from long distances into limited areas which provide suitable conditions of moisture and vegetation for breeding. Thus in late November 1950, for example, scattered locusts, at densities ranging from 1 to 100 per 100 yd. of traverse, were encountered in uniformly dry conditions at a series of points extending along 58 miles of the Eritrean coast near Massawa, while on a second reconnaissance over the same route a fortnight later locusts were found, at densities of 400–600 per 100 yd., only within the eight-mile stretch to which rains in the meantime (totalling 5·6 in. at Massawa) had been restricted[30]. This mechanism may well be of vital importance to the continued existence of species such as the desert locust, inhabiting regions of scanty and erratic rainfall with an egg-stage almost aquatic in its moisture requirements[31], and moreover suggests a possible survival value of flight without consistent orientation for other insects.

The data used in this work have been made available by the co-operation of the meteorological services and of the locust control and research organizations of the whole area considered, from French Equatorial Africa to India. I am furthermore particularly indebted to members of the forecast staffs of the meteorological offices at Aden, Asmara, Cairo, Djibouti, Ismailia, Karachi, Khartoum, Mogadiscio and, particularly, Nairobi, for the benefit of their synoptic experience; to Dr. B. P. Uvarov, of the Anti-Locust Research Centre, and Mr. P. R. Stephenson, of the Desert Locust Survey, for their support and active interest in this investigation; to Miss Z. Waloff and Messrs. Y. R. Ramchandra Rao, K. F. Sawyer, W. J. Stower, T. Weis-Fogh and N. W. Wootten, for the use of unpublished data; and to members of the Nairobi Scientific and Philosophical Society, for their comments on the hypothesis at the Society's meeting of November 21, 1950.

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EXPERIMENTS ON THE HIGH-ENERGY NUCLEONS AND QUANTA*

By SIR JOHN COCKCROFT, C.B.E., F.R.S.

EXPERIMENTAL nuclear physics is to-day moving into a very exciting new phase, the phase in which we are attempting to discover the nature of the forces between the so-called elementary particles of matter, in particular the forces between the nucleons—protons and neutrons—of which atomic nuclei are made up. We wish to know the relations of these forces to the twenty or so other elementary particles which have been discovered within the past two decades or are due for discovery in the near future.

Before I embark on this, it is worth while to look back at the first three ages of nuclear physics.

The Ages of Nuclear Physics

The first age, which will for ever be associated with the Curies and with Rutherford's work at McGill, saw the discovery of radioactivity and of radioactive change; the discovery that the heavy elements are unstable, changing gradually through the emission of electrons and α-particles—or helium nuclei—to lead.

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* Substance of a Friday Evening Discourse delivered at the Royal Institution on November 2.

The second age gave rise to the conception of the nuclear atom. In this age, which was coincident with Rutherford's Manchester days, experimenters in his laboratory studied the interactions of high-speed α-particles from radium with matter. Geiger and Marsden showed that these particles could be reflected backwards from metal surfaces—an observation which, as Rutherford said in later years, was to him as surprising as if a 15-in. shell had bounced back from a sheet of tissue paper. He calculated the enormous magnitude of electric or magnetic fields required to produce this repulsion of the particles, and from this came to his conclusion that such forces could only be provided by a nuclear model of the atom in which the greater part of the mass and an electric charge proportional to the atomic number is concentrated in a central core of the atom having a diameter of the order of 10^{-13} cm.

Within this age there developed also the remarkable work of Niels Bohr, which explained the stability of the electron orbits outside the nucleus; and the work of Moseley, which showed that the electronic structure and the chemical properties of the elements depend on the nuclear charge.

The third age opened with the discovery by Rutherford that the nuclei of the light atoms could be penetrated and transmuted by his high-speed α-particles. The forces near the nucleus were shown to be represented by the electrostatic forces corresponding to a central charge Ze, provided the exploring particles did not approach closer than 10^{-13} cm. to a nucleus. If they came closer, the forces could no longer be so represented, showing that inside the nucleus we had to do with a different realm—a realm scarcely explored in this third age.

The scope and scale of Rutherford's disintegration experiments were enormously extended by the invention of particle accelerators designed to accelerate hydrogen and deuterium nuclei, and so provide for the physicist streams of atomic projectiles a million-fold greater in intensity and exceeding in energy the α-particles available to Rutherford. These accelerators consisted of three main types: the voltage multiplier type of generator associated with Prof. E. T. S. Walton and myself; the Van de Graaff electrostatic generator; and the cyclotron of Prof. E. O. Lawrence. This age has been called by some the Golden Age of Nuclear Physics; by others—whose dreams reach far into the future—the Stone Age.

One of the greatest achievements of the Golden Age was the discovery of the neutron by Chadwick. This led to a new concept of the internal constitution of the nucleus, which was now thought of as consisting of an assembly of N neutrons and Z protons:

$$Z + N = \text{isotopic weight.}$$

This close-packed assembly of nucleons was seen to require a new kind of inter-nucleon force to hold it together, for the disruptive effect of the positive electrostatic forces of the protons is enormous. If, for example, we consider the 92 protons of a uranium nucleus to be distributed half on each hemisphere of a nuclear surface of radius 10^{-12} cm., a simple calculation shows that there will be a disruptive pressure of about 10^{23} atmospheres. There must therefore be counterbalancing attractive forces between nucleons which prevent the nucleus from blowing up.

Since these forces act between uncharged neutrons and charged protons, and presumably between pairs of neutrons, these forces cannot be electrical or magnetic in origin. The discovery of their nature is one of the major problems of the new age.

I should also recall the discovery of the first of the transient or short-lived elementary particles—the positive electron, discovered first in cosmic rays by Anderson. Blackett and Occhialini obtained beautiful pictures of the creation of pairs of positive and negative electrons, while Chadwick and Goldhaber showed that the electromagnetic radiation of the gamma-rays could create these pairs. The creation of matter from radiation, and its inverse—the annihilation of the positive electron to produce radiation—was established.

The closing years of this age saw the discovery of nuclear fission and its sombre consequences.

Nuclear Forces

If I turn now to the post-war developments—the fourth age—our major interests are focused on the nature of the forces which hold the nucleus together, and on the nature of the new members of the family of so-called elementary though transient particles which workers in the cosmic ray field present to us year by year. We believe that these transient particles are closely connected with the intense forces acting between nucleons.

The experimental nuclear physicist attacks the problem first with the classical methods. If a nucleus such as beryllium consists of four protons and five neutrons bound together by the nuclear force, he fires into these nuclei streams of neutrons, or alternatively streams of protons, sufficiently energetic so that the electrostatic forces of repulsion outside the nucleus will be negligible. We can then study, in the classical way, the angular distribution of particles coming *out* of the nucleus. We can think perhaps of the nucleus as a snooker pool of red and white balls, into which we fire either a red ball or a white ball, and look for the angles of emergence of the balls struck.

The high-speed neutrons and protons used in this type of experiment are most conveniently produced by the cyclotron, and the Harwell cyclotron is typical of several machines built for such studies. This machine has been built and operated by a group at Harwell led by Pickavance, Cassels, Taylor and Dickson. The cyclotron produces an internal circulating beam of about one micro-ampere of protons (or 6×10^{12} protons/sec.) which can attain an energy of 180 million electron volts if they are allowed to spiral out to full radius. If a target interrupts their path at a smaller radius, the final proton energy is correspondingly reduced. We can therefore carry out experiments over a wide range of proton energies.

We can also extract part of the beam by scattering it from a thin uranium foil into a channel screened from the magnetic field of the accelerating space. The protons can then escape from their spiral orbit and are directed down a long pipe to the experimental chamber situated beyond thick concrete walls. We have about 2×10^{5} protons/cm.^{2}/sec. coming out of the end of the pipe, 40 ft. from the cyclotron.

When we wish to produce high-speed neutrons for experiment, we allow the protons to strike a target of beryllium—our snooker pool of four protons and five neutrons, if I may return to the simile. We find then that neutrons are projected forward with practically the full energy of the impacting proton—180-MeV. protons produce some neutrons of 178-MeV. energy. This can only happen if our striking nucleon makes a head-on shot on a neutron, knocking it forward with full momentum and coming to rest itself. In order to be able to do this, it must not disturb the rest of the balls of the snooker pool.

At Harwell the neutrons pass out of the vacuum chamber of the cyclotron, through tubes in the 15-ft. shielding blocks of concrete and so into a long experimental tunnel. The highly collimated beam of neutrons then strikes a thin disk of polythene $(CH_2)_n$ from which hydrogen nuclei or protons are ejected. These protons have in turn almost the full energy of the neutrons, and by measuring their energy spectrum we determine the neutron energy spectra.

We look, therefore, for these protons at an angle of projection of 10° and arrange there a so-called 'telescope' of three counters which operate an electronic register when a particle passes through all three.

We can now introduce a disk of graphite between the second and third counter; when its thickness is equal to the maximum range of the protons in graphite, we cease to record protons passing right through the telescope. The graphite disk enables us, therefore, to determine the energy of our protons, just as thin slips of mica—so thin as to show interference fringes—enabled us to measure α-particle energies in the 'Golden Age'. The comparison of the thin mica films with the graphite disk illustrates directly the great increase in particle energies since the 1932's.

We can therefore measure the energy spectra of the protons and hence deduce the energy spectra of the neutrons projected out of the beryllium target. The result is a peak of almost the full energy, indicating that a large fraction of the protons transfer their full momentum to a single neutron. This shows that the incoming proton does not interact with most of the other nucleons, otherwise some of its energy would go to them. Hence also the range of action of the nuclear forces must be small—smaller than 2×10^{-13} cm.—otherwise the fast proton would transfer some of its energy to other nucleons.

However, there is a tail of neutrons of lower energy. If we replace the beryllium target by an aluminium target, the tail becomes much more prominent. Since we are all the time observing neutrons projected in the forward direction, this must mean that some of the struck neutrons make small-angle multiple collisions in the snooker pool of the nucleus before emerging.

We can compare these results with those of the Harvard workers, who use 110-MeV. protons. The peak for the Harvard experiment is much more pronounced when the lower-energy protons are used. This can be explained by the fact that neutrons of energy less than about 90 MeV. do not escape easily from the nucleus, whereas neutrons of higher energy do escape because of a curious interference effect. The neutron spectrum is therefore filtered in favour of high-energy neutrons. The carbon nucleus is more tightly bound; the threshold energy for neutron production is about 20 MeV. and so no neutrons more than 90 MeV. are produced. No peak is found in the Harvard results for carbon.

We find also that neutrons of much lower energy emerge from the nuclear pool. Mrs. Skyrme has looked for these by a quite different technique. The direction of the proton beam was reversed. She then investigated the backward direction for low-energy neutrons by means of photographic plates, and found another substantial peak having a maximum at about 1 MeV. neutron energy. These neutrons result from a general transfer of energy from some protons to the whole nuclear pool. The nucleus is 'heated up' to a temperature corresponding to a million volts, or about 2×10^{9} °C. Neutrons then evaporate and the evaporating neutrons have a Maxwellian spectrum. On the average, about four neutrons evaporate from a tungsten target for each striking proton which loses energy. When light targets are used, less than one neutron evaporates for each collision. We have therefore the two mechanisms of transferring energy: the single-shot, head-on collision with one nucleon; the second, the 'bosh shot' which heats up the whole pool and leads to neutron evaporation.

The next experiment studied the angular deflexions in collisions of the high-energy neutrons with the protons of the polythene disk. We are dealing here with the collisions of nucleons of almost the same mass. If the nucleons were to behave like minute elastic billiard balls, we would expect that in the centre-of-gravity co-ordinates—thinking of the two balls moving towards each other with half velocity—all directions would be equally probable after the collision.

If, then, we were to plot the number of neutrons emerging from the collision at different angles per unit solid angle, the number would be constant for all angles. Actually, we observe quite a different distribution. There are far fewer protons emerging at 90° than at 180°, and there is not even symmetry about 90°. Our nucleons do not therefore behave like minute elastic billiard balls.

We next use 145-MeV. *protons* as exploring projectiles. To do this we move our experiment to the other side of the cyclotron—to use the protons coming down the long pipe. Again we look for projected protons, and can at the same time look for the deflected striking protons which should emerge at right angles. Actually, they do not emerge quite at right angles—since the striking protons are moving quite fast they are slightly heavier because of relativity, and the angle after the collision is observed to be slightly less than 90°.

We find now that protons colliding with protons do behave like elastic billiard balls, at any rate down to angles of about 30°. However, this difference does not show immediately that the forces between protons and protons and those between neutrons and protons are different. The reason is that the Exclusion Principle modifies the proton–proton collisions, but not, of course, the neutron–proton collisions. It is still a matter of controversy whether these high-energy experiments do provide evidence for such a difference, but recent work at rather lower energy (14 MeV.) suggests that it does, in fact, exist.

Another question raised by the high-energy work, to which Berkeley (345 MeV.), Rochester (240 MeV.), and Harvard (110 MeV.) are also contributing, is the following: Is it possible to explain all the observed effects by the use of forces which do not vary with the relative velocity of the particles? Here the answer appears to be 'No', although theoretical investigation continues. Theoretical physicists have tried to find a potential of interaction representing an attractive force at large distances and a repulsive—hard core—force at short distance. They then vary the parameters in order to achieve a fit with results. This is the so-called 'phenomenological approach'. So far this approach has not been very successful, in that the curves calculated for the angular distribution after the collision, however much adjusted by variation of parameters, cannot achieve a good fit.

In these circumstances it seems scarcely fair to set a still more difficult problem of nuclear dynamics to the theoretical physicist. The cyclotron group has, in spite of this, studied the collision of high-speed protons with nuclei of heavy hydrogen, which consist of one proton and one neutron, so that we may have a three-body interaction.

The scattering curves found are quite different from either proton–proton or proton–neutron scattering. An explanation of this will have to await the solution of the two elementary processes already considered. The next, and more difficult, step in the experiments is to study the scattering of neutrons by deuterons. A comparison between the results for proton–deuteron and for neutron–deuteron scattering should then enable us to say whether the neutron–proton and proton–proton interactions are similar. This seems to be the most direct way of obtaining information about neutron–neutron forces, since the scattering of neutrons by neutrons cannot be observed.

At this stage we should inquire whether there is not some other influence affecting these collisions. The obvious particle to suspect is the meson. Mesons were, in fact, invented by the Japanese physicist Yukawa so long ago as 1935 just in order to account for nuclear forces. He suggested the existence of this new particle having a mass such that the wavelength $\lambda = h/mv$ was equal to the expected range of nuclear forces, 2×10^{-13} cm. The new particle should then have about 200 times the electron mass. The mesons then might be considered to be the heavy quanta of the nuclear field.

Soon after this, by a remarkable coincidence, the so-called μ-mesons were found in the cosmic rays by Anderson and Neddermeyer. Although we do not now believe that these μ-mesons, which have 220 times the electron mass, have anything to do with nuclear forces—since the μ-mesons scarcely interact at all with nuclei—the Yukawa hypothesis has had an important stimulating effect. Indeed, in 1947, Powell, by his remarkable photographic plate technique, discovered another kind of meson—the π-meson or pion—which does interact with nuclei. These π-mesons have about 275 times the electron mass. There are three kinds, π^+-mesons carrying a positive charge, π^0-mesons which are uncharged and π^--mesons which are negatively charged. The π^+-meson changes into μ-mesons after a very short life—of the order of 10^{-8} sec. Since then, evidence for heavier mesons has appeared in cloud chamber photographs: there is a ν-meson which can change into a proton and there are k- and τ-mesons.

The connexion of these transient particles with nuclear forces becomes evident as we increase the speed of our nucleons in proton–proton and proton–neutron collisions. We find that as the proton energy rises beyond 200 MeV., π-mesons come out of the nuclear pool as though they were transient sparks struck in the intense fields of close collisions. This method of creation of mesons was discovered first in the huge Berkeley cyclotron. The protons from the cyclotron strike a target of graphite. Photographic plates are exposed near by to record any mesons produced. The Berkeley workers found that both π^+- and π^--mesons were produced, and the numbers increase rapidly as the proton energies increase beyond 200 MeV. The still larger Chicago cyclotron now produces so many π-mesons that they have as many as 1,000 a second emerging from a two-inch pipe through their massive concrete shields.

The Berkeley workers found also that gamma-rays having energies of up to 200 MeV. began to be produced at about the same proton energies as the π^+- and π^--mesons. These gamma-rays were also shown, by a brilliant piece of experimental work, to be emitted in pairs. It was found also that they are more energetic in the direction of the proton than in the opposite direction. This suggested that some particle is projected forward by the protons and that it breaks up into the two gamma-rays. By the well-known Doppler effect, the frequency of the rays coming backwards could be less and so their energy would be less. These particles were assumed to be neutral pions, and this has been abundantly confirmed. They are even more transient sparks than the charged pions, for they last only for 10^{-15} sec.

If we agree that these pions must be connected with nuclear forces, how do we visualize the connexion? In a collision of a proton with a neutron, we think of the two nucleons as surrounded by a meson field just as two electrons are surrounded by an electric field. When they come close together, the proton can emit a positive pion or heavy quanta. This pion is then absorbed by the neutron, which becomes a proton. The overall result is a scattering of the two nucleons, which then change their direction. This is a very nice picture; but until theoretical physics can develop the full meson theory and apply it quantitatively to nuclear collision, we must remain only partially convinced of its truth.

Disintegration produced by High-Energy Nucleus

The nuclear disintegration produced by nucleons having energies of up to 10 million volts resulted in the nucleus splitting into two or three fragments at most, since the energy transferred to the nucleus was not sufficient to dismember it still further. Examples of this type of transmutation were the splitting of a beryllium nucleus of mass 8 into two α-particles and the splitting up of a carbon nucleus into three α-particles.

When nucleons having energies of the order of 160 MeV. are used, much greater energies are transferred to the nucleus and more complete fragmentation occurs.

Nuclear transmutations produced by high-energy neutrons and protons enable new radioactive isotopes to be discovered and the empty spaces in the chart of isotopes to be filled.

Dr. F. D. S. Butement and Mr. R. Shillito at Harwell have used the high-energy neutrons from the Harwell cyclotron for such studies. In typical reactions, the absorption of a neutron by the nucleus is followed by the expulsion of a proton or an α-particle. In this way, for example, two new isotopes of gold having isotopic weights of 201 and 202 were found; they are known as neutron-rich isotopes.

Photodisintegration has been used by Dr. Butement and Mr. Shillito as a second method of producing new radioisotopes. The absorption of a high-energy quantum from the Harwell 23-MeV. synchrotron is often followed by the emission of a proton. By these two methods twenty-six new isotopes have been found. One interesting reaction was discovered and investigated by Dr. J. M. Dickson and Mr. T. C. Randle. It is the production of beryllium-7 by proton bombardment of carbon, according to the reaction:

$$^{12}_{6}\mathrm{C} + ^{1}_{1}\mathrm{H} \rightarrow ^{7}_{4}\mathrm{Be} + 3p + 3n.$$

Beryllium-7 has a long half-life of 53 days, so that its strength builds up over a long period. Now in the cyclotron it is necessary to shield the electrodes from the protons scattered from the targets being used in the experiments described previously. The cyclotron group decided to use carbon for this purpose, thus producing as much as 10^{-6} gm. of beryllium-7 every two months while the cyclotron is being used for its main programme. This beryllium-7 has been extracted by Dr. Butement and has been used as a target in further experiments. Dr. R. C. Hanna has shown that it absorbs slow neutrons very strongly ($\sigma = 10^4$ barn).

I will now describe another group of experiments carried out with high-energy quanta produced by the electron synchrotron at Harwell or by the 17·6- and 14-MeV. γ-rays produced by the well-known reaction of protons on lithium. The synchrotron produces electrons of about 23 MeV. energy, and these electrons produce quanta of X-rays when they strike a target. When these quanta enter a nucleus, they set the nucleus into vibration and transfer the energy of the quanta to it. The nucleus can then break up by emitting one or more particles.

To do this the Harwell workers in Mr. Goward's and Dr. Titterton's groups introduced various elements into the emulsion of the special nuclear photographic plates. The nuclei of these elements absorb a quanta and are disintegrated, and the tracks of the particles are made visible on development.

One group of experiments was devoted to the photodisintegration of light nuclei. They showed that in the photodisruption of the nucleus many different types of nuclei are flung out. They include neutrons, protons, deuterons, tritons, helium nuclei and beryllium nuclei. Dr. Titterton and Mr. Brinkworth exposed plates loaded with the separated light isotope of lithium, namely, lithium-6. When these were exposed to 17·6-MeV. γ-rays, V-shaped tracks were found. It appears that these are due to a neutron being ejected from lithium-6, leaving the radioactive nuclei of lithium-5 behind ·

$$^{6}\mathrm{Li} + h\nu \rightarrow {}^{1}n + {}^{5}\mathrm{Li}.$$

This lithium-5 nucleus is known to have a very short life—of the order of 10^{-21} sec. It breaks up in flight into a proton and helium-4, producing a typical V track. A detailed study of the events shows that in some cases lithium-5 is found in a state having about 2·5 MeV. excess energy.

In another experiment, the plates were loaded with the lithium-7 isotope and again exposed to 17·6-MeV. radiation. Some of these showed the long track of an energetic proton and a very short track of a heavy recoiling nucleus. It appears, then, that the disruption of a quantum ejects a proton from the nuclei, leaving behind a nucleus of helium-6 :

$$^{7}\mathrm{Li} + h\nu \rightarrow {}^{1}\mathrm{H} + {}^{6}\mathrm{He}.$$

Then plates loaded with lithium-7 were exposed to these same 17·6-MeV. gamma-rays. In this case a triton was ejected from the lithium-7 nucleus :

$$^{7}\mathrm{Li} + h\nu \rightarrow {}^{4}\mathrm{He} + \mathrm{T}\ ; \text{ also } {}^{11}\mathrm{B} + h\nu \rightarrow \mathrm{T} + {}^{8}\mathrm{Be}.$$

The fourth experiment, by Goward and Wilkins, studied the photodisintegration of carbon-12 nuclei. In this case the long track of a helium nucleus and heavy V-shaped tracks at one end were found. The ejection of the helium nucleus leaves behind a beryllium-8 nucleus which is unstable and immediately breaks up into two α-particles which recoil in opposite directions. The beryllium-8 nucleus is, however, moving at high speed before it breaks up, so that the two α-particles carry the momentum but diverge due to the mutual recoil.

The fifth experiment, using plates loaded with boron-11, shows a rather similar event. In this case the boron-11 nucleus breaks up into a triton and a beryllium-8 nucleus moving in opposite directions. The beryllium-8 nucleus then breaks up into two α-particles giving the characteristic V-shaped track.

In a sixth experiment, carbon and oxygen were irradiated with gamma-rays having energies up to 80 MeV. Carbon disintegrated into three α-particles and oxygen into four α-particles. On examining how the chances of these disintegrations vary with energy, Goward and Wilkins found that there were two prominent resonances in the energies at which they occur.

Conclusion

I have dealt mainly with the Harwell contributions to this new and exciting field of high-energy physics.

In this field the cosmic ray workers using high-energy particles provided by Nature have been the pioneers, and the schools of Bristol and Manchester have discovered the π-, the k- and τ- and the ν-mesons since the War. The high-energy machines are an essential complement to this work, since it is only by their help that we can investigate nuclear forces and the process of creation of mesons in sufficient detail to arrive at an understanding.

Work is proceeding in many laboratories in the United States and will soon be starting in Glasgow, Birmingham and Liverpool as their powerful new machines come into operation. We can be confident that we have at least a decade of work in front of us as the frontiers of our knowledge of the physical world are still further advanced.

OBITUARIES

Prof. A. L. Mellanby

Alexander Lawson Mellanby, emeritus professor of civil and mechanical engineering in the Royal Technical College, Glasgow, died at Bridge-of-Weir, after a short illness, on November 26.

He was born at Hartlepool on July 3, 1871, and was educated at Barnard Castle School. After an apprenticeship at the Central Marine Works, Hartlepool, he entered Durham College of Science, and graduated B.Sc. with honours. He was awarded an 1851 Research Scholarship and went to McGill University, where he carried out research on the reciprocating steam engine. Returning to Great Britain he was appointed chief technical assistant with T. Richardson and Sons, engineers, of Hartlepool, but after a year left industry to enter the academic profession, in which he remained for the rest of his professional life.

His first appointment in this field was as chief lecturer in engineering at Battersea Polytechnic in 1898. Shortly afterwards he was appointed to the Manchester College of Technology as assistant to Prof. J. T. Nicolson, and took a large part in designing and equipping the laboratories, workshops and power station of that College. In 1905 he was appointed to the chair of motive power engineering at the Royal

Technical College, Glasgow, and was in the service of the College until he retired in 1936. His success in this chair was such that first the Department of Applied Mechanics and later the Department of Civil Engineering were merged with his Department into a single Department of Civil and Mechanical Engineering and Applied Mechanics.

Prof. Mellanby was one of the first to realize the importance of experimental work in engineering courses, and, soon after his appointment to the Royal Technical College, he established a heat engines laboratory, outstanding at that time for its size, range and standard of equipment. In those days technical colleges suffered severely from financial and staff limitations ; but Mellanby saw that, without adequate experimental facilities, the highest levels of teaching and research would never be reached. His own work lay mainly in the field of steam and internal combustion engines. Following on his early work on reciprocating engines he took up an intensive study of the flow of steam through nozzles, and was the author of many papers, some of which were in collaboration with Dr. Wm. Kerr, who later succeeded him in the chair. He took an important part in the work of the Marine Oil Engine Trials' Committee, a joint committee of the Institution of Mechanical Engineers and the Institution of Naval Architects, which carried out a series of authoritative trials on marine oil engines of different types. His services were widely sought as a consultant, and special reference was made to this when the University of Glasgow conferred the LL.D. degree upon him in 1936. He served as a member of Council of the Institution of Mechanical Engineers, and took an active part in the operation of the national certificate scheme for engineering students in Scotland. He was a firm believer in academic institutions maintaining close contact with the world of practice and, at an early stage, fostered the establishment of sponsored research projects for industry.

Intellectually a man of science and professionally an engineer, Prof. Mellanby had the sure instinct of the former for the fundamental factors in a complex problem, and the sound judgment of the latter on all practical issues. He deprecated narrow specialization, whether in courses of study, staff training, experimental method or technical authorship, holding that range was essential to quality of judgment. He made many contributions to technical literature, all of which kept in proper balance and perspective the fundamental and practical issues. He was deeply concerned with the welfare of his students and, long after they had left the College, he followed their careers with interest, always willing to give advice in the solution of problems or a helping hand towards further advancement. Few professors had more sympathy with the struggling part-time student, and nothing gave him greater pleasure than to pick out the really talented from this group and assist them to transfer to full-time courses.

Throughout the long period of his retirement, his activity of mind and body remained unimpaired almost up to the last, and his interest in matters educational and practical was unabated. In him human, social and professional qualities were not only fine but also finely balanced, and they were exercised with a quiet dignity and a true sense of duty and service. He will be very much missed in engineering and academic circles in Glasgow and the west of Scotland, and indeed over a much wider area.

DAVID S. ANDERSON

Prof. Rikiti Sekiguti

PROF. RIKITI SEKIGUTI, formerly director of the Tokyo Astronomical Observatory, Mitaka, near Tokyo, died suddenly from heart failure on August 10 at Kamakura.

Sekiguti graduated at the University of Tokyo in 1907, taking astronomy as his subject. He served in meteorological observatories—at a weather station in Korea, at the Marine Meteorological Observatory at Kobe, and for a time as the head of the Solar Section of the Central Meteorological Observatory. Meanwhile he was sent to Europe for study, and worked at Cambridge with the late Prof. H. F. Newall for about a year. In 1936 he was made a professor of astrophysics in the University of Tokyo and the director of the Tokyo Astronomical Observatory. He taught astrophysics to students of astronomy at the University for more than ten years until his retirement at the age of sixty in 1946. At one time he served in the Government as the head of the Special Education Bureau of the Ministry of Education, and took several important steps for the promotion of scientific research.

Sekiguti's main scientific work was devoted to meteorology and oceanography. He developed solar meteorology by applying Margules's theory to the solar atmosphere. He took part in the solar eclipse of 1936, using a small spectrograph of his own design, and announced the recognition of several new spectral lines.

Sekiguti was a good writer. He published several books in Japanese, "The Sun", "Astrophysics", "Introduction to Astronomy", etc. He was an enthusiastic and hard worker in any subject he took up. The Tokyo Observatory was damaged towards the end of the Second World War, and since then his health had declined. His daughter is married to Dr. Shinichiro Tomonaga, a well-known nuclear physicist.

Y. HAGIHARA

Dr. S. Hill

DR. SYDNEY HILL, who died as a result of a street accident on November 27, in his twenty-eighth year, was educated at Holt High School, Liverpool, and proceeded to the University of Liverpool, where he graduated B.Sc.(Hons.) in 1943 and was awarded the Campbell Brown Fellowship. He joined the staff of Peter Spence and Sons, Ltd., in 1943 and was granted leave of absence during 1945–48 to take up the Fellowship, and was awarded a Ph.D. in 1948 for research work in electrochemistry. This work was the subject of several papers published jointly with A. Hickling in the *Transactions of the Faraday Society* and the *Journal of the Electrochemical Society*. Dr. Hill returned to industrial work and at the time of his death was engaged in further electrochemical investigations. His tragic death at an early age closes a career that held great future promise. He was unmarried.

WE regret to announce the following deaths :

Lord Addison, K.G., P.C., chairman in 1948 of the Medical Research Council, on December 11, aged eighty-two.

Prof. H. S. Raper, C.B.E., F.R.S, dean of the Medical School and professor of chemical physiology in the University of Manchester, on December 12, aged sixty-nine.

NEWS and VIEWS

Civil Engineering at Adelaide: Prof. F. B. Bull

THE appointment has recently been announced of Mr. F. B. Bull to the chair of civil engineering in the University of Adelaide, South Australia. Mr. Bull, who is at present a University lecturer at the Engineering Laboratory, Cambridge, studied at University College, Nottingham, where he took the London (External) B.Sc.(Eng.) with first-class honours. After graduation Mr. Bull worked for a number of years with Messrs. Dorman Long and Co., Ltd., where he was engaged in the design of structural steelwork. Following this he was for four years a lecturer in structural engineering at the Constantine Technical College, Middlesbrough. During the Second World War, Mr. Bull served with the Admiralty Department of Scientific Research, where he led a party of engineers, physicists and naval architects engaged in the experimental determination of the stresses in ships' structures. This programme of trials, which was designed to reveal any differences in structural behaviour between ships of welded and riveted construction, included comprehensive measurements of the forces to which a ship is subjected when in a seaway. Various technical papers on this work have been read to professional societies, and the results of the trials are being published by H.M. Stationery Office. Since the War Mr. Bull has been on the staff at the Engineering Laboratory, Cambridge, where he has been concerned with teaching surveying and the theory and design of structures.

Royal Society: Officers for 1952

THE following have been elected Officers and Council of the Royal Society for the ensuing year: *President:* Prof. E. D. Adrian; *Treasurer and Vice-President:* Sir Thomas Merton; *Secretaries and Vice-Presidents:* Sir Edward Salisbury and Sir David Brunt; *Foreign Secretary:* Sir Cyril Hinshelwood; *Other Members of Council:* Dr. R. W. Bailey, Dr. O. M. B. Bulman, Prof. P. A. Buxton, Sir John Cockcroft, Dr. I. de B. Daly, Prof. E. C. Dodds, Prof. M. G. Evans, Sir Howard Florey (vice-president), Mr. P. Hall, Sir Geoffrey Jefferson, Prof. E. J. Maskell, Dr. W. G. Penney, Prof. H. H. Plaskett, Dr. R. Stoneley, Prof. A. R. Todd, and Prof. J. Z. Young.

National Science Foundation: Officers

DR. CHESTER I. BARNARD, president of the Rockefeller Foundation, has been elected chairman of the National Science Board of the National Science Foundation at its second annual meeting held in Washington on December 3. Dr. Barnard succeeds Prof. James B. Conant, president of Harvard University, who was the first chairman of the Board, having been elected to serve for the initial term which began December 12, 1950. Dr. Edwin B. Fred, president of the University of Wisconsin, was re-elected vice-chairman of the National Science Board. The new chairman and the vice-chairman were elected for two-year terms of office as prescribed by the National Science Foundation Act of 1950. Dr. Barnard, who plans to retire soon from the presidency of the Rockefeller Foundation and General Education Board, was long associated with the American Telephone and Telegraph Company. He was a member of the board of consultants to the State Department on atomic control in 1946 which drafted the Acheson–Lilienthal Report. He was also a member of the Presidential Special Committee on Integration of the Medical Services in the Government in 1946. Dr. Fred has been president of the University of Wisconsin since 1945. He is a bacteriologist, and was chairman of the Advisory Committee on Biological Warfare of the U.S. National Academy of Sciences during 1941–43.

New Engineering School, University of Bristol

ON December 12, at Bristol, the Chancellor of the University, Mr. Winston S. Churchill, laid the foundation stone of the new Engineering School building, in the presence of the Lord Mayor of Bristol, other civic dignatories, many distinguished visitors and members of the University. In a brief ceremony, the architect, Mr. R. H. Brentnall, was presented to the Chancellor by the chairman of Council, Mr. W. R. Verdon Smith. Mr. Brentnall then presented the representatives of the contractors and consultants, after which he handed the Chancellor a set of silver tools with which he laid the stone. In declaring the stone well and truly laid, Mr. Churchill spoke of the great need for hastening the application of the discoveries of science by training men and women for this purpose. He complimented the University of Bristol in devoting its greatest post-war expansion to this end.

The complete building will comprise a central block around two small courtyards, with two large wings, running roughly east and west, to form a magnificent frontage over the City below. The whole building, 690 ft. long, is to be faced in light-coloured brick with its principal features in Bath stone. Of the three main floors, the ground floor will consist of the laboratories of mechanical engineering in one wing, aeronautical engineering in the other, with civil engineering in the centre block. On the first floor, electrical engineering and geology will occupy two wings, with staff and student rooms occupying the central block, where the main lecture theatre forms the division between the two courtyards. The second floor provides lecture rooms and drawing offices and will house the departments of mathematics and theoretical mechanics. Completion of the interim stage is expected in two years.

Lord Rutherford

TO mark the opening of the Rutherford Memorial Appeal in New Zealand, six addresses were delivered at Canterbury University College, Christchurch, on May 18. Three of these were afterwards broadcast. The text of the six addresses is reprinted in the July number of the *New Zealand Science Review* (9, No. 7), the official organ of the New Zealand Association of Scientific Workers. Lord Rutherford of Nelson was born on August 30, 1871, at Brightwater, near Nelson, in New Zealand. He was a student at Canterbury University College and graduated M.A. in 1893 with double first-class honours. He was awarded an 1851 Exhibition science scholarship in 1895, and he left New Zealand to study in Cambridge under Sir J. J. Thomson. Except for brief visits on official occasions, Rutherford never took up residence again in his native land, although many New Zealand physicists came to Great Britain to study under him. Five of the addresses are by his former students. Rutherford's early life is described by Dr. L. Bastings; his connexion with Canterbury University College by Prof. R. S. Allan, now professor and formerly lecturer in geology at the College; and the period spent by Rutherford at McGill University and the University of Manchester by Prof. D. C. H. Florance, who worked with Rutherford at Manchester at the time when the latter was formulating his theory of atomic structure. Dr. G. T. P. Tarrant, now senior lecturer in physics at Canterbury University College, but who formerly spent eight years at Cambridge, three as undergraduate and five as a research worker directly under Rutherford's guidance, contributes an appreciation of Rutherford and his work while at the Cavendish Laboratory, Cambridge. Dr. E. Marsden, who was associated with Rutherford both as student and colleague, and who has already paid tribute in Great Britain (Rutherford Memorial Lecture of the Physical Society, 1948) to Rutherford's kindness, amiability and greatness, gives an account of him as a man. The sixth address, by Prof. R. R. Nimmo, who recently returned to New Zealand after working for several years at the University of Birmingham on nuclear physics, describes the significance and importance of Rutherford's work in present-day nuclear research. This special issue of the *Review*, illustrated with several interesting photographs which have been made available by Lady Rutherford and which are published for the first time, is a fitting tribute to the great man's memory.

Phytomorphology: a New Botanical Journal

With the appearance of the first numbers of *Phytomorphology*, a new botanical journal makes its appearance. This is the organ of the International Society of Plant Morphologists, founded at a meeting of the Pan-Indian Ocean-Science Congress held in Bangalore, India, in January of the current year. The object of the Society is to promote international co-operation in work on plant morphology, anatomy and embryology in the widest sense. It is hoped that the new journal will appear four times a year after the first year. Prof. P. Maheshwari, of the University of Delhi, is acting as convener of the Society and as editor (with the co-operation of botanists in different parts of the world) until formal elections to the executive council and editorial board can be held in 1952. Already some 290 members had been enrolled by October 1.

The first two numbers of vol. 1 of *Phytomorphology* make a substantial beginning. The papers include some of a specific factual kind and others in which themes of a more general character are discussed. Among the latter may be mentioned "The Use and Abuse of Anatomical Data in the Study of Phylogeny and Classification" (I. W. Bailey), "The Relationship of the Caytoniales" (T. M. Harris), "Organization in Plants" (C. W. Wardlaw), "The Male and Female Gametophytes of Angiosperms—An Interpretation" (E. Battaglia). A considerable paper on "The Leguminous Seed" is contributed by E. J. H. Corner, while A. G. Stokey has dealt in some detail with "The Contribution by the Gametophyte to Classification of the Homosporous Ferns". The journal is printed in a good clear type in double columns. The subscription is £2 10*s*. a year.

Physics in Canada, 1951

A recent publication of the Canadian Association of Physicists, "Physics in Canada, 1951", contains several interesting articles and a valuable factual survey of research in physics in Canadian universities, research foundations and industrial and government laboratories, in addition to a directory of Canadian physicists. The preponderance of nuclear studies over other branches of physics is particularly striking. The director of the computation centre at the McLennan Laboratory of the University of Toronto, Dr. G. C. Gotlieb, in an article entitled "Machines for Thought", discusses the various types of computing machines and indicates their probable development and effects on scientific work. Turning to their effects on society, Dr. Gotlieb examines Wiener's ideas on the subject as stated in the latter's book, "The Human Use of Human Beings", and asserts that Wiener does not make it clear that the Industrial Revolution originates from a deeper source than the development of machines. Cosmic ray research in Canada is reviewed by Dr. D. C. Rose, of the National Research Council, Ottawa, and some trends in modern meteorology by Dr. D. P. McIntyre, of the Meteorological Division of the Department of Transport. "As I recall Rutherford" is the title of a brief article by Dr. O. H. Westcott, associate professor of physics at McGill University, and formerly of the University of Birmingham and the Telecommunications Research Establishment, England. Dr. Westcott, in his appreciation of Rutherford, recalls some of the impressions he gained when a research student at Cambridge in the Cavendish Laboratory during the last four years of Rutherford's directorship of the Laboratory.

Publication of Papers by the Institution of Electrical Engineers

A noteworthy modification in practice in regard to the publication of scientific papers by the Institution of Electrical Engineers was initiated with the issue in October of a new section, Part 4, of the *Proceedings* of the Institution. In this new Part will be published from time to time, and in any case not less often than once a year, papers which are considered to be of so specialized a character as to be essential to the work of only a small minority of the readers of Parts 1, 2 and 3 of the *Proceedings*. The printing of such papers proceeds as soon as possible after their acceptance, and they are made available without delay as separate Institution monographs. The appearance of these is announced in the *Journal* of the Institution and on separate announcement sheets. A further step towards making Institution papers available as early as possible is the provision of early proofs of papers intended for presentation at a meeting of the Institution. Papers accepted for reading have first to take their place in the programme of meetings and may, after being read, have to wait possibly four or five months before being published. These papers are now printed without delay, and proofs are made available as soon as they are ready and are announced along with the monographs. There are, however, no early proofs of papers which have been accepted for publication but are not for reading at a meeting. The price of early proofs is 2*s*. 6*d*. and that of monographs 1*s*. 3*d*., but the early-proof service provides, without further charge, a reprint of the paper together with the report of the discussion on it. To facilitate the purchasing of early proofs, reprints and monographs, books of eight voucher-labels are available at a cost of 10*s*.

Earthquake Activity in New Zealand during 1949

The *Bulletin* of the Dominion Seismological Observatory, Wellington, extracted from the annual report for 1950 of the New Zealand Department of Scientific and Industrial Research, states that in 1949 the greatest number of earthquakes felt in New Zealand occurred during February of that year; and one of the strongest shocks of the year happened on February 10 off the coast of South Taranaki. The highest intensities in this shock affected the Taihape–Wanganui area, and it was perceptible from Tolaga Bay to South Canterbury. A shock of intensity 6 on the Modified Mercalli scale occurred in the southern part of South Island on May 27; and one of intensity 5–6 occurred between Murchison and Hanmer on September 28. On June 27 a shock in the White Island region occurred at a depth of 330 km. Shocks located in unusual regions occurred on April 14 and May 27, some 100–200 miles east of Christchurch, and on September 16 west of Cape Egmont. In all, ninety-seven earthquakes were reported felt during the year: seventy-one in North Island, thirty-four in South Island, and eight in both Islands. By arrangement with the Director of Meteorological Services, records from the Milne–Shaw seismograph at Suva, Fiji, were sent to Wellington for interpretation and publication of readings. Work has also been begun at the Observatory on a series of measurements of wave periods in local earthquakes, recorded at various seismograph stations in New Zealand, to provide some provisional data for the design of earthquake-resistant structures.

Territorial Behaviour in Birds

In some experimental work which involved the movement of nests within and across the boundaries of male territories in a small nesting colony of red-winged blackbirds (*Agelaius phoeniceus*), R. W. Nero and J. T. Emlen, jun., demonstrated certain characteristics of territorial behaviour which had not previously been described (*Condor*, 53, No. 3; May–June 1951). They show that the males recognized sharp and stable territorial boundaries which could be defined within a few feet and that they vigorously defended their territories against the intrusion of alien males, females or fledglings except when the latter were quiet; they also tolerated the introduction of alien nests. The males did not extend their aggressiveness beyond their territory boundaries even in the defence of their mates or nests in neighbouring territories. The females freely followed their nests as they were moved experimentally through the territory of the mate, but assumed a subordinate attitude and followed with difficulty when their nests were transported across territory boundaries; they took no part in the defence of the male territory, but opposed the encroachment of alien females on their nest vicinities. Males eventually accepted alien females which persistently invaded their territories to reach transported nests, while female residents of the same male territory tolerated each other at close quarters after nesting was under way but repulsed actual visits to the nest.

Council for the Promotion of Field Studies: Annual Report for 1950–51

In his annual report for 1950–51 to the Council for the Promotion of Field Studies, the director, Mr. F. H. C. Butler, states that the hope that local authorities would provide grant-aid to students to meet the increased charges recommended by the Ministry of Education has not been realized. This, coupled with the fact that a large number of students are not eligible for grants of any kind, has resulted in a serious decline in the number of students attending three of the Council's centres. At the fourth, Malham Tarn, the support of authorities in the North of England, and of the West Riding of Yorkshire in particular, has led to little decline in bookings. Hitherto, the salaries of scientific staff have been met by a direct grant from the Ministry of Education, and it would appear that the negative practice of providing grant-aid through local authorities is bound to lead to insecurity and lack of confidence among the scientific staff at the centres. The methods of providing grants for the Council should be re-examined, and its needs both as regards capital and maintenance re-assessed with due regard to those problems of conservation and pressure of student population which are particular to the Council's case (see *Nature*, June 30, p. 1041).

The Biology of Hot and Cold Deserts

The Institute of Biology is arranging a three-day conference on "The Biology and Productivity of Hot and Cold Deserts" during September 25–27 at the Royal Institution, London. Speakers from some eight countries have accepted invitations to give papers which will deal with problems of physiology and plant and animal ecology resulting from particular geographical conditions. Further particulars will be available in due course from the Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.1.

University of Glasgow

The following lecturers have been appointed in the University of Glasgow: A. W. Babister (aeronautical engineering), S. A. Barrett (zoology), E. H. Bellamy, W. K. Burton, A. L. Cockroft and J. G. Rutherglen (natural philosophy), W. A. Donaldson, J. Hunter and A. P. Robertson (mathematics), A. B. Garven and J. E. Gibson (civil engineering), J. S. S. Inglis (animal husbandry), S. Jennings (veterinary surgery), J. Loudon (engineering production), I. M. McIntyre (veterinary medicine and surgery), H. A. Moisley (geography), W. Mulligan (veterinary biochemistry), and R. S. Patrick (pathology). R. Ogilvie MacKenna has been made librarian and keeper of the Hunterian Books and MSS. Group-Captain W. K. Stewart has been appointed honorary lecturer in aviation physiology. John B. Birks has resigned from a lectureship in natural philosophy to become professor of physics in Rhodes University, Grahamstown. For the present session, new admissions to the Science Faculty of the University amount to 232, compared with 250 a year ago; and there are about two hundred research students. Over all departments of the University, the total number of matriculated students is now about 6,500 (5,150 men and 1,350 women).

Announcements

The annual meeting of the Science Masters' Association will be held in the University of Liverpool during January 2–5, under the presidency of Dr. J. F. Mountford, vice-chancellor of the University. Particulars can be obtained from W. G. Rhodes (Annual Meeting Secretary), 318 Granville Road, Sheffield 2.

The Mathematical Association is holding its annual meeting during January 3–4 at the Polytechnic, Regent Street, London, W.1. Particulars can be obtained from F. W. Kellaway, 87 Pixmore Way, Letchworth, Herts, or Miss W. A. Cooke, High School, Slough, Bucks.

THE STEPHENSON BUILDING, KING'S COLLEGE, NEWCASTLE UPON TYNE

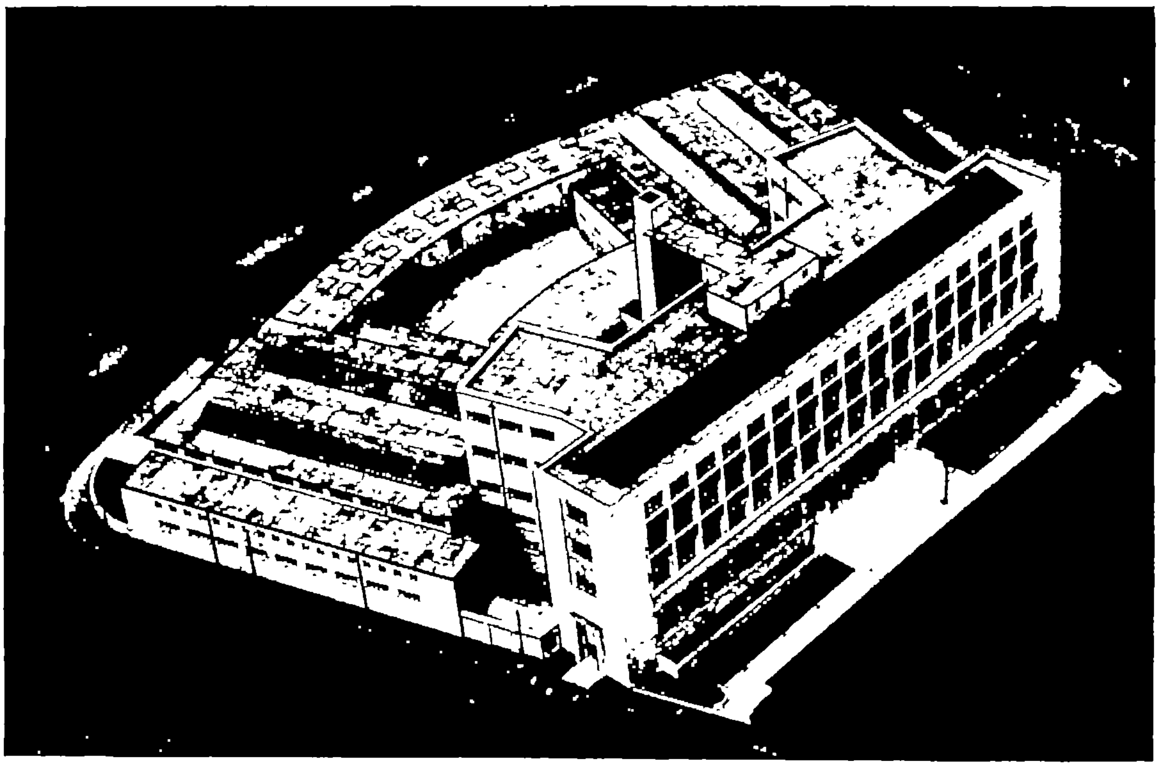
ONE of the most difficult problems of the older civic universities is that of finding room for the expansion necessitated by the large increase in the number of students and the widening scope of university studies. In Newcastle upon Tyne, King's College (the Newcastle Division of the University of Durham) lies near the centre of the city, and the civic authorities, conscious of the value of the College to the city and much impressed by its development in recent years under the guidance of Lord Eustace Percy as Rector, have been of great assistance in making possible the expansion of the College in its present locality. It is thanks to their co-operation, and that of the freemen of the city, that an island site very near the old College has recently been made available for the erection of a new building for the Department of Mechanical and Marine Engineering, with its allied branches of Chemical Engineering, Production Engineering, Fuel Technology and Agricultural Engineering.

This is the Stephenson Building, formally opened on November 28 by H.R.H. The Duke of Edinburgh, who explained in his speech that the building is named after George and Robert Stephenson, the father and son who did so much to develop mechanical engineering. George Stephenson lived for a time within a stone's throw of the site, and it is a matter for congratulation that the Department now possesses his portrait, recently presented to King's College by Dr. S. F. Dorey, president of the Institution of Mechanical Engineers during 1950–51, and a former student of the College. It is a copy of the Lucas portrait painted in 1847 when George Stephenson was the first president of the Institution of Mechanical Engineers.

The Stephenson Building has been designed for the study and teaching of mechanical and marine engineering, and its allied branches. It will accommodate 650 students in all.

The Department is well known for its courses in marine engineering—only three British universities offer such a course. Of recent years, increasing numbers of students from all parts of the world go to Newcastle, not only to attend the University course, but also to take advantage of the opportunity to visit local industries and works concerned with marine engineering and shipbuilding. Apart from the specialized courses, of which marine engineering is only one, students from other branches of engineering and applied science attend the Department of Mechanical Engineering for part of their studies. Other buildings in the College are available for specialized instruction in electrical engineering, civil engineering, metallurgy, naval architecture and mining.

In the Stephenson Building there is 70,000 sq. ft. of working floor space under cover, and half of this is on the ground floor. There is in addition an enclosed courtyard. To make the best use of the site an extra 10,000 sq. ft. of floor space has been added by building an additional storey on the front part of the building. For the time being, the additional floor is being used to accommodate the Department of Mathematics, and the proximity of the Engineering and Mathematics Departments is expected to be to their mutual advantage.



Aerial view of the Stephenson Building

Photo: Turners

Where very large rooms were required, for example, for laboratories for strength of materials, hydraulics, heat engines, chemical engineering and workshop, goods entrances have been provided directly into each laboratory, and overhead travelling cranes of 5 tons capacity have been installed. Service ducts are provided underground to supply electricity, water, gas and steam to any point required on the ground floor.

The laboratories have been designed so that changes can be made there as easily as possible. For example, there are test points in the walls for tapping off a substantial electricity supply for experimental work; there are grillages in the floor to which apparatus and machined cast-iron blocks may be fixed whenever required. Concrete foundations for machinery have been used only when there was no other alternative. Service pipes have been fixed in many of the laboratories high up on the walls, so as to make access easy for connexions and alterations. Classrooms and lecture theatres have been located in the upper storeys, away from the noise of the laboratories and workshops. A noteworthy feature is the large number of small rooms used for study rooms, classrooms, offices, stores and research rooms. There are more than a hundred of these small rooms in the Stephenson Building, taking up nearly 40 per cent of the total working floor space.

Private rooms for the teaching staff have been placed as near to the laboratories and workshops as possible. This has been achieved by arranging them on a gallery around the periphery of the laboratories, which has the advantage that it provides for observation and supervision of the laboratories without perambulation. In the main block there is a single entrance for students and visitors, so that the laboratories are not used as corridors.

A larger proportion of the resources available than is usual has been spent on workshop facilities. Prof. A. F. Burstall considers that a high-grade workshop equipped with up-to-date machine tools and measuring equipment is the first essential for a department of mechanical engineering, for the dual purpose of making apparatus for the whole Department (and for other departments of the College) and serving as an experimental laboratory for the course that has recently been started in production engineering. This workshop is particularly useful for making special apparatus for students' projects, which are specific tasks allotted to honours and postgraduate students and requiring the design and manufacture of a piece of equipment as part of the student's training. Apart from its value for this purpose, it has been found a useful way of adding to the Department's store of apparatus and special equipment.

At a Congregation of the University of Durham held in the building before the opening ceremony, the honorary degree of doctor of civil law was conferred by the Vice-Chancellor on the Duke of Edinburgh. In declaring the building open, the Duke said that two great wars had destroyed the prosperity which the Stephensons helped to create; it is now the task of universities and technical colleges to train and develop the minds of men who may one day be the means of restoring that prosperity. Engineers and men of science must produce new ideas and improved ways of supplying the world's demands. Prof. A. F. Burstall, head of the Department of Mechanical and Marine Engineering, in thanking the Duke for opening the building, said he hoped that the work done there would justify the faith of the University Grants Committee and the generosity of the Government.

PURIFICATION OF THE CELLULASE OF *MYROTHECIUM VERRUCARIA*

By D. R. WHITAKER

Division of Applied Biology, National Research Laboratories, Ottawa

SINCE the early work of Pringsheim, a multi-enzyme system has been repeatedly postulated to explain the enzymatic breakdown of cellulose to glucose[1,2]. The evidence for this mechanism is largely indirect and, so far as I know, no extensive concentration or purification of any enzyme component has been reported. The need for more direct evidence prompts this communication on procedures for the concentration and purification of the cellulase in culture filtrates of *Myrothecium verrucaria* Alb. et Schw., strain *USDA* 1334.2. Many of the cellulolytic properties of this culture filtrate have been described by Saunders *et al.*[3].

The mould was grown in a medium of 0·1 per cent glucose, 3 per cent benzene-alcohol extracted, ground cotton linters, and mineral salts of essentially the same composition as given by Saunders *et al.*[3]. No glucose was included in the medium for the shake-culture inocula. After nine to twelve days incubation at 30° C., with continuous aeration and rotary shaking, the medium was filtered, chilled to 1° C. and cleared in a Sharples super-centrifuge.

Enzyme activity was assayed by the increase in the Somogyi reducing-sugar titre given by the enzyme after 17 hr. at 35° C. in a shaken 1 per cent dispersion of precipitated cellulose in 0·05 *M* acetate buffer of *p*H 5·6. Thymol was present as an antiseptic. The precipitated cellulose was prepared from non-absorbent cotton by the method of Scales[4], followed by dialysis, precipitation and washing with ethanol, and vacuum drying. The relationship between the concentration of enzyme preparation and the reducing-sugar titre was approximately linear at low enzyme concentrations. The assay standard was taken as 0·5 ml. of untreated culture filtrate in 20 ml. of assay medium, and more concentrated solutions were assayed at dilutions giving approximately the same assay as the standard.

The culture filtrate was concentrated in 30-litre batches to about 8 litres by two passages at 30° C. through a Bartholomew evaporator[5], and then to about 3 litres by slow freezing at − 12° C. in an insulated glass jar, the ice being removed in a basket centrifuge. This concentration caused little loss in activity. The concentrate was cleared in a high-speed centrifuge and fractionated at *p*H 7 with ammonium sulphate; the precipitate forming at between 30 per cent and approximately 95 per cent saturation contained most of the activity. It was centrifuged to minimal volume, extracted by shaking with 200 ml. of distilled water for 6 hr. at 1° C., and the extract cleared by centrifuge. A typical extract, with a protein content of 2·6 per cent, had approximately a hundred times the activity of the original culture filtrate. There was no appreciable loss in activity on freeze-drying or on dialysis against dilute phosphate buffer with gold-beater's skin membranes. In the ultracentrifuge, the extract showed only one peak at *p*H 6·8, but this spread rather rapidly, suggesting polydispersity (Fig. *A*1). Electrophoresis at *p*H 6·8 showed at least four components (Fig. *A*2).

This extract could be purified chromatographically on calcium phosphate gel columns by the method of Swingle and Tiselius[6]. The most active fraction was

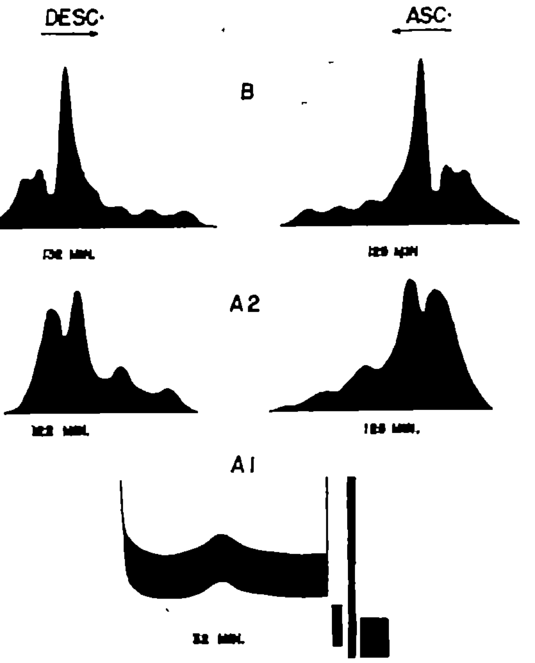


Fig. *A*1. First extract. Protein concentration 0·61 per cent, *p*H 6·8, *μ* 0·2. Speed, 60,000 r.p.m.
Fig. *A*2. First extract. Protein concentration 0·61 per cent, *p*H 6·8, *μ* 0·2
Fig. *B*. Fraction 2. Protein concentration 0·66 per cent, *p*H 6·8, *μ* 0·2

obtained by adsorption at 1 per cent protein concentration in 0·001 *M* KH_2PO_4,Na_2HPO_4 at 1° C., and elution with 0·05 *M* KH_2PO_4,Na_2HPO_4. Its activity per unit protein concentration was approximately double that of the extract. The main change in the electrophoretic pattern was a marked reduction of the slowest-moving component, and, in addition, a further minor fast-moving component could be resolved. Total recoveries from the columns were low, there being a marked tailing effect on elution.

A simpler fractionation is by ammonium sulphate precipitation in 2*N* acetate buffer of *p*H 5·6. On a 1 per cent protein solution, pooled from the most active chromatographed fractions, fraction 1 (precipitated at 50 per cent saturation) contained 23 per cent of the total protein and 18 per cent of the total activity towards precipitated cellulose. Its electrophoretic pattern showed marked enrichment in the fastest- and the slowest-moving components. Fraction 2 (precipitated at 100 per cent saturation) contained 72 per cent of the protein and 81 per cent of the activity. Its electrophoretic pattern (Fig. *B*) showed appreciable enrichment in the main intermediate component and appreciable loss in the fastest and slowest ones.

The enrichment of fraction 2 in activity towards precipitated cellulose was accompanied by enrichment in activity towards cellobiose and towards linters swollen in alkali by the method of Jørgensen , a swelling treatment claimed to cause only a conversion of crystalline to amorphous cellulose. Assays with swollen linters gave a somewhat higher value (c. 85 per cent) for the total activity in fraction 2. Assays with cellobiose gave results that depended on the concentration of cellobiose, hydrolysis appearing to be inhibited at higher concentrations. However, at all concentrations tested, from 0·1 to 1 per cent cellobiose, fraction 2 had the highest activity.

The rate of enzymatic hydrolysis varied greatly with the substrate, the following data for fraction 2 being typical :

0·1 per cent cellobiose, 0·0025 per cent protein :	54 per cent hydrolysis in 17 hr.
1 per cent precipitated cellulose, 0·0003 per cent protein :	12 ,, ,, ,, ,, ,,
1 per cent swollen linters, 0·0006 per cent protein :	5·2 ,, ,, ,, ,, ,,
1 per cent ground linters, 0·006 per cent protein :	1·2 ,, ,, ,, 40 ,,

The percentage hydrolyses for the celluloses were calculated by converting reducing-sugar titres to glucose and are thus minimal. Untreated linters was thus very slowly attacked. The importance of its crystallinity in this respect has been stressed by Pigman[8].

I am indebted to Dr. W. H. Cook and Dr. J. R. Colvin of this Division for the ultracentrifugal and electrophoretic examinations. [July 12.

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[3] Saunders, P. R., Siu, R. G. H., and Genest, R. N., *J. Biol. Chem.*, **174**, 697 (1948).

[4] Scales, P. M., *Z. Bakt. Parasitenk.*, 2 Abt., **44**, 661 (1916).

[5] Bartholomew, W. H., *Anal. Chem.*, **21**, 527 (1949).

[6] Swingle, S. M., and Tiselius, A., *Biochem. J.*, **48**, 171 (1951).

[7] Jørgensen, L., "Studies on the Partial Hydrolysis of Cellulose", 140 (Oslo: Trykt Hos Emil Moestue, 1950).

[8] Pigman, W., "The Enzymes", **1**, Pt. 2, 733 (New York: Academic Press, Inc., 1951).

WORLD CONFERENCE ON DOCUMENTATION

THE eighteenth Conference of the International Federation for Documentation was held in Rome during September 15–21, under the auspices of the Consiglio Nazionale delle Ricerche.

More than three hundred participants, representing thirty-one countries and a few supra-national bodies, including the Organization for European Economic Co-operation, Unesco and the Food and Agriculture Organization, took part in the proceedings, which were inaugurated by an official ceremony at the Capitol. The entire Conference was housed in the building of the Consiglio Nazionale delle Ricerche, Piazzale delle Scienze, in front of the Città Universitaria.

More than one hundred papers had been prepared, and, with most of them printed and some duplicated, they filled four bulky volumes which take a few weeks to study. To facilitate reference, not only for the future, but also, mainly, for purposes of the Conference, these papers have been listed in two ways : by country and subject. It is thus possible to gain an overall picture of achievements, ideas, suggestions in a particular country, or study developments, trends and openings in any specialized field. The listing by subject followed closely the grouping adhered to in the Conference programme as follows : (1) application of the Universal Decimal Classification ; (2) documentary reproduction methods and mechanical selection devices ; (3) bibliography and abstracting ; (4) auxiliary publications ; (5) training of documentalists ; (6) general problems of classification ; (7) linguistic problems and terminology.

It was unfortunate that only a few delegates had received their papers in time to allow preparatory study. For technical reasons, outside the control of the organizers, the rest became available for distribution only after the proceedings had started.

It would require a separate article to assess the encyclopædic value of these papers, record their contributions to routine, point to new problems which are raised and new approaches which are suggested. The present review must limit itself to the Conference and its outcome.

The main topics discussed by the various sections may be briefly described by abbreviated versions of the recommendations. The recommendation of Section (1) refers to the question of authorities responsible for publicizing and explaining the principles and practice of the Universal Decimal Classification. Among the specific tasks recommended for immediate attention, the following are especially mentioned: compiling and circulating a list of Universal Decimal Classification users; securing distribution of the new cumulative Extensions and Corrections to the Universal Decimal Classification; preparing a short edition based on the latest available Dutch "Verkorte Uitgave"; assisting in the revision of specific Universal Decimal Classification sections with special reference to the preparation of the fourth (English) and fifth (French) editions; preventing the distribution of unauthorized editions. Multilingual editions were also recommended by the Section.

The deliberations of Section (2) were centred on the comparative merits of the different micro-techniques, and the recommendations limited to matters of format and terminology. Questions of method and policy, touched upon in some of the printed papers, did not come up for discussion. Some of the delegates found fault with the exhibition of technical devices, organized for the Conference at the Istituto di Matematica, because it did not offer the ultimate solution of their problems. While the scope of the exhibition did not differ greatly from similar shows previously displayed in Britain or elsewhere, attention might be directed to a series of microcard readers, at different price-levels, from the United States, and to a prototype of a simple camera of Italian make for taking flat micro-film of the 'fiche' or sheet type. This type of film, incidentally, is gaining popularity (as might have been foreseen) for purposes where convenience of handling, filing, and so on, are more important than speed of initial operation.

Section (3) emphasized the need for better dissemination of technical information contained in patent specifications, recommended the drafting of standards for citations and descriptions of references, and discussed the possibility of standardizing the bibliographical and formal presentation of abstracts.

The discussions of Section (4) resulted in a recommendation urging universities and scientific institutions to have academic writings which they deem important published or reproduced by an appropriate process in numbers sufficient for the needs of exchange purposes, and noting, further, that such exchanges should not be based on the monetary value of the document. The Section also suggested that other scholarly production existing only in manuscript form should be listed in analytical bibliographies with indication of the depository library or documentation centre able to supply copies upon demand.

Much thought was devoted by Section (5) to the problem of training documentalists. It was, *inter alia*, suggested that archives and museums should be invited to participate in the deliberations hitherto attended mainly by librarians; that professional education should be regionalized wherever such development might be considered useful; that prototype programmes of education in documentation should be discussed in 1952, and a conference of persons responsible for the training of librarians and documentalists should be convened for 1953. It was finally suggested that, in response to an international need, documentation should be recognized as a profession in its own right, and that a professional statute for documentalists should be drawn up.

Section (6) recommended a survey of the different systems of classification now used in libraries, archives, documentation centres and government offices, and expressed the hope that possibilities of co-ordinating the different systems might be explored.

The recommendations of Section (7), worked out in considerable detail, may be summarized as follows. The specialized dictionaries hitherto available cover no more than a small part of all technical subjects and languages. Most of these dictionaries are technically inadequate from the user's point of view. Production of specialized vocabularies should be organized on international and national levels, and should be preceded by preparatory tasks under these headings: standardization of terminological and lexicographical principles; compilation of terminological bibliographies and directories of organizations dealing with terminological questions; compilation of bibliographies of classifications and of directories of organizations dealing with classifications. The various tasks should be assigned to specialized agencies, and only the international co-ordination should remain centralized.

The full text of the recommendations—of which only the gist could be given here—was formally adopted by the plenary session and submitted to the Council of the International Federation of Documentation, of which M. Arne Møller (Denmark) is now president.

The working programme of the Conference was pleasantly interrupted by a number of social engagements. A special and unexpected event was the audience granted to the participants of the Conference by the Pope at the Palazzo Pontificio di Castel Gandolfo, the Pope's private residence in the Alban Hills. His speech, in French, in which he summed up the problems confronting documentation, was afterwards published in the *Osservatore Romano* on September 21.

LUCIA MOHOLY

STATISTICAL METHODS IN CHEMISTRY

ON October 25, the London and South Eastern Counties Section of the Royal Institute of Chemistry held a discussion on "The Application of Statistical Methods to Chemistry". This was planned as a supplement to the course of lectures on statistical methods given for the Institute by Mr. D. R. Read in September 1950. Under the chairmanship of Dr. C. W. Herd, more than two hundred members assembled to hear four speakers give prepared answers to questions that had been submitted and to inquire for further information on special points.

In the first of the four short papers, Dr. E. C. Wood described how careful attention to experimental design can benefit the chemist. He emphasized particularly the difference between the 'classical' approach of testing each relevant factor in turn, in order to assess its effect on a quantity to be determined, and the modern method of factorial design. He showed that, when the best value for one factor in a chemical reaction depends upon the level of others, the classical method might fail to discover the optimal conditions in respect of the several factors. The alternative of testing a carefully selected set of combinations of levels of all the important factors may give more information on the optimal, from a smaller total number of observations yet with increased assurance that relevant interactions of factors had not been overlooked. Dr. O. L. Davies supplemented Dr. Wood's remarks by illustrating how, when tests of combinations of factors are to be made in succession rather than simultaneously, recent developments of special designs in the 'steepest ascent' technique can be made to yield information on the optimal even more economically. Dr. D. J. Finney later directed attention to the importance of randomization and the true independence of replicate observations in order that valid assessments of experimental error might be made.

In the second paper, Dr. D. J. Finney was concerned with the problem of choosing a form of curve to represent experimental data. He said that if mathematical theory can suggest the appropriate type of curve, this should be used and statistical theory would then show how to estimate it. If not, the experimenter should ask himself whether he really wants a curve, and should not try to fit one unnecessarily. Various transformations might be tried in order to bring a freehand curve into approximately linear form; but data additional to the first experiment would be needed in order to estimate the relationship as well as to infer its form. For smoothing and interpolation, as distinct from study of the fundamental relationship, the precise form of curve is often unimportant, as, for example, in bioassay. He warned particularly against extrapolation and against confusion of purpose between a 'utilitarian' curve and one representing fundamental properties of the material. Mr. D. R. Read illustrated the occasional need for fitting a complicated curve.

Dr. Davies had been asked to discuss a particular question relating to the sampling of tablets required to conform to a specification of density. He spoke of the need for care in the selection of a representative sample from each batch of tablets. This sample must be large enough to give reasonable confidence that a bad batch will not be accepted as good, nor will a good batch be rejected as bad on account of sampling variations. He gave details of two statistical tests, both sequential. The first involves classification of a random succession of tablets as 'good' or 'bad' until evidence on the proportion of good ones enables a decision to be taken. The second, using a sequential t-test, requires measurement of the density of each tablet instead of mere classification, but on an average would permit a decision to be reached from examination of about half as many tablets; the choice between the two methods must depend upon the relative costs of classifying a tablet as good or bad and measuring its density. For either test, the tablets in the whole sample selected must be examined in random order. Dr. Wood mentioned the dangers of uncritical use of sequential sampling.

Mr. Read's paper related to the rejection of apparently anomalous outlying members of a series of chemical determinations. He said that, though some discrepant observations might justifiably be rejected because of known accidents or anomalies during the experiments that produce them, the chief difficulty relates to whether (and when) observations might be rejected purely on the internal evidence that they had been affected by exceptionally large 'random' errors. He held that even in these circumstances an observation may occasionally be legitimately rejected, in the light of common sense, knowledge of relevant circumstances, and demonstration that its value is almost certainly too discrepant to be due to chance. He presented several statistical tests recently proposed for assessing the evidence for significant aberrancy in outliers, and suggested comparing their merits in terms of the probabilities that they would discover the contamination of a set of observations by an accidental error of specified size. He considered that one or other of these tests might be of real practical value, but that neither should be uncritically adopted. Dr. Finney and Dr. Wood later expressed doubts about the general utility of statistical tests for making what is basically a moral decision: whether or not to regard a particular observation as the product of accident, incompetence, or lunacy (rather than as a fair representation of natural deviation from a norm), on the sole basis of the internal evidence of the data. Dr. Wood nevertheless advised that long experience of the type of variation normally encountered with certain material might justify the experimenter in attributing an occasional aberrant value to an unsuspected accident.

The chairman then reviewed the papers. Before opening the meeting to general discussion, he commented on two matters: the frequent need for a decision, at one moment of time, on the sampling procedure for a bulk of material (such as a consignment of iron ore) that would thereafter not be available for further study, and the permissibility of rejecting a measurement about the validity of which an expert analyst is suspicious even though he cannot assign a reason. In reply, Dr. Davies emphasized the need for treating every sampling problem on its merits, in the light of knowledge of the material and its variability; the statistician could not devise a good scheme without preliminary study, possibly based upon a pilot sample. Mr. Read pointed out that only the experimenter could decide whether his 'hunch' justified him in rejecting the observation immediately or in making further experiments and applying a statistical test for rejection.

The questions and discussion that followed were of great interest, but can be reported only briefly. Many raised further points about the rejection of outliers. Mr. A. L. Bacharach pointed out that Dr. Wood's suggestion of deciding on rejection from past experience of the reasonable variation in the material under test is essentially an appeal to a statistical criterion (or else a doctrine of expediency). Dr. Finney suggested that control charts might be adapted to the evaluation of past experience in relation to rejection, and Mr. Sears said that the Institute of Petroleum has recommended something of this kind. Mr. Battersby mentioned that, in the analysis of bauxite, if two different analyses are seriously discrepant, it is customary to make several additional analyses and to average all results without rejection. Mr. Haslam spoke of the need for checking the effect of the personal factor, by making analyses or other measurements on material the true nature of which is known to others but not to oneself. Mr. Stevens commented on the danger of a spurious appearance of precision when publication of an analytical process in a standard work of reference is based upon multiple analyses in one laboratory: other workers, whose laboratories are possibly less exactly controlled, may show much poorer agreement through no fault of their own. Dr. Davies agreed that different laboratories often show appreciable differences in standard analyses. Dr. Finney emphasized the need for remembering that any standard deviation relates to the variation from a particular set of causes, and may well fail to characterize the dispersion of actual observations when additional sources of variation are introduced. Mr. Bacharach argued strongly that new standard analytical techniques ought to be studied collaboratively in several laboratories; he also reminded the audience that outliers should never be rejected without examination of causes, for observations that were apparently anomalous have often been the start of great new developments. Mr. Smart quoted an instance of a set of two hundred observations that conformed excellently to a normal (Gaussian) distribution if six extreme values were rejected; Dr. Finney maintained that this in itself did not justify the rejection unless there were strong *a priori* reasons for believing that the true distribution was normal.

Mr. Senior asked for advice on the sampling of very valuable material, for which the actual cost of the portion used in analysing a sample might be important. Dr. Davies suggested that the difficulty could be removed by the chemist devising techniques for the analysis of very small quantities. Dr. Wood pointed out that the policy to be adopted must be determined on economic grounds: if decisions of great monetary or other importance depend upon reliable analytical information, even large expenditure on sampling may be a desirable measure of insurance against grave errors.

Several other inquiries related to the sampling of continuous processes. Mr. Hewitt asked about the frequency with which indicators of a process ought to be read in order to provide adequate evidence of whether or not the process is in control. Mr. Soper suggested standard quality-control practices of intensifying observations when the control is under suspicion. Dr. Davies said that observations must be frequent enough to detect fluctuations of a size that would be important to the process, and that only by knowledge of the process could any more exact guidance be given. Dr. Wood warned against dependence on observations at regular intervals of time, regular in relation to shifts, or in any other way likely to be related to periodicities in the process, since periodic changes might impair the validity of estimates of variability; Dr. Finney directed attention to the non-independence of successive observations on a continuous process and the possibly autoregressive character of the errors.

In reply to a question from Mr. Berkovitch about the number of levels of various factors to be used in a factorial experiment for the estimation of optimal conditions, Dr. Wood suggested that three or four levels of each factor usually suffice. Dr. Finney thought that many factors at two levels each might be used in a preliminary trial, and those that were found most important might later be tested more intensively, at three or four levels each, over a narrower range. Dr. Davies again emphasized the great advantages of a sequential steepest-ascent investigation where this is practicable. Mr. Berkovitch also suggested that extrapolation from a set of observations, in spite of its logical and theoretical flaws, may legitimately be used to indicate useful lines for further experimentation; Dr. Finney fully agreed that this is valuable and certainly permissible provided that the extrapolations are not regarded as established before experiment has confirmed or refuted them. Mr. Soper suggested that time ought often to be regarded as a factor in an investigation, and all experiments repeated at two or three distinct times, since extrapolation in time is essential to the usefulness of any inferences drawn.

D. J. Finney

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING, SHINFIELD

REPORT FOR 1950

The farm must obviously be the site of much of the experimental work of a research organization such as the National Institute for Research in Dairying, Shinfield, and in the annual report for 1950, which has recently been published*, it is made clear that the farm is the important background of much of the laboratory work. The Institute has two farms, covering about seven hundred acres, with more than two hundred head of cattle—largely Shorthorns but with some Friesians and Guernseys. As in many other agricultural research centres, some developments, particularly those involving buildings, are unavoidably slow, and preparation for them occupies a lot of the time of the staff. But within these limits the work of the farms is very progressive, including the implementing of a well-defined breeding programme and the careful cataloguing of all records that may conceivably be needed in the interpretation of experimental results.

Besides maintaining the essential work and records of the farms as such, the Dairy Husbandry Section has a good deal of experimental work to its credit, including a continuation of studies of the rates of milking, of the suitability of certain fodder crops for milk production, and various experiments on the rate of growth and milk yields of pigs.

For some years the Institute has been concerned with factors affecting the efficiency of the use of food by ruminants, and the experimental work has lately been much facilitated by the design of a harness for the satisfactory separation of the urine and the fæces of the dairy cow. Much of this work has since been published. In the recent work it has been found that the softening of finely divided hay (as opposed to long hay) by grinding in the mouth reduces the ability to regurgitate. Initiation of the regurgitation reflex has, however, sometimes been brought about by appropriate hand-scratching.

It has been found that diets low in roughage cause a reduction in fat yield but do not affect the percentage of non-fatty solids. The properties of butter were affected, too, by low roughage diets, the butter having a higher percentage of unsaturated acids and a low softening point.

The report for last year called in question the use of lignin as a 'reference' substance in studying rates of digestion. The validity of using lignin depends on the assumption that it is not digested; but recent work at the Institute has shown that the results of the estimation of lignin digestion can differ considerably according to the method used, and also by the same method according to differences in composition of the diet. The lignin ratio technique is therefore suspect.

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* University of Reading: National Institute for Research in Dairying. Report for 1950. Pp. 103. (Shinfield: National Institute for Research in Dairying, 1951.) 2s.

The important work following the recent demonstration of œstrogen in British pasture is continuing in conjunction with the Courtauld Institute of the Middlesex Hospital. While œstrogenic activity was marked in grasses in 1949, there was little in 1950, and attention has been given to broad red clover, the œstrogen content of which seems to be more consistent. The work has been largely directed to the identification and separation of the active substances and to their occurrence, distribution and physiological action. Isolation is proving a difficult problem, but work is being pursued with a good hope that œstrogenic substances will be identified without isolation by a radioactive isotope method.

Work continues on the effects of different levels of œstrogen on mammary growth-rates in rats. American work having shown that a deficiency of folic acid restricts the effects of œstrogen in growth-rates in other connexions, the effect of administering a folic acid antagonist is being investigated in this work. While it is well established that aminopterin has a pronounced effect on body growth in general, nothing specific to mammary growth has yet been found.

The continued study of the synthesis of the fatty acids of milk from acetate (using sodium acetate with radioactive carbon in the carboxyl group) gives further evidence of the view that short-chain acids are intermediate in the formation of long-chain acids from acetate and emphasizes the importance of fatty-acid synthesis in the udder from small molecules. The belief that the utilization of acetate for milk fat synthesis takes place in the udder itself has been substantiated by experiments in which reactions in the liver and elsewhere were excluded.

Bacteriological work is involved in a large number of investigations, and the bacteriological examination of the milk produced on the farm has been systematically carried out. The Institute has co-operated in the work of a committee appointed by the Ministry of Agriculture to examine the resazurin and methylene blue tests, and investigations have been carried out into faults in cream and sterilized milk. The study of the classification of streptococci and lactobacilli continues to occupy several members of the staff. Work on the problem of fat absorption by the cup liners of milking machines, referred to in a previous report, has been finished, and the incorporation into the linings of a proportion of synthetic fat-resistant rubber has been shown to be possible.

Some interesting work is in progress on the role of micro-organisms in the synthesis of B vitamins in the rumen. Straw pulp, alkali-treated straw, hay and concentrates showed, in the order named, decreasing amounts of vitamin complex synthetized and a correlated decrease in the number of micro-organisms in the rumen fluid and on the food.

There is a good deal of work on the effects of antibiotics. The effects of certain antibiotics in accelerating growth in normal chicks have been confirmed. With chicks deficient in animal protein factor, however, this stimulation only occurred with vitamin B_{12}, which can presumably replace the other components of the animal protein factor. In work on the production of antibiotics, no streptococci outside the lactic group have yet been found with antibiotic-producing power.

Study of the physical properties of cheese has suggested some practical tests for quality assessment. The physical and rheological properties of butter have been claiming attention, but the work has not yet reached a stage for report.

The proteins of milk are the subject of a number of investigations. Work connected with the inactivation of lysine during the storage of dried skim milk gives support to the view that lysine is not essential for maintenance in rats. The preheating of milk under pressure before spray-drying did not seem to affect either the biological value or the digestibility of the protein. There is evidence that vitamin B_{12} is involved in protein metabolism: the biological value of casein fed to chicks without B_{12} was 82·2; with vitamin B_{12} it was 89·7.

The testing of all kinds of equipment is a continual concern of the Engineering Department. The work there, however, is not confined to routine; it includes studies of the electronic treatment of milk and of boiler water and the ultra-violet irradiation of milk. In much of this work the staff are in close contact with workers in other countries.

Reference can only be made in this short account to some of the work being done; but these references will show the kind and the diversity of the work, and a catalogue of it can be seen in the list of ninety-five publications appended to the report.

MELLON INSTITUTE, PITTSBURGH

ANNUAL REPORT FOR 1950-51

THE thirty-eighth annual report of the president of the Mellon Institute, Dr. E. R. Weidlein, to the board of trustees, published under the title "Current Scientific Researches in Mellon Institute, 1950–51"*, covers the year ended February 28, 1951. During this year the Institute's building was completed, including new executive offices, a new periodical room for the library and a new conference room.

In the Department of Chemical Physics a collaborative programme on the properties of synthetic rubber, initiated under the ægis of Multiple Fellowships, designed to study the infra-red spectra of rubber-like polymers, has already shown that sometimes both *cis*- and *trans*-polyisoprenes are produced by the same biological plant. A special Weissenberg camera and a Laue camera have been designed and built for the crystal study at temperatures down to that of liquid nitrogen of compounds normally liquid or gaseous at room temperature. Research in physical chemistry has been principally in the theory of distillation, including a completed study of the performance of intermittent take-off heads for distillation columns. In the Department of Organic Chemistry work has persisted on diabetes caused by alloxan, and work on the biochemistry of mental diseases has tentatively confirmed the hypothesis that the urine (and, presumably, the blood) of some patients contains a pathological constituent, suggesting that the patients also suffer a metabolic or endocrine disturbance. Two series of pteridine derivatives were in the course of being studied—one related to folic acid, and the other to the antagonist, aminopterin. The fellowships which began in 1950–51 have been for research on artists' materials, the technology of furfuraldehyde, matches, meters, and nitrogen compounds, and a comprehensive programme on special fibres. Fellowships completed during the year dealt with the processing of fibres for felt hats, the neutralization of acid mine drainage, the properties of silica gel and the related oxides and the influence of methods of preparation on properties, catalysts for butadiene and synthetic rubbers, the preparation of collapsible tubes from plastics, and the dimensional stabilization of wood by impregnation with a phenolic resin or other chemicals.

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* Current Scientific Researches in Mellon Institute, 1950–1951: the Thirty-eighth Annual Report of the President, E. R. Weidlein, to the Board of Trustees of the Institute for the Fiscal Year ended February 28, 1951. Pp. iv+52. (Pittsburgh, Pa.: Mellon Institute, 1951.)

The bulk of this report is concerned with research under continuing fellowships, and of these it is only possible to mention but a few to illustrate the wide range of activities at the Institute. Under the Optical Glass Fellowship the variations in physical properties with heat treatment are being investigated, while during the fifteenth year of the Mineral Products Fellowship four products from siliceous wastes from plate-glass plants have been derived. The Ceramic Chemicals Fellowship has been extended to studies of the fundamental reactions of vitreous enamels and to the formulation of compositions yielding enamels which mature at relatively low temperatures and which can be fired at higher temperatures without change in opacity or colour and are highly resistant to acid. Work under the Multiple Fellowship on Acid Recovery has been directed to simplifying a process for the recovery of manganese from low-grade ores with waste pickle liquor, and under that on Chemical Storage a report has been made on the proper storage of forty-four different substances, and also on evaluating the stresses in large tubular elevated water-tank columns. A similar Fellowship on Insulation and Roofing has provided technical information on a new 'Super-Light' 85 per cent magnesia insulation and the development of a new high-temperature insulating material, 'Tempchek'. The Fine Wire and Flat Strip Fellowship has been turned to the production of fine flat-strip for use in such end-products as razor blades, clock and watch springs, pen points and umbrella ribs.

Under the Multiple Fellowship on Nickel a study has been made on several supported nickel sulphide catalysts in the hydrocarbon–steam reaction in the presence of sulphur compounds. The report reviews briefly the twenty years of work under the Multiple Fellowship on Sulphur; the causes, prevention and control of bituminous coal-waste fires were being investigated under the Coal Waste Control Fellowship, while under the Fellowship on Tar Constituents new methods have been worked out for the analysis of crude phthalic anhydride, for the determination of thionaphthen in naphthalene and the analysis of commercial divinylbenzene. Research under a Fellowship on Effluents has led to the isolation of strains of micro-organisms which utilize phenol, and has built up their tolerance to a strength which will destroy phenol in concentrations of 500–1,000 p.p.m. in a modified mineral-salts bacteriological medium; under a Fellowship on Aromatic Anhydrides improved catalysts for the manufacture of phthalic anhydride have been developed; and under another on Special Resins a thorough kinetic study has been made of the condensation of resorcinol with formaldehyde in various solvents. The work of a Multiple Fellowship on Petroleum has included the separation and identification of sulphur compounds in crude oils, the deterioration of lubricating oils by oxidation and the study of metallic catalysts for hydrocarbon synthesis from carbon monoxide and hydrogen. A fundamental study has been made of the factors affecting the loss of activity of granular sugar-refining absorbents in service, while the piperonyl insecticides have been proved safe to warm-blooded animals and are being used in liquid insecticide aerosol formulations, and especially for the protection of stored grain.

Under a Silk Fellowship the factors in the throwing operation which may affect the dyeing characteristics of nylon have been investigated as well as new sizing materials available for nylon yarns. Under the Garment Filling Fellowship a new fibre-forming process, by the corrugation of fibrous webs, has given fillers of exceptional resistance to compression, while in research on fillers for sleeping-bags an entirely new process for utilizing chicken feathers has been developed. Further work on the effects of various 'size additives' has been carried out under the Paper Fellowship, and considerable progress has been achieved during the year under a Multiple Fellowship on Synthetic Rubber Properties in techniques for determining molecular structure and for studying physical properties. A detailed examination of the dynamic and creep properties of poly*iso*butylene as a function of frequency and temperature has been completed.

During the year, under the Multiple Fellowship on Organic Synthesis, some 130 new products were made available in research quantities, fifteen new compounds, including substituted glycols and aromatic glycol ethers, were prepared in pilot plant equipment, and the feasibility of solvent recovery with activated carbon was investigated for the new applications. Fundamental studies were made of the utilization of glyoxal for rendering proteins and carbohydrates insoluble, while a study of 'builders' and formulating techniques has promised to yield non-ionic detergents of high scouring-efficiency and adequate foaming-value. Other work has increased the knowledge of the effect of conditions of application on the performance of polyvinylbutyral 'wash primer' coatings, and improvements in the extrusion rheometer have increased its value in predicting the coating properties of dispersion formulations. Lubricants, anti-foaming agents, resins, moulding compounds and laminating materials developed from organo-silicon compounds in twelve years of work under the Fellowship on Technical Glassware are finding increasing application, while a Cork Fellowship has demonstrated the value of synthetic resins, with their superior abrasion and resistance to solvents, as binders for floorings. Under an Orthopedic Appliances Fellowship a special type of knee joint and lock has been developed and adapted for mass production from die stamping, and improvement has been made in the characteristics of the 'Fibreglass'–'Bakelite' low-pressure resin-laminating system, which is being widely used in the brace and limb industry.

The quantitative pharmacology of more than sixty chemicals has been outlined under the Fellowship on Chemical Hygiene, a detailed study made of ten established compounds, and correlations established between frequencies and depths and the retention of inhaled dusts. Field researches have included studies on the chemistry of the oxidation of sulphur dioxide and the development of instruments for measuring the intensity of atmospheric pollution at ground-level, as well as six medical surveys and various studies in industrial hygiene.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

ABO Blood Groups and Sex-Ratio at Birth in Man

SEX-RATIO at birth in man and some other organisms has been a subject of investigation for several decades. No clear evidence has been available indicating its association with any known hereditary trait. The purpose of this note is to point out such an association of sex-ratio with *ABO* blood groups in man. The data consist of *ABO* determinations of 1,330 mothers and cord blood of their newborn infants, delivered during the second half of 1944, at the Nowrosjee Wadia Maternity Hospital in Bombay. The original purpose of that investigation was to study the frequency of subgroups of *A* in the sample of mothers[1] and the incidence of hæmolytic anæmias in their newborn infants[2,3]. Recently there was occasion to re-examine the data for *ABO* determinations and sex-ratio in infants. Results of this analysis are given in Table 1.

Table 1. *ABO* BLOOD GROUPS OF INFANTS CLASSIFIED ACCORDING TO SEX AND BLOOD GROUPS OF THEIR MOTHERS (BOMBAY)

Infant		Mother				
Group	Sex	*O*	*A*	*B*	*AB*	Total
O	Male	158	46	53	—	257
	Female	103	42	44	—	189
A	Male	50	108	20	16	194
	Female	55	109	15	16	195
B	Male	45	23	124	25	217
	Female	33	24	91	18	166
AB	Male	—	19	25	14	58
	Female	—	22	21	11	54
Total	Male	253	196	222	55	726
	Female	191	197	171	45	604

In this table, figures in the three classes, namely, *O* infants born to *O* mothers, *A* infants born to *A* mothers, and *B* infants born to *B* mothers, are large enough for further consideration. There is a significant difference ($\chi^2 = 5 \cdot 57$, $P < 0 \cdot 02$) in the sex-ratio (percentage of males) of *O* infants born to *O* mothers ($60 \cdot 5 \pm 3 \cdot 0$) and the sex-ratio of *A* infants born to *A* mothers ($49 \cdot 8 \pm 3 \cdot 4$). The sex-ratio of *B* infants born to *B* mothers ($57 \cdot 7 \pm 3 \cdot 4$) is similar to the sex-ratio of *O* infants born to *O* mothers. The overall sex-ratio is $54 \cdot 6 \pm 1 \cdot 4$.

It was thought necessary to check this finding with data from some independent source. At the Presbyterian Hospital, New York, *ABO* determinations have been made as a routine, mostly of *Rh*-negative mothers and their newborn infants, for the past few years. Analyses of the data collected since January 1949 are given in Table 2.

There is a similar difference ($\chi^2 = 4 \cdot 93$, $P < 0 \cdot 05$) in the New York data to that found in the Bombay data, in the sex-ratio of *O* infants born to *O* mothers ($56 \cdot 3 \pm 3 \cdot 0$) and the sex-ratio of *A* infants born to *A* mothers ($45 \cdot 7 \pm 3 \cdot 7$). The overall sex-ratio in New York data is $52 \cdot 7 \pm 1 \cdot 7$.

It would be difficult to speculate how general is the trend shown in Bombay and New York data. Such a difference could arise by differential mortality during the prenatal period, or differential gametic fertilization or both. Differential mortality, if it exists, would not be explained only in terms of the process of isoimmunization due to *A* and *B* antigens, as the notable differences in the sex-ratio are found in combinations where mother and her newborn infant belong to the *same* *ABO* blood group. A detailed account of this finding with some related evidence will be published elsewhere.

Table 2. *ABO* BLOOD GROUPS OF INFANTS CLASSIFIED ACCORDING TO SEX AND BLOOD GROUPS OF THEIR MOTHERS (NEW YORK)

Infant		Mother				
Group	Sex	*O*	*A*	*B*	*AB*	Total
O	Male	153	45	21	1*	220
	Female	119	54	21	—	194
A	Male	55	85	6	9	155
	Female	51	101	6	3	161
B	Male	21	7	29	7	64
	Female	23	4	15	4	46
AB	Male	—	9	4	4	17
	Female	—	2	4	2	8
Total	Male	229	146	60	21	456
	Female	193	161	46	9	409

* Exception to Bernstein's theory of *ABO* heredity.

I am grateful to Dr. V. R. Khanolkar for technical facilities at the Tata Memorial Hospital, Bombay. I am also grateful to Prof. Leslie C. Dunn, of Columbia University, and Dr. Richard L. Day, of the Presbyterian Hospital, New York, for consultation and encouragement. Information collected at the Presbyterian Hospital by Dr. John L. Scudder was kindly placed at my disposal by Dr. Day.

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Discovery of the Expected Hæmagglutinin, Anti-Fy^b

THE hæmagglutinin described in this note was found in the serum of Mrs. Hahn, of Berlin, following the birth of her third child.

The mother gave no history of blood transfusion. Neither her two previous children, nor the third, showed any signs of hæmolytic disease of the newborn, though the first died at the age of two months of a nutritional disorder. She was delivered of her third child, a female, at the Wenckebach Hospital, Berlin Tempelhof, by Dr. Haacke, and the abnormal antibody was discovered two days after delivery in the course of the routine examination of all post-natal maternal sera, carried out at the Robert Koch Institute.

The antibody was found to have a titre of 16,000 when tested against the red cells of both the husband and of the new-born child, suspended in gelatin solution. Against a number of specimens of group *O* cells suspended in saline the titre was 16. The serum was next tested in Berlin against the blood of seven persons whose red cells had previously been tested for nearly all known antigens. The antigen defined by the new antibody was present in six of these bloods, and did not correspond to any for which they had previously been tested. The serum was further tested in London against a larger panel of red cells. It was observed that reactions were stronger in albumin than in saline, and stronger at 37° C. than at room temperature. Again, no correspondence was

THE BLOOD GROUPS OF THE HAHN FAMILY

Initials	Relationship to U. H.	Reaction with serum of U. H.	Fy^a	ABO	Rh	MNS	P	Lu^a	$Kell$	Le^a	Le^b
U. H.	—	−	+	O	R_2r	MMS	+	−	−	−	+
Rg. H.	Husband		+	A_1	R_1R_1	MMS	+	−	−	+	−
A. H.	Second child		+	A_1	R_1r	MMS	+	−	−	−	+
E. B.	Mother	+	+	O	R_1R_2	MNS	+	+	−	−	+
M. H	Mother-in-law		+	A_1	R_1R_1	MMS	+	−	−	−	+
Er H.	Father-in-law	+	−	O	R_1R_1	MNS	−	−	−	−	+

observed with any known antigen; but it was found that all the non-reactors were positive for the Duffy antigen (Fy^a) of Cutbush, Mollison and Parkin[1] and that all the Duffy negatives were positive for the new antigen.

This suggested that Mrs. Hahn's serum contained the expected but hitherto undiscovered antibody anti-Fy^b, reacting with the antigen produced by the gene Fy^b, the allele of Fy^a. The accompanying table shows the reactions of the red cells of Mrs. Hahn and her family with anti-Fy^a, and, where possible, with her own serum. Owing to shortage of this serum no attempts were made to absorb out the contained anti-A and anti-B, and all tests, both of the family and of other specimens, were confined to blood of group O. The family results are clearly consistent with the hypothesis here put forward.

During the whole course of the investigation fifty-nine specimens of known reactions with anti-Fy^a were tested with the new serum. Of these, twenty-eight were positive with both, eleven with anti-Fy^a only, and twenty with the new serum only; none was negative with both. The probability of obtaining such a result by chance if the sera were unrelated is 1 in 167.

One hundred unselected blood specimens were tested in Berlin with the new serum, of which seventy-nine were found to react, this corresponding well with the theoretical proportion of 83·17 per cent of Fy^b reactors in the English population, based on the calculations of Race and Sanger[2].

While this work was in progress, Drs. R. R. Race and Ruth Sanger had been carrying out titrations of large numbers of blood specimens with an anti-Fy^a serum. They had assigned scores to the titrations in the manner described by Callender and Race[3], and had found that these scores fell clearly into two classes, with very few intermediates, the lower scores corresponding to heterozygotes Fy^aFy^b in all cases where the genotype could be deduced from family studies. They very kindly allowed us to make use of these results.

Twenty specimens showing low Fy^a scores and therefore presumed to be heterozygous were tested with the new antibody and all were found to be positive. Seven showing high scores were all negative with the new antibody. The probability of obtaining such a result by chance with two unrelated sera is about 1 in 900,000. Moreover, three of the twenty presumably heterozygous specimens could be shown, from genetical studies with anti-Fy^a alone, to be actually heterozygous. These tests were confined to bloods which gave clear-cut results in the Fy^a titrations; but we afterwards tested with the new serum two specimens which gave intermediate scores with anti-Fy^a. One was, in fact, found to be positive and one negative with the new serum, the positive one, contrary to expectation, giving the slightly higher score with anti-Fy^a.

Sixteen tests with the new antibody were carried out by a titration technique. Of the eleven specimens giving positive results, two showed markedly higher titres than the rest. These two were the only Fy^a-negatives in the series.

These observations appear to furnish conclusive proof that the new antibody is anti-Fy^b. The possible existence of a rare third allele of Fy^a and Fy^b, giving rise to reactions with neither antibody (or with both), is not, however, ruled out.

A further specimen of serum was obtained from the donor ten weeks after delivery, but was found to contain very little antibody. Further investigations must therefore await the development of a more powerful antibody, either in this or some other human subject, or possibly in an animal.

If good supplies of both antisera, anti-Fy^a and anti-Fy^b, should become available, the gene frequencies are such that the system would be a most useful one for purposes such as personal identification and the exclusion of disputed paternity.

We should like to thank Drs. R. R. Race and Ruth Sanger for allowing us to quote their unpublished observations, and Dr. D. Lehane, who supplied the anti-Fy^a serum used in the investigation.

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Complete Sporogonic Development of *Plasmodium berghei* in Experimentally Infected *Anopheles* spp.

SINCE the discovery of *Plasmodium berghei* by Vincke and Lips[1], repeated attempts have been made to infect various anopheline and culicine mosquito species with this plasmodium in the laboratory. Oocysts and sporozoites have been observed in naturally infected *Anopheles dureni*[2], but apart from the finding on two occasions of small numbers of young oocysts in experimentally infected *A. maculipennis* var. *atroparvus*[3], no sporogonic development of *P. berghei* under experimental conditions has hitherto been described.

In this preliminary communication we are able to report successful laboratory infections of *A. stephensi* with *P. berghei*, and the complete sporogonic development of the parasite from young oocysts in the mid-gut to mature sporozoites in the salivary glands.

The strain of *P. berghei* used in the present experiments was a recently isolated strain producing large numbers of mature gametocytes in infected mice and rats. This strain (*S.P.* 28 *S.* Keiberg) was derived from sporozoites of a wild-caught *A. dureni* inoculated into white rats. The strain was received through the courtesy of Prof. J. Rodhain on January 11, 1951, and has been maintained in the laboratory by blood inoculation. Previous attempts to infect *A. stephensi* with this strain met with only slight success. Although exflagellation was found to occur regularly, only small oocysts were observed, occurring singly or in small numbers, in eight *A. stephensi* from a total of 93 dissected.

In the present experiment a group of 120 *A. stephensi* were fed on a rat infected with *P. berghei*. 29 mosquitoes dissected at intervals up to fourteen days later showed no evidence of oocyst or sporozoite development. 76 *A. stephensi* surviving from this group were allowed to feed on a golden hamster (*Mesocricetus auratus*) infected seven days previously by blood inoculation, and 15 were maintained as controls on raisins only. All the mosquitoes were kept at a temperature of 26–27° C. and at high humidity in the insectary. Dissections of stomachs and salivary glands were made from the fifth day onwards.

All stages in oocyst development have been seen in the dissected *A. stephensi*. Mature oocysts containing sporozoites were observed at the end of the seventh day and after. Sporozoites in the salivary glands were found by the twelfth day. The fully developed sporozoites measured 11·5–13 µ in length. The number of sporozoites in the salivary glands was found to be surprisingly small, and the percentage of infected glands was low (3 out of 23, or 19 per cent of mosquitoes dissected from the tenth day after feeding) compared with the oocyst infection-rate. Of 71 *A. stephensi* dissected 52 were found to be infected, giving an infection-rate (oocysts and/or sporozoites) of 73 per cent. None of the controls showed evidence of infection.

The results obtained show that *A. stephensi* under laboratory conditions will produce mature oocysts containing sporozoites in a very high percentage of mosquitoes fed on infected hamsters, and that under the experimental conditions described only a small number of the sporozoites reached the salivary glands. The very high infection-rate produced in *A. stephensi* fed on a hamster infected with *P. berghei* demonstrates the usefulness of *M. auratus*[4] as a mammalian host in the laboratory study of *P. berghei* infections.

This work has been carried out in the Department of Parasitology, London School of Hygiene and Tropical Medicine, in collaboration with the Ross Institute. We wish to thank Prof. H. E. Shortt and Dr. P. C. C. Garnham for their advice and encouragement.

Nov. 9.

A similar technique was used for investigations on *A. maculipennis* and *A. quadrimaculatus*.

Thirty-five laboratory-bred *A. maculipennis* var. *atroparvus* and ten *A. quadrimaculatus* were allowed to feed on hamsters infected with the *S.P.* 28 Keiberg strain of *P. berghei* and showing mature gametocytes in the peripheral blood. The mosquitoes were kept in the insectary at 26–27° C. and at a high humidity. Dissections started from the third day onwards, and revealed moderate and high oocyst infections (see photomicrographs) in both these species. Oocysts on the fourth day averaged 7 µ, on the fifth day 11 µ, on the sixth 16–18 µ, and on the seventh day 18–21 µ. Ripe oocysts were detected from the eighth day onwards and averaged 30–34 µ. The first detection of sporozoites in the salivary glands occurred on the ninth day after feeding. Of 29 *A. maculipennis* dissected, 18 were infected (62 per cent); of 10 *A. quadrimaculatus* dissected, 7 were positive (70 per cent).

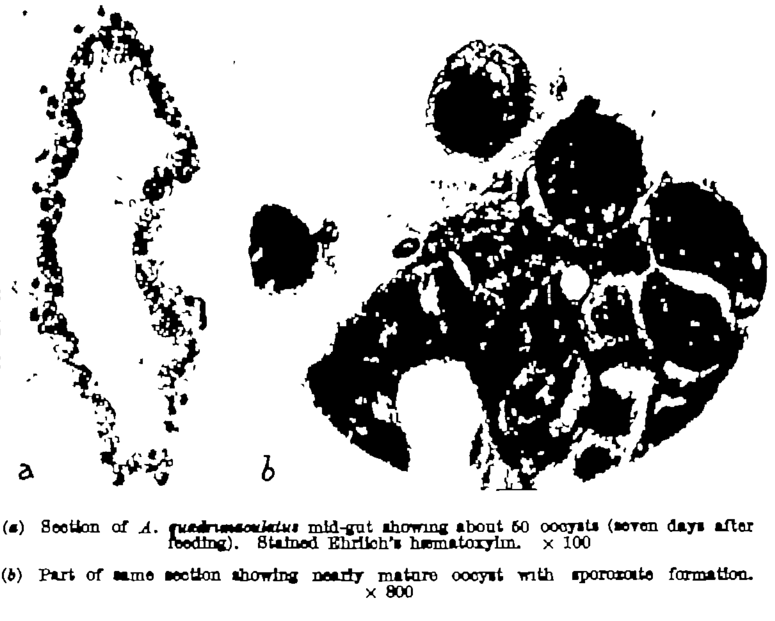
The development of the oocysts under the experimental conditions described was rapid; on the fourth day some oocysts showed advanced nuclear division.

Black spores and chitinization of sporozoites in the ripe oocysts and in the salivary glands occurred in a number of infected mosquitoes from the tenth day onwards.

Successful laboratory infection with *P. berghei* (*S.P.* 28 Keiberg strain) has now been established in three different species of mosquitoes: an Indian oriental species (*A. stephensi*), a European palæarctic species (*A. maculipennis* var. *atroparvus*), and a north American species (*A. quadrimaculatus*).

Transmission of *P. berghei* by inoculation of sporozoites from ruptured oocysts (of *A. stephensi*) into a young hamster has been carried out. Parasites were first found in the blood on the tenth day after inoculation.

This work has been carried out in the Department of Parasitology, London School of Hygiene and Tropical Medicine, in collaboration with the Ross Institute. We have pleasure in acknowledging the



(*a*) Section of *A. quadrimaculatus* mid-gut showing about 60 oocysts (seven days after feeding). Stained Ehrlich's hæmatoxylin. × 100

(*b*) Part of same section showing nearly mature oocyst with sporozoite formation. × 800 assistance given by the technical staff of the Ross Institute.

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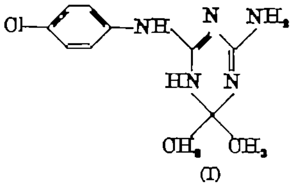
A Metabolite of 'Paludrine' with High Antimalarial Activity

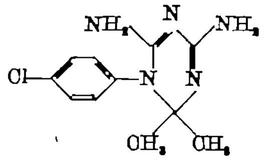
Since the discovery of 'Paludrine' (proguanil, N^1-*p*-chlorophenyl-N^5-*iso*propyldiguanide) by Curd, Davey and Rose[1], considerable evidence has accumulated that this drug probably differs in its mode of action from most other antimalarials. Direct evidence that proguanil is transformed in the animal body into another, more active, compound was provided by Hawking[2] and Hawking and Perry[3], who showed that proguanil has no action on *in vitro* cultures of the exo-erythrocytic forms of *Plasmodium gallinaceum* or on the blood forms of *P. cynomolgi*, whereas, under similar conditions, serum from animals dosed with the drug has high antimalarial activity.

Experiments have therefore been in progress for some years with the object of isolating and identifying this hypothetical metabolite of proguanil, and these have now been successful. From the urine of rabbits receiving daily doses of proguanil (50 mgm./kgm.), there has been obtained a basic substance, isolated first as the picrate, crystallizing from ethanol in canary-yellow needles of melting point 206°, and then as the free base, which crystallized from a mixture of moist chloroform and ether in colourless prisms of melting point 146°. The same product has also been isolated from the fæces of rabbits, and from the urine of human volunteers receiving proguanil. Experiments have shown that the metabolite is about ten times as active as the parent drug against infections of *P. gallinaceum* in chicks.

Analysis of the picrate and of the free base showed the empirical formula of the metabolite to be $C_{11}H_{14}N_5Cl$, the molecule having two atoms of hydrogen fewer than that of proguanil. When the base is heated, either alone or in alkaline aqueous solution, it is readily converted into an inactive isomeric substance which is identical with a compound prepared by Birtwell, Curd, Hendry and Rose[4] from N^1-*p*-chlorophenyldiguanide and acetone in the presence of piperidine, to which the structure 4-amino-2-*p*-chloroanilino-1 : 6-dihydro-6 : 6-dimethyl-1 : 3 : 5-triazine (I) had been assigned. The two isomers are readily distinguished by their chemical and physical properties, and especially by their ultra-violet absorption spectra. The chemical evidence indicates that the active metabolite is 2 : 4-diamino-1-*p*-chlorophenyl-1 : 6-dihydro-6 : 6-dimethyl-1 : 3 : 5-triazine (II), and this structure has been confirmed by an X-ray crystallographic analysis by Miss M. Bailey and Dr. A. F. Wells.

Crounse[5] has described the isolation of two substances as metabolites of proguanil, namely, the inactive triazine (I) and N^1-*p*-chlorophenyldiguanide.


(I)


(II)

In view of the easy conversion of (II) into (I), and its ready hydrolysis to N^1-*p*-chlorophenyldiguanide by dilute acid, it seems likely that neither of these substances was a primary product of metabolism, but that both were derived from (II). We ourselves have no definite evidence of the direct production of either of them from proguanil in the animal body.

The condensation of N^1-*p*-chlorophenyldiguanide with acetone by Birtwell *et al.* had been carried out under conditions in which the active metabolite is not stable, but by modifying these conditions an easy synthesis of the desired substance has been achieved[6]. The synthetic method has been applied to a wide range of diguanides and aldehydes and ketones. The antimalarial activity of the dihydrotriazines thus formed is in the main parallel to that of the corresponding diguanides, but at a much higher level. In particular, 2 : 4-diamino-1-(3 : 4-dichlorophenyl)-1 : 6-dihydro-6 : 6-dimethyl-1 : 3 : 5-triazine shows outstanding activity, with an effective dose of about one-hundredth that of proguanil against *P. gallinaceum* in chicks.

Details of this work will be reported elsewhere.

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Occurrence of Thin Membranes in the Surface Layers of Human Skin and in Finger Nails

As reported earlier[1], wool fibres are enveloped by a thin membrane, the epicuticle. This structure is also found not only on human, horse and other animal hairs, but also on feathers[2]. Since structures of this type seem to be rather common, a few more animal structures have been investigated.

Thin pieces of skin loosened from sun-burnt human back were treated with 1 per cent sodium sulphide at 50° C. for six days followed by treatment at room temperature for fourteen days. This treatment is similar to the method used for isolating epicuticle from wool[3]. The residue was washed with water and examined in the electron microscope after shadowing with palladium at an angle of 4 : 1. Pieces of the type shown in Fig. 1 were found. The thickness of the pieces are of the order of magnitude 100 A., which is the same as for the mem-

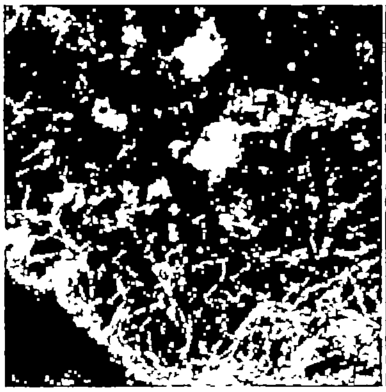

Fig. 1. Folded membrane from skin of the human back. Palladium shadowing, 4 to 1

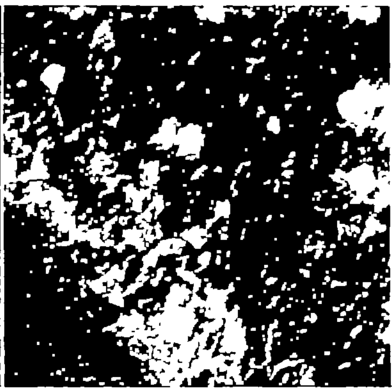

Fig. 2. Membrane from thickened skin from the palm of the hand. Palladium shadowing, 4 to 1

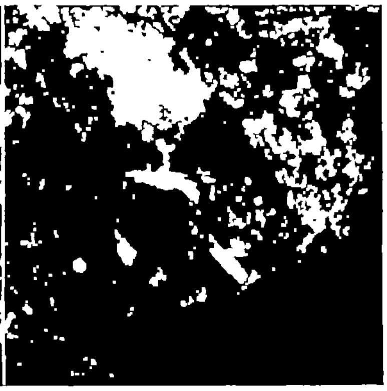

Fig. 3. Membrane from finger nail. Palladium shadowing, 4 to 1

branes earlier mentioned, and the diameter of the pieces is approximately 20–30 μ. In contrast to the membranes from hairs and feathers, the membranes from the skin are wrinkled to a much higher degree. The wrinkles are here running in all directions, whereas the membranes from wool and other hairs are mostly folded in one direction. This difference might be due to different geometrical arrangements. The membranes previously observed envelop cylindrical structures, whereas the membranes originating from the skin might envelop ellipsoidal structures, such as cells.

Thickened skin from the palm of the hand was cut off and treated in the same way. Membranes of the same type were obtained (Fig. 2). Finger-nail parings were also treated in the same way, with similar results (Fig. 3); this structure is also of the epicuticle type, but is more contaminated by extraneous material. This might be expected because of the degree of hardening of this material. Similar structures to those obtained from human skin have been observed in specimens from horse's skin from which the hairs had been removed using Ellis's method[4].

As hyaluronidase has been widely used as a 'spreading factor', it may be of some interest to mention that epicuticle from wool, examined in the electron microscope after treatment with hyaluronidase at 40° C. at different pH's for two days, showed some evidence of being attacked. Damage to the epicuticle of wool will usually give an increased rate of acid sorption by wool fibres[5]. If, however, wool was treated with hyaluronidase at 40° C. at about pH 7 for one day, no increase in the rate of acid sorption could be observed.

We wish to thank Prof. Nils Gralén for stimulating discussions. One of us (G. L.) is indebted to the International Wool Secretariat for a research fellowship enabling him to carry out studies on the epicuticle.

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A Resistant Membrane in Wool

IN a recent communication, Mercer[1] disputes our isolation[2] of a resistant membrane situated below the scales and surrounding the cortex of the wool fibre on the basis of experiments with membranes prepared by an entirely different method. He contends that the membrane consists of a thin film originating from the outside of the scales, and called the epicuticle, to which adhere, as contaminants, cuticular remnants.

The following points show this view to be unsound. (*a*) The tubes have considerable strength and can be manipulated to show osmotic phenomena[3]. The epicuticle, approximately 100 A. thick, could not provide the necessary strength, since it can represent at most 2 per cent by weight of the membranes as isolated by our method. (*b*) The same membrane can be obtained from wool the epicuticle of which had been completely removed[4]. (*c*) There is no evidence that the epicuticle forms a coherent film over the whole of the fibre, and detailed work by Müller[5] indicates that it never extends over more than one scale. (*d*) The membrane has a chemical composition distinctly different from that of the fibre as a whole[6]; it represents a definite fraction of the fibre (8–10 per cent), and since the same quantity is always obtained whatever the variation in the extraction technique, it is unlikely to consist almost wholly of adventitious impurities. (*e*) Microscopic observation during the isolation indicates that the membrane is below the scales and surrounds the cortical cells; Zahn and Haselmann[7] have confirmed this unambiguously by sectioning hair with a razor and extracting mechanically a chemically resistant membrane from the surface of the cortex.

The confusion concerning the membrane in wool arises from the fact that in 1944 Lehmann[8] claimed to have isolated a membrane very much thinner than that found by us, which was shown in Prof. Gralén's laboratory to consist of epicuticle and scales only. Gralén *et al.*[9] have made a careful electron microscopic examination of membranes prepared by us and conclude: "The main part of it is probably the outer, resistant part of the cortex . . . nothing indicates that this membrane should be identical with the subcutis of Reumuth, Lehmann, and Elöd and Zahn which originates from the outside of the fibre . . . the membrane isolated by them [Alexander and Earland] is a new discovery not identical with Lehmann's subcutis". Mercer's experimental evidence, which was obtained with membranes isolated by a procedure completely different from ours, is therefore irrelevant and does not invalidate our results. He does not appear to have examined a membrane of the type studied by us.

Bamford *et al.*[10] have already dealt with the next criticism made by Mercer, namely, that the membrane could not be present in the β-configuration in the original fibre since no β-reflexions are visible in its X-ray photo. We pointed out in the original publication[2] that an unoriented β-phase would probably not be detected among crystalline α-keratin by X-rays; a conclusion that has since been confirmed in another system by Bamford *et al.*[11].

Finally, Mercer contends that we ascribed the insolubility of the membrane to the fact that it is in the β-form. We have not made such a claim; on the contrary, we stated quite clearly[2] that the β-configuration was *not* sufficient to account for the insolubility of the membrane and suggested the presence of non-disulphide cross-links. There can be little doubt that the same protein is less soluble when in the β- than when in the α-configuration, and we demonstrated this by converting the soluble α-keratose into the β-form. Ambrose *et al.*[12] found afterwards that silk behaved in a like manner.

Earlier this year, Peacock *et al.*[13] examined membranes prepared by them according to our methods and claimed that these were in the α-configuration and suggested that our membranes had been converted to the β-configuration by heat denaturation. Our preparations, however, were never heated above room temperature, and on repeating our experiments we have again found the membranes to be in the β-form. The soluble α-keratose dissolves slowly because of its high molecular weight, and it seems possible that the preparation of Peacock *et al.*[13] was contaminated with this α-material. This would also explain why their tubes changed from α- to β-configuration on heating, since we have found[14] that the soluble α-keratose readily undergoes this transformation. To ensure that the membrane is free from α-keratose, it must be shown to weigh no more than approximately 10 per cent of the original fibre.

In conclusion, it may be said that no unambiguous proof exists that the membrane is present in the fibre in the β-form and that it is not changed from α to β during isolation. Since in the extraction process the majority of the wool retains the α-configuration, there seems to be no reason why the configuration of the membrane alone should be altered. It seems definite, however, that there is present in wool fibres (and possibly in all keratin fibres) a fraction contributing approximately 10 per cent by weight, which resists dissolution after breakdown of the disulphide bonds, even in such powerful protein solvents as cupriethylene-diamine and concentrated lithium bromide. This material must therefore be considered as a separate component of the wool fibre.

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Submicroscopic Structure of Fibres and their Formation

From electron microscope investigations it is known that the cellulose in the walls of all plant cells so far studied consists of discrete submicroscopic fibrils[1-4]. This is also true for the cellulose of bacteria[5] and tunicates[6] (electron microscope studies by B. Rånby on tunicate cellulose are also proceeding at this Institute).

According to some authors[1-3,5], the fine fibrils of plant and bacterial cellulose have diameters which lie between 250 and 400 A. Others have reported a value of the order of magnitude 100 A. for the fibrils of plant cellulose[4,7,8]. A constant diameter of about 200 A. was measured for the fibrils of tunicate cellulose[6]. The length of the cellulose fibrils is indefinite.

It was interesting to find that even dissolved and reprecipitated cellulose, in the case of viscose rayon, is built up from submicroscopic fibrils which are about 100 A. wide[9]. At the time of this observation, it was inappropriate to discuss the problem as to whether or not these fibrils may have their origin in crystalline residues of native cellulose which have been preserved during preparation of the specimens.

In order to approach this question and to gain a more general knowledge of the nature and formation of fibres, the morphological and structural investigations have been extended. To this end, chitin, which possesses a micellar framework like cellulose, has been investigated at the same time as synthetic polyamide fibres and polyethylene plastics. These studies were carried out by means of electron microscopy, electron and X-ray diffraction.

In crustacean tissues of varying physiological functions, fibrils of a thickness of about 100 A. were again found to be a structural element[9]. The different structural patterns of specific types of tissues depend on differences in the organization of these fibrils.

Also in fibres of polyamides (for example, the polymer of ϵ-amino-caproic acid), a system of submicroscopic fibrils was found to form a structural unit[10]. As is known, such a fibre is formed when the fibrous molecules are crystallized from a melt with artificial orientation. Even in a polyethylene plastic bundles of fibrils were observed[10]. The fibrils of these two synthetic products are morphologically identical with those of cellulose and chitin. All samples investigated were dispersed by means of ultrasonic waves before electron microscopy. Wood, chitinous tissues and viscose rayon fibres were studied also in thin, unfragmented microtome sections. Both methods gave pictures showing the same kind of fibrillar units. Thicker products, obtained after ultrasonic treatment, could always be split up further and shown to consist of elementary fibrils. There was nothing to indicate a splitting of the elementary fibril itself.

Hence the submicroscopic fibril is not specific for cellulose, but is obviously a quite general morphological element which may be formed when linear macromolecules order themselves in a lattice (macromolecular lattice, according to Staudinger and Signer[11]). Indeed, it might be expected that molecules which are chemically different but of similar structure, and therefore crystallizing in the same type of lattice, would form colloidal aggregates of the same shape and size.

According to modern views, the formation of a micellar structure[12] is due to the fact that long-chain molecules have an exactly parallel orientation over a given region. The linear macromolecules may then pass through several such ordered regions. If it is supposed that a fibril is built according to modern micellar theory, the areas of lattice order will occur with colloidal dimensions also in the direction of the fibril, and not only perpendicular to it.

As a modification of Frey-Wyssling's[13] theory of the micellar framework structure of cellulose, the idea will be stressed here that the dimensions of the crystallized areas perpendicular to the main valence chains correspond quite generally to the thickness of the submicroscopic fibrils (of the order of magnitude 100 A.), which was observed by means of electron microscopy. This has earlier been suggested for cellulose[7,8] and was clearly confirmed, in a rather unexpected way, by investigations on chitin[9]. The studies on chitin made it possible to exclude objections which might otherwise have been valid.

For the formation of a system of elementary fibrils with the character of a fibre, an external orienting force is necessary.

From the investigations on viscose rayons[8] and polyamide fibres[10], it may be concluded that there is already a pervading system of the fine fibrils before the orientation is high enough to give an ideal fibre diagram. An orientation of a higher degree may then be due to the elementary fibrils orientating themselves parallel to one another. In the case of the viscose rayon, the crystallinity does not increase thereby.

An orientation mechanism is necessary also for the formation of the cellulose fibres of plants. As is known, the fibre character of plant material is due to the structure of the secondary walls of the cells. The fibrils of these walls are formed at the surface of the plasma. In this case, the orienting effects come from the streaming of the plasma. The discrete fibrils appear, therefore, in lamellar layers, the fibrils of which are orientated in a parallel manner in the direction of the plasma stream.

Hence, from the results reported here, it seems that the observed structure of viscose rayon[8] is not necessarily due to crystalline residues from the native cellulose.

I wish to express my thanks to Profs. T. Svedberg, A. Tiselius and S. Claesson for their great interest in this work.

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Stimulation by Insulin of *In vitro* Fat Synthesis by Mammary Tissue studied with Carbon-14 and Tritium

RESPIRATORY observations have been interpreted[1] as indicating that lactating mammary gland slices are able to utilize acetate for net fatty-acid synthesis *in vitro*, either as sole substrate (ruminants: sheep, goat, cow) or in the presence of glucose (non-ruminants: rat, rabbit). Tissue respiration measurements have, moreover, led to the further conclusion[2-4] that insulin, added *in vitro*, causes a marked stimulation of fat synthesis by lactating mammary gland slices from rat, rabbit and mouse.

This striking *in vitro* action of insulin has now been investigated by the isotope incorporation technique. In experiments on mammary tissue from lactating rats killed at the 14th–15th days of lactation, approximately 2-gm. batches of slices were incubated for 3 hr. at 37° with 0·02 *M* sodium acetate (containing 10 µC., or in later experiments 1 µC., $CH_3{}^{14}COONa$) and 0·3 per cent glucose, dissolved in 20 ml. Krebs–bicarbonate–saline (containing 200 µC. TOH), in equilibrium with 95 per cent oxygen and 5 per cent carbon dioxide. The total fatty acids were isolated from the tissue and their calcium salts treated by combustion in oxygen. The carbon dioxide and water thus produced were stripped from the gas stream by means of liquid-air cooled traps. The carbon dioxide was separated from the water by sublimation *in vacuo* at – 78° and counted in an internal gas counter; the water was converted to butane for determination of tritium as described by Glascock[5]. Each experiment included a control incubation in which the tissue was killed at the outset by addition of acid, and in all cases the incorporation of carbon-14 and tritium into the fatty acids was very small compared with the value after a 3-hr. incubation.

It will be seen from the results of eight experiments reported in the accompanying table that insulin (1 I.U./ml.) increased the carbon-14 content of the fatty acids 1·4–4·5 times and the tritium content 1·3–5·0 times. The increases in the carbon-14 content of the fatty acids due to insulin were in many cases greater than those reported by Brady and Gurin[6] for liver slices incubated in acetate.

The carbon-14 determinations confirm previous conclusions drawn from respiratory results on the marked ability of lactating mammary tissue to incorporate acetate carbon into fatty acids *in vitro* and the stimulation of this process by insulin.

Exp. No.	^{14}C in fatty acids (c.p.m./mgm. C) × 10^{-3}		T in fatty acids (c.p.m./mgm. combustion water)	
	Insulin		Insulin	
	–	+	–	+
1	74	136	435	1,630
2	71	97	330	417
3	38	84	181	346
4	27	96	162	326
5	35	82	158	367
6*	5·9	8·1	134	330
7*	2·8	12·5	46	223
8*	5·5	12·0	117	306

* 1 µC. sodium acetate in 20 ml. medium in these experiments; 10 µC. in all others

The results on the incorporation of tritium into fatty acids more generally illustrate the ability of mammary tissue to synthesize fatty acids from small molecules, and in agreement with the carbon-14 observations further confirm the insulin effect. The results point to the usefulness of tritium as a label for body water, since it can be measured at much lower concentrations than deuterium.

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Influence of Adrenotropic Hormone Fractions on 'Adrenal Repair' and on Adrenal Ascorbic Acid

WE have studied[1] the activity of pituitary extracts in the Sayers test[2], which depends on ability to induce a rapid fall in the ascorbic acid content of the adrenal glands of hypophysectomized rats, and in an adrenal 'repair' test based on the increase in the adrenal weight of the rat hypophysectomized one to three weeks previously and given three intraperitoneal injections daily of pituitary extract for three days, the animal being killed on the fourth day. Since an adrenal weight-increasing effect (*AW* effect) does not necessarily measure only changes in the weight of active cortical tissue, such an effect is necessarily less precisely defined than an ascorbic acid reducing effect (*AA* effect). In our investigation of these two activities of different pituitary extracts, we have adopted as our standard for the ratio *AW*/*AA* the pig pituitary preparation 84–85 *U*, kindly supplied by Armour Laboratories, Ltd.; this preparation is about 2·5 times as active in the ascorbic acid reduction test as the Armour standard preparation *La*-1-*A*, the provisional International Standard. We have followed three main lines of investigation, which it will be convenient to consider separately.

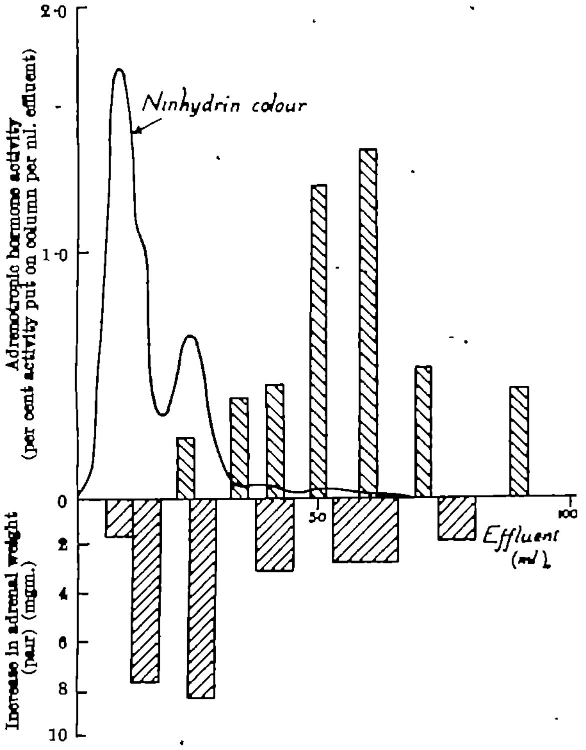
Activity of crude pituitary extract. For crude extracts of sheep, pig or beef pituitary glands, prepared by acid–acetone extraction, *AW*/*AA* does not differ significantly from that of our standard, that is, unity. Nevertheless, crude alkaline extracts of ox anterior pituitary tissue rich in growth hormone but with very slight *AA* activity yield *AW*/*AA* ratios up to 5,000/1. Growth hormone[3] was found also to show significant *AW* activity in a total dose of 20 mgm., though its ascorbic acid reducing activity was so small that 20 mgm. of the hormone was equivalent to only 2·2 μgm. of 84–85 *U* in this respect. The ratio of activities of the growth hormone was about 800/1.

When a total of 20 mgm. of growth hormone was given under the conditions of the adrenal weight increase test, histological examination revealed the presence of lipid in the site of the former sudanophobe zone[4] with many mitotic figures in the cortex. With a preparation highly active for the reduction of ascorbic acid (84–85 *H*) in a dose (0·5 mgm.) considerably greater in *AA* activity but much less in *AW* activity than 20 mgm. of growth hormone, there was also a return of lipid to the sudanophobe zone, but mitotic activity was much less than with growth hormone treatment. A dose of 84–85 *H* (2·5 μgm.), approximately equivalent in *AA* activity to 20 mgm. of growth hormone, produced no repair of the sudanophobe zone or significant change in the weight of the adrenal glands. In view of the large doses of growth hormone needed in these tests, and the probability that the growth hormone preparations used may be contaminated with traces of other hormones, it is not necessary to assume that the growth hormone itself is the active factor.

The crude alkaline extracts of ox pituitary tissue we have used contain only about 0·01 per cent of the total *AA* activity calculated to be present in the original pituitary tissue, while the *AW* activity of these extracts is 2–20 per cent of that extractable by other means, for example, by acid–acetone extraction. The possibility arises that the *AA* activity is almost completely destroyed in the process of extraction (by pituitary enzymes ?) but that the *AW* factor is more stable under these conditions.

Activities of purified ascorbic acid reducing fractions. Two pig pituitary preparations were supplied by Armour Laboratories, Ltd., preparation 84–85 *H* being derived from 84–85 *U* by a process which involves partial hydrolysis by heating in acid solution. If the *AW*/*AA* ratio for 84–85 *U* is taken as unity, the ratio for 84–85 *H* is found to be about 1/8. This suggests that the *AW* activity of 84–85 *U* is more labile towards acid hydrolysis than is the *AA* activity, a fact which is in accordance with some recent results of Reinhardt and of Li[5]. Nevertheless, there may be some substance in 84–85 *U* which has a potentiating effect on *AW* activity and which is more labile towards acid hydrolysis than is the *AA* activity. We consider, however, that this is unlikely. The preparations which are more highly purified with respect to *AA* activity might be more quickly absorbed and excreted and thus be less effective in a long-term test, such as that for increase of weight of adrenals, than in the ascorbic acid reduction test, which lasts only one hour. Accordingly, we have carried out adrenal weight tests with preparations mixed with substances designed to slow absorption from the peritoneal cavity. When a solution of freeze-dried plasma was added just before injection to give a final concentration of 3 per cent, there was little or no potentiation of the activities of 84–85 *H* and 84–85 *U* in such a test. When, however, tannic acid was added just before injection to give maximum precipitation, or alumina paste was added, potentiation of the *AW* activity of both 84–85 *H* and 84–85 *U* was observed, the *AW*/*AA* ratio of both being increased about five-fold. Since the difference between the two preparations remains, it seems unlikely that the original difference in *AW*/*AA* ratio between 84–85 *H* and 84–85 *U* can result only from a difference in the rate of absorption of the two preparations from the tissues of the rat.

Fractionation of unhydrolysed adrenotropic hormone preparations on an ion exchange resin[6]. In the accompanying diagram is given a typical result for the fractionation on 'Amberlite *IRC*-50' (Rohm and Haas Co.) of a crude adrenotropic hormone preparation obtained by the method of Astwood and his collaborators[7] from pig's pituitaries. In order so far as possible to equalize the rates of absorption from the intraperitoneal tissues in the adrenal-weight test, samples for that assay were mixed just before injection with 0·025 per cent (final concentration) of serum albumin or casein and then tannic acid sufficient to give a maximum precipitation (0·0125 per cent). All the fractions active in the ascorbic acid reduction test also possessed *AW* activity (see diagram), but the faster-running fractions produced very large adrenal glands indeed in the *AW* test, although they showed only slight *AA* activity. These results strongly



Chromatogram of 'crude corticotropin' (ref. 7) on 'Amberlite *IRC*–50' (200–400 mesh) in 0·2 *M* sodium phosphate buffer pH 6·60 containing 0·2 per cent phenol and 0·5 per cent thiodiglycol. 475 mgm. of crude corticotropin was extracted with 9·5 ml. of the buffer and 8 ml. of the solution put on a 2 cm. × 29 cm. column. Weight of untreated adrenals, 9·0 mgm.

suggest that *AW* and *AA* activities can be separated by a process which does not involve hydrolysis.

We do not know if all the effects described above can legitimately be attributed to the presence of only two factors in the pituitary gland. It seems necessary, however, to assume the existence of at least two factors which may be described under the term adrenotropic hormone.

We are grateful to the Nuffield Foundation for generous support of this work and to Armour Laboratories, Ltd., for the gift of adrenotropic hormone preparations 84–85 *H* and 84–85 *U*. One of us (H. B. F. D.) wishes to express his thanks to the Medical Research Council of Ireland for a studentship held while much of this research was carried out.

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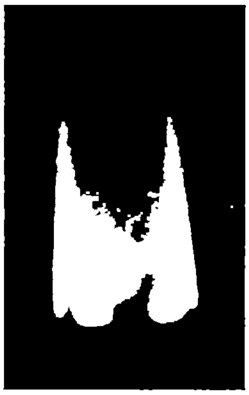
Polyhedral Diffusion Flames

BURNER flames of unusual structure may be obtained when certain hydrocarbon gases and vapours are burnt in admixture with air or oxygen. Thus, as first noted by Smithells and Ingle[1], and later by Smith and Pickering[2], the inner cones of the flames may assume the form of a polyhedron, the number of sides of which is dependent upon prevailing conditions, and which may or may not rotate about a central, vertical axis. More recently, Mann[3] and Behrens[4] have reported the occurrence of polyhedral flames using weak mixtures of hydrogen and air.

During the course of an investigation into the processes responsible for the formation of polyhedral flames, we have observed that the phenomenon is not confined solely to aerated flames, but may occur also with flames of the diffusion type provided that an inert gas be mixed with the inflammable gas prior to combustion.



The accompanying photograph is of a diffusion flame produced when a mixture of hydrogen and carbon dioxide, containing 19·35 per cent of the former, is burnt at atmospheric pressure upon a cylindrical tube of 1·1 cm. internal diameter. The flame, which will be seen to be composed of five bright segments separated by dark lines, could be made to rotate or to remain stationary by adjusting the rate of flow of the mixed gas.

Similar polyhedral diffusion flames have been obtained when nitrogen instead of carbon dioxide was used as the diluent gas.

An account of our investigation is to be published shortly.

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The Lotmar–Picken X-Ray Diagram of Dried Muscle

THE publication by Lotmar and Picken[1] of an X-ray photograph of a certain dried muscle preparation produced considerable interest and controversy, since, in addition to indicating an unusual degree of crystallinity, the diagram showed no sign of the 5·15 A. meridional arc which hitherto had been regarded almost as a diagnostic feature of the X-ray photographs of α-fibrous proteins. While we do not wish to enter the controversy as to whether or not Lotmar and Picken's photograph is indeed that of myosin, or any other protein, we should in passing like to point out the striking resemblance between their photograph and that of an oriented film of poly-γ-methyl-L-glutamate, published by Bamford, Hanby and Happey[2]. Recently, Pauling and Corey[3] have claimed that Lotmar and Picken's results support their suggestion that the polypeptide chains in fibrous proteins have their α-helical configuration, particularly in that the fibre axis translation of 5·65 A. calculated by Lotmar and Picken is in good agreement with the distance in the axial direction between adjacent turns of the α-helix. It is therefore perhaps worth while pointing out that the fibre repeat deduced by Lotmar and Picken is not consistent with certain features of their fibre diagram, and that the true value (or a submultiple) should be about 5·3 A.

Lotmar and Picken remark that the absence of diatropic reflexions makes the estimation of the fibre repeat somewhat uncertain. However, consideration of the semi-angle χ subtended at the centre of the diagram by the strong reflexions on the first layer line shows immediately that the repeat r cannot be as large as 5·65 A. Thus, for the reflexions (I_1) corresponding to d = 4·80 A., χ = 22° 40′; whereas the calculated value assuming r = 5·65 A. is 30° 34′. This discrepancy is well outside the probable error of measurement and indicates that r is actually less than 5·65 A. The same conclusion follows from the positions of the other reflexions on the first layer line. It may readily be shown that the value χ = 22° 40′ corresponds to a fibre repeat of about 5·26 A. The χ-values for the other reflexions on the layer line also correspond to this repeat.

This value is consistent with the main d-distances listed by Lotmar and Picken, and also with those given earlier by Herzog and Jancke[4], as shown in the accompanying table. The calculated values are those for a monoclinic cell with a = 12·0 A., b = 5·3 A. (fibre axis), c = 9·8 A., β = 76°. While the agreement between calculated and observed values is only fair, it is probably as good as Lotmar and Picken's, and within the limits of accuracy of the measurements. This unit cell is therefore preferable to that of the earlier authors, since it is consistent with the observed χ-values. The calculated density, assuming two residues per unit cell, has the satisfactory value 1·26 gm./c.c.

OBSERVED AND CALCULATED d-VALUES

	Herzog and Jancke	Lotmar and Picken	Calculated
Equator	10·00	9·24	9·50 (001)
	6·40	6·56	6·62 (10$\bar{1}$)
	5·79	5·94	5·85 (200)
		4·71	4·75 (002)
	3·92	3·96	4·08 (10$\bar{2}$)
		3·73	3·94 (201) 3·90 (300)
		3·49	3·45 (202)
		2·94	2·92 (400)
		2·74	2·62 (10$\bar{3}$)
Meridian	5·23		5·30 (010)
1st layer line	4·89	4·80	4·80 (110)
	4·66		4·64 (011)
		4·26	4·14 (11$\bar{1}$)
		3·96	3·92 (210)
		3·62	3·64 (012)
	3·44		3·30 (212)
	3·10		3·17 (310)
		2·72	2·72 (013)
		2·51	2·56 (410)

If these results can be applied to the fibrous proteins, it is clear that, in order to be satisfactory in this respect, the α-helix will require compression to reduce its pitch from about 5·65 A. to rather less than 5·3 A. This might introduce difficulties, for example, by producing improbably short hydrogen bonds. Further, the axial translation per amino-acid residue would thereby be reduced to 1·43 A., which is appreciably smaller than the spacing (1·50 A.) observed by MacArthur[5] and by Perutz[6], and considered by the latter to refer to this axial translation.

Note added in proof. Since this communication was written, Bear and Cannan[7] have published an X-ray diagram of dried muscle generally similar to that of Lotmar and Picken, but which shows distinct diatropic reflexions. These authors calculate a fibre repeat of 5·3 A., in excellent agreement with our value obtained from the original Lotmar and Picken diagram.

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Blue Sun and Moon

Paul and Jones[1], discussing the blue sun caused by selective absorption of a cloud of uniform spheres of radius r in light of wave-length λ, have considered the curve relating K (the ratio of effective to geometrical cross-section of a particle) and α, where $\alpha = 2\pi r/\lambda$. They suggest a simple physical explanation of the maxima and minima of this curve on the basis of resonances. The maxima and minima in the case of small dielectric spheres can also be explained from the principles of physical optics; this point of view was used by Van de Hulst[2] in considering some aspects of the subject that could not so readily be treated by electromagnetic theory.

Interference occurs between the portions of a wave-front passing through a particle and through the adjacent continuous medium. The opacity of a particle has maximum and minimum values when these two are in opposite and like phase respectively. That is, approximately, when n is an odd or even integer in the relationship $2r(\mu - 1) = n\lambda/2$, where μ is the refractive index of the particle relative to the surrounding medium, when

$$\alpha = \frac{2\pi r}{\lambda} = \frac{n\pi}{2} \Big/ (\mu - 1). \qquad (1)$$

Furthermore, if the cross-section of an incident beam is S and the much smaller cross-section of a particle in the beam is s, and if the incident amplitude is B per unit area, then for maximum opacity, that is, opposite phases, the intensity transmitted in the forward direction is $[B(S - s) - Bs]^2$, and the relative transmission is $t = B^2(S-2s)^2/B^2S^2 \approx (1-4s/S)$; the 4 in this expression is the value for K, which agrees with that given for the first maximum in Fig. 1 of Paul and Jones's communication.

Obviously, the different paths through the sphere give different retardations, and more exact calculations[3] have been made by dividing the wave-front through the sphere into annular zones and calculating the phase and amplitude in the forward direction, using Kirchhoff's diffraction formula, for each zone. Some of the results are shown in the accompanying table. The value of K calculated for the first maximum is 3·66 compared with 3·8 from electromagnetic theory[4,5]. Considering that elementary diffraction theory is not expected to be very exact for particles only $3\lambda/2$ in diameter, the agreement is fairly satisfactory.

Values of $2\pi r/\lambda$ corresponding to Successive Maximum and Minimum Values of K, for Water Drops

	Max.	Min.	Max.	Min	Max.
Calculated from equation 1	4·7	9 4	14 1	18·8	23 5
Calculated by Lothian and Chappel[3]	5·0	10·0	14·7	20	25
Calculated from electromagnetic theory[4]	6·2	11 6	16	21	

The name for the coefficient K is not yet generally agreed. Different authors[1–5] have used the terms 'extinction', 'scattering area coefficient' and 'total scattering coefficient'. It is suggested that the first term should be avoided because it is generally used—in Great Britain at least—to denote the quantity $\log_{10}(1/t)$. I myself prefer the term 'total scattering coefficient'.

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Calculation of χ^2 for a 2 × 2 Table

SEVERAL algebraically equivalent methods are in use for calculating χ^2 for a 2 × 2 contingency table; but there is one attractive algorithm that does not seem to have been described. Write the table and its marginal totals in the usual notation:

a	b	$a + b$
c	d	$c + d$
$a + c$	$b + d$	N

where $N = a + b + c + d$. Let A be the difference between the two observed ratios when the table is read across, so that

$$A = a/(a + b) - c/(c + d).$$

Similarly, let D be the difference when the table is read downwards, so that

$$D = a/(a + c) - b/(b + d).$$

Then it can be shown that

$$\chi^2 = ADN.$$

The computer may write in the four ratios instead of, or in addition to, the marginal totals. This method is easily memorized, leads to a simple computation, and has the advantage of bringing prominently to notice the actual ratios being compared. To apply the Yates correction, add or subtract 0·5 in the usual way before calculating A and D.

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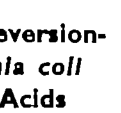
Enhancement of the Normal Reversion-rate of a Serineless *Escherichia coli* Mutant by Certain Organic Acids

SOME mutant genes involving loss of function are known to be capable of reversion at the specific locus; this fact implies that in mutant organisms particular genes are not necessarily destroyed, but may be merely altered, or 'inactivated' with respect to the specific reaction they once controlled. The gene is, so to speak, in an inactive allelic state—but one which can revert or back-mutate to the active allelic state of the wild-type parent. Can environmental conditions other than general mutagenic agents enhance the reactivation of a mutated gene to its original allelic state? It is conceivable that the presence of certain common metabolites, the configuration of which is related to the damaged enzyme – gene system, might, by some as yet unknown mechanism, have such an influence. In various connexions, 'substrate-induced mutations' have been previously discussed[1–3].

It has been found that the normal back-mutation rate of a mutant of *E. coli* (*P.A.*1.5), requiring either serine or glycine, is strikingly enhanced in the presence of certain organic acids not serving as substitutes for serine, but sharing the configuration



$$\left(\begin{array}{c}\text{COOH}\\ |\\ \text{CHOH}\\ |\end{array}\right)$$

namely, 3-phosphoglyceric, glyceric, lactic, tartaric and malic acids. Malate is apparently the least active. Natural D(+) tartaric acid is active; the L(−) form is inactive. The reversions in the presence of these acids give rise to cell types both partially and fully independent of serine or glycine. In control experiments with other acids (or none) the great majority of reversions are to full independence, or wild type; intermediate types are rare.

The fluctuation test of Luria and Delbruck[4] for determining mutation-rates was used. Forty 2·5–3·0 ml. cultures were shaken at 37° C. in 20-ml. Freudenreich flasks for 39 hr. Control cultures, as well as cultures containing glycerate, lactate, etc., contained a glycerol-minimal medium, pH 6·2, supplemented with an amount of glycine in slight excess of that necessary for maximum growth of the (inoculated) dependent mutant. This mutant grows in such a medium with about the same generation time (1·5–2·0 hr. at 27° C.) as does the reverted, fully or partially independent cell type. Plating 1-ml. samples from the individual cultures (20 experimental and 20 control) to minimal agar revealed the numbers of independent cells which had arisen and multiplied during incubation.

The results of a typical experiment are given in the accompanying table; essentially the same results are obtained if (1) each culture is centrifuged, the cells washed, and plated to purified agar; (2) the same amount of tartrate which is transferred to the plates from the primary experimental cultures is also added to the control plates. Therefore, selective survival of mutants on the plates due to the transfer of tartrate, glycerate, or some unknown substance does not occur. Microscopic examination at various times of regions with no reversions on the control and experimental plates reveals no differences with respect to cell density or distribution. Reverted types are referred to as fast, intermediate, or slow synthesizers, depending upon their ability to

REVERSIONS IN THE PRESENCE OF GLYCERIC AND SUCCINIC ACIDS

Glyc. plate*	Colony counts† F	I	S	VS	Succ. plate*	Colony counts† F	I	S	VS
1	6		36	60	1	3			
2	3		33	39	2	6			
3	3		9		3	3			
4		3	6		4	3			
5		3	27	15	5	3			
6	3		105		6–20	No reversions			
7	24		33	30					
8		6							
9		6							
10	6		12						
11		3	42	81					
12		6	105	750					
13			6						
14		12	150	300					
15		3	12						
16			9						
17			15	48					
18			15	9					
19–20	No reversions								

* The plates were selectively numbered after reverted colonies began to appear.

† *Corrected for sampling.*

'F' indicates a fast synthesizer (wild type), 'I' an intermediate, 'S' a slow, and 'VS' a very slow synthesizer. The plates were observed and colonies counted after 48, 56 and 72 hr. of incubation at 35° C. Generally speaking, fast synthesizers were observed after 48 hr., and intermediate or slow after 56 or 72 hr.

synthesize serine and glycine, and hence upon their rate of growth on the minimal agar plates. The glycerate concentration was $0 \cdot 2\,M$, and the succinate $0 \cdot 1\,M$.

The mean number of back mutants per culture is 101; the variance is about 42,000.

After incubation of the liquid cultures, the pH of the glycerate series had dropped to 5·6, and the succinate series to pH 6·1; other experiments demonstrate that pH differences between the two series of this order of magnitude do not affect the results. Both types of cultures had reached $1 \cdot 5 \times 10^{9}$ cells/ml. Summarizing the results of this and three similar experiments reveals that, in the controls, 14 out of 80 cultures contained one to six independent bacteria; in the glycerate series, 55 out of 80 cultures contained 1 to 10^{4} (full and partial) reverted cells. The concentrations of glycerate were between 0·15 and $0 \cdot 2\,M$; the enhancement of reversions is greater with increasing amounts of this acid. Despite the extremely high concentrations, it seems unlikely that a general mutagen present as an impurity is the effective agent, since (1) the calcium glycerate, barium phosphoglycerate, and tartaric acid used were in a highly purified crystalline form; (2) the sources of the effective acids are very different: glycerate and lactate were synthesized chemically, phosphoglycerate and tartaric were isolated from natural sources; (3) the D-, but not the L-, form of tartaric acid is active. Such high concentrations may be necessary at the pH used in order to have enough undissociated acid present. Studies of the dependence of rate of reversion on the pH of the cultures are in progress. Related acids in control cultures were used in the highest non-toxic concentration possible; those found to be without influence on the rate of reversion are: citrate, succinate, adipate, acetate, formate, oxalate and malonate.

It is conceivable that as many phenotypically expressed mutants arose in the control as in the experimental series, but that their multiplication was for some reason selectively inhibited in the former cultures. To test this possibility, it is best to plate out all of each control culture to see how many flasks contain any mutants. Such experiments were done, plating both to minimal agar and to minimal agar supplemented with tartaric acid. The number of cultures with mutants was no greater than would be expected on the basis of results obtained from sampling some two hundred control cultures. Sampling cultures in the presence of the highest possible concentrations of DL-glycerate and D(+)-tartrate ($0 \cdot 2\,M$ and $0 \cdot 03\,M$ respectively) showed that at least 57 out of 60 cultures contained reversions, as contrasted with 14 out of 30 completely plated-out cultures in the control series. The difference is highly significant ($P < 0 \cdot 01$ by the χ^2 test).

There are two alternatives to the conclusion that the phenomenon described is a specific, environmentally induced mutation.

(*a*) It is possible that glyceric acid, lactic acid, etc., are non-specific mutagens, under the conditions of testing described above. Using a sensitive technique[5] for testing the mutagenic effect of substances on a micro-conidiating strain of *Neurospora crassa*, it was found[6] that glyceric acid is not a strong or moderately strong general mutagenic agent. Glyceric and tartaric acids were also tested for their influence on the rate of reversion of a tryptophaneless and a histidineless *E. coli* mutant, and found to be without effect. Nevertheless, however extensive, such experiments cannot make it possible to claim that these acids could never induce mutations in a less specific way.

(*b*) It is conceivable that, by some unknown mechanism, the effective acids allow the phenotypic expression of the mutations, which actually occur as frequently in the absence as in the presence of these acids[7]. Such a situation would have many aspects (for example, specificity) in common with a directed mutation; it would be difficult, if not impossible, to distinguish experimentally between the two alternatives.

In the presence of glycerate, the relative numbers of fast, intermediate and slow back mutants on individual plates suggest that the faster types arise from the slower ones. The 'intermediate' or partially reverted cell types which so frequently arise in the presence of the effective acids retain their characteristic generation times (as originally seen during their initial growth in liquid minimal medium) for many weeks and often months when cultured on complete media[6]. Their peculiar characteristics will be described in a later publication, to appear in *Comptes Rendus des Travaux du Laboratoire Carlsberg*, Série Physiologique.

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Formation of New Cell Walls in Cell Division

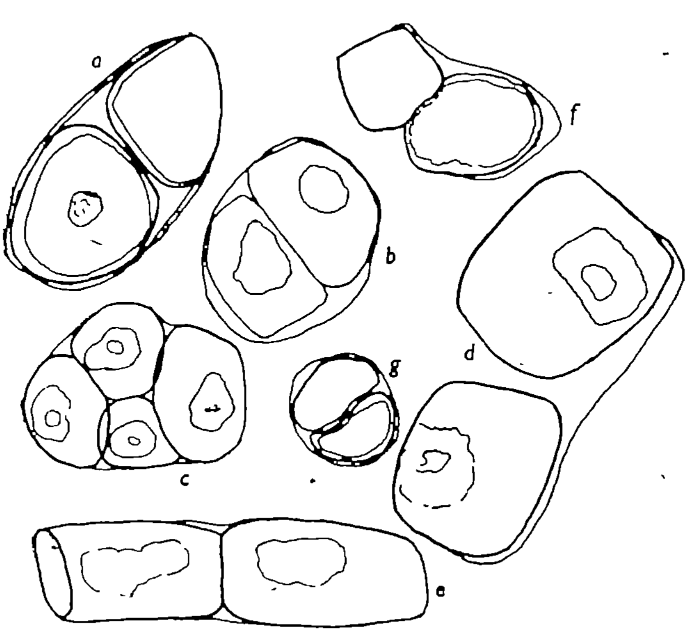
In 1882 Giltay[1] suggested that the new cell wall was not a partition separating the daughter protoplasts, but that the latter each secreted a continuous wall around itself; the two daughter cells remaining for a time within the stretched wall of the parent cell.

This suggestion was neglected until 1938, when Priestley and Scott[2] published evidence of the phenomenon in the parenchyma, collenchyma and sclerenchyma of dicotyledons. This evidence was based on a maceration technique which dissolved the middle lamella, leaving only cellulose walls. Observations on such macerated material showed files of daughter cells surrounded by the stretched wall of the original parent cell.

I have applied this maceration technique to a number of flowering plants and found the phenomenon common to both stem and root tissues. This treatment has produced the same results in the rhizomes of *Aspidium* and *Equisetum*, the stem of *Sphagnum*, the thallus of *Lunularia* and the cortical cells of *Fucus* (see Figs. *a*–*g*). Another example of this type of cell-wall formation in the algæ is reported for *Dictyosphaeria favulosa* by K. Wilson[3].

Priestley and Scott hesitated to attribute this mode of wall formation to meristematic cells of the shoot apex, in view of the lack of information on the nature of these cell walls and their behaviour under maceration. It is, however, interesting to note that in the transverse section of the shoot apex of *Lupinus albus*, Ball[4] depicts groups of cells surrounded by a common wall.

More data are required before generalizations may be made, but the above evidence derived from representatives of the Bryophyta, Pteridophyta and Spermatophyta suggests that this mode of cell wall formation may be universal in the higher plants.



Camera lucida drawings (⅙″ objective; reduced to ½) of macerated material of (*a*) *Lupinus albus* stem, (*b*) and (*c*) rhizome of *Aspidium*, (*d*) rhizome of *Equisetum*, (*e*) stem of *Sphagnum*, (*f*) thallus of *Lunularia*, (*g*) cortical cells of *Fucus*, showing groups of cells enclosed or partially enclosed in the original parent cell wall. In most cases the cells are showing plasmolysis

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The 'Golgi Substance'

In *Nature* of August 11[1], Dr. A. J. Dalton described the appearance under the electron-microscope of the 'Golgi substance' in cells of the mammalian intestinal epithelium and liver. During a period of many years I have devoted a great deal of attention to the part of the intestinal epithelial cell studied by Dr. Dalton and have reported my results in full[2].

To find out what lies in this part of the cell, it is necessary to make one's examination before the cell has undergone any visible changes resulting from its death. The intestinal epithelial cell of the mouse can easily be examined in what is usually called a 'supra-vital' state; that is, the living tissue can be removed from the body and at once examined in a suitable saline solution. The cells undergo no visible change for a considerable time. Under phase-contrast the so-called Golgi region (close to the nucleus and on the side of it directed towards the free border) can be seen to contain a number of separate spherical or sub-spherical bodies, some of them containing one or more vacuoles. These bodies I call lipochondria. I reject the name 'Golgi apparatus', because that, by Golgi's definition, is a network.

Lipochondria are easily stained supra-vitally with neutral red or dahlia. If one wishes to have a permanent preparation, one should use the sudan black method[3], though even this may somewhat distort them. The non-vacuolate bodies are lipoid all through; the vacuoles, when they occur, do not contain lipoid.

I have demonstrated these lipochondria of the living cell to others repeatedly (for example, in my classes in the University, at the meeting of the Association of British Zoologists in London in January 1950, and to Prof. Jean Brachet during his visit to Oxford in the same month), and am prepared to do so again.

The classical 'Golgi apparatus' consists of particles of osmium hydroxide or of silver deposited in or on various objects in various cells: in this particular cell on the lipochondria. Silver has a strong tendency to produce an artificial appearance. It is as though one were to try to find the shape of a group of transparent spheres by throwing particles of mud at them and recording accurately the shape assumed by the mud. Naturally enough, it often assumes the shape of a net. One could alter the appearance at will by throwing more or less mud, and the same applies in making silver preparations of the cell.

Osmium has less tendency to produce an artificial effect, and if it is used sparingly it can give a life-like appearance to lipochondria[3]. If the latter are crowded together and too much osmium is used, it artificially joins them. Dr. Dalton's Fig. 2*B* shows them quite well; but the osmium has been deposited in such a way as to join nearly all the lipochondria into groups.

When an object is sufficiently large to be seen with the light-microscope, there is no purpose in trying to determine its form by use of the electron-microscope. On the contrary, it is necessarily more distorted than it would have been if it had passed through the ordinary routine of microtomy, because it must be perfectly dry. The electron-microscope has value only in throwing light on sub-microscopic structure.

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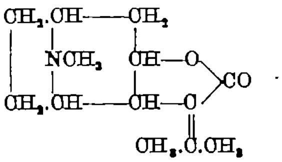
An Alkaloid of *Dioscorea hispida*, Dennst

THE alkaloid dioscorine, $C_{13}H_{19}O_2N$, was first isolated in 1894 by Boorsma[1] from *Dioscorea hirsuta*, Bl., and obtained in a crystalline condition by Schutte[2]. On the basis of degradation experiments, Gorter[3] in 1911 suggested that the alkaloid belonged to the tropane group, and proposed the following structure:



In 1937, Leyva and Gutierrez[4] isolated from the tubers of *Dioscorea hispida*, Dennst, a base which gave the same colour reactions and possessed the same toxicological properties towards mice and monkeys as dioscorine. Although the base could not be crystallized, and no derivatives were described, these authors considered their product to be identical with dioscorine.

In this Laboratory, the isolation of the alkaloidal material from *D. hispida* has been repeated by a modified procedure. From 3·5 kgm. of the tubers, 2·0 gm. of an oily base was obtained. The base, which was purified through its hydrochloride, distilled *in vacuo* without decomposition, and gave the same colour reactions as dioscorine. It crystallized on keeping, and formed beautifully crystalline derivatives, all of which gave analytical figures in support of the formula $C_{13}H_{19}O_2N$ for the alkaloid. The accompanying table shows how the properties of the alkaloid and its derivatives compare with the properties of dioscorine as described in the literature.

It seems that, in spite of discrepancies, the base may be identical with dioscorine; but this question must be regarded as *sub judice*. An investigation of the molecular structure of the substance is in progress. The ultra-violet and infra-red absorption spectra show that an αβ-unsaturated lactone system is present. On oxidation with acid permanganate the base yields only formaldehyde, and the absence of acetaldehyde and acetone as products of this reaction would appear to exclude an ethylidene and an *iso*propylidene group respectively. It may be concluded that either Gorter's formula for dioscorine must be revised, or that the base from *D. hispida* is not dioscorine.

	Dioscorine (m.p.)	Alkaloid from *D. hispida* (m.p., uncorrected)
Free base	43·5° (ref. 2)	54–55°
Hydrochloride	204° (ref. 2)	210–211° (decomp.)
Methiodide	213° (ref. 3)	203° (decomp.)
Picrate	183–184° (ref. 2)	187° (decomp.)

I am grateful to Sir Robert Robinson for his interest in this investigation.

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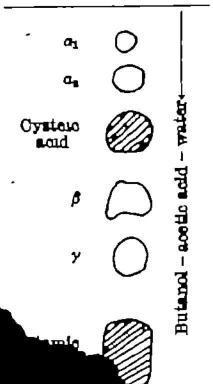
Artefacts in the Chromatography of Mixtures of Amino-acids containing Cysteine

IN the course of an investigation of the amino-acid metabolism of *Staphylococcus aureus*[1], using paper partition chromatography, I used the bromine water oxidation method, devised by Consden and Gordon[2], to avoid trouble during the separation of mixtures containing cysteine. The following procedure was used: to a neutralized solution of cysteine and glutamic acid (10 mgm. per ml. of each acid) enough bromine water is added to oxidize all the cysteine to cysteic acid (about 0·1 ml. of bromine water saturated at 20° C. per mgm. of cysteine hydrochloride); the solution is then evaporated to dryness *in vacuo* at room temperature to remove the slight excess of bromine and the hydrobromic acid formed during the reaction. The residue is dissolved in a small amount of distilled water and dried three times, then made up to the original volume and neutralized. Chromatographic separation on paper (Whatman No. 1 or No. 3), with butanol/acetic acid/water as solvent[3], shows, as illustrated on the diagram, four unexpected spots giving slowly a reddish-purple colour with ninhydrin. The two top ones (α_1, very weak, and α_2, stronger) give, after elution and acid hydrolysis (in 6*N* hydrochloric acid, 3 hr. at 105° C.), strong cysteic acid spots on a new chromatogram. The two others (β, strong, and γ, weak) run between the two initial amino-acids and are hydrolysed into cysteic and glutamic acids; they move also as single spots in a propanol/water mixture[4] (80 : 20, v : v). These spots are not due to incomplete oxidation, since excess of bromine water does not prevent their appearance; working at 0° C. does not affect the result.

New spots are also obtained when other amino-acids (glycine, alanine, valine, serine, arginine) and also triethylamine are used instead of glutamic acid; they move in butanol/acetic acid/water between



cysteic acid and the other compound. If thiomalic acid is present instead of cysteine as —SH group carrier, new materials are also formed. They give but a weak brownish colour with ninhydrin, as might have been expected, and glutamic acid is liberated on hydrolysis.

Hydrogen peroxide, replacing bromine as oxidizing agent, produces identical but weaker spots; autoxidation of the solution gives only trails due to incomplete reaction.

Nothing is known about the chemical link between the of these must be the sulphur spots do not appear after the absence of sulphydryl acid solution, but α_1 and α_2 en cysteine alone is oxidized. ip might be the amino group, ven as yet; the facts support- re the slowness of the appear- spots and their weakness when ose of the amino-acids obtained of an equivalent amount of product; sts the unmasking of amino groups. On hand, deamination of the compound giving (see diagram) according to Consden, d Martin[5] leads to the complete dis- of both amino-acids after hydrolysis; be due to the liberation of the presumedly ed amino groups in the strong acid solution hydrochloric acid) in which the reaction takes place.

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July 5.

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, Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, 41,
).

f Deoxyribonucleosides on Paper Chromatograms

chromatography of deoxyribonucleo- described by several workers[1–4]. The e located on the chromatogram by r ultra-violet light[1,6,7], by a micro- [3,5] or by means of the Feulgen [4]. A colour reaction between and cysteine in sulphuric acid Dische[8,9]. This has now been etection of deoxyribonucleosides on atograms. While all the deoxyribosides, s deoxyribose itself, give the reaction, neither nor the ribonucleosides can be detected by hod.

The reagent consists of a solution of cysteine hydrochloride (0·5 gm.) in 3 *N* sulphuric acid (100 c.c.). The air-dried chromatogram is sprayed with the solution. After 5–10 min. at 85°, pink spots appear. Quantities of 10–20 μgm. can be easily detected when the compounds are introduced to the chromatogram in 1 per cent solution. Spots containing more than about 50 μgm. of the compound are pink with a brown centre. The purine deoxyribosides react more rapidly than the pyrimidine derivatives, especially at 75°, due to their labile glycosidic linkage. There is, however, no difficulty in detecting the pyrimidine compounds. This is a distinct advantage over the earlier chemical tests, in which colour development with pyrimidine deoxyribosides is slow (in the Feulgen and Dische reactions), or which lead to gross decomposition of the filter paper (Dische reaction)[4]. A certain amount of care is necessary in handling chromatograms after treatment at 85°. The colours fade rapidly on exposure to light, and if a permanent record is required it is advisable to photograph the chromatogram immediately after development of the colour.

The R_F values of the naturally occurring deoxyribonucleosides in two solvent systems are given below. The butanol solvent gives fairly good resolutions of the pyrimidine deoxyribosides, while the alkaline phosphate system resolves the purine derivatives.

Compound	*n*-Butanol saturated with water	5 per cent Na_2HPO_4 in *iso*-amyl alcohol (ref. 10)
Cytosine deoxyriboside	0·23	0·77
5-Methylcytosine deoxyriboside (ref. 11)	0·25	0·76
Thymine deoxyriboside	0·51	0·78
Uracil deoxyriboside	0·38	0·79
Adenine deoxyriboside	0·35	0·55
Guanine deoxyriboside	0·21	0·62
Hypoxanthine deoxyriboside	0·23	0·70
2-Deoxyribose	0·36	0·87
2-Deoxygalactose	0·23	0·86

It is hoped that this technique, together with the phosphate spray of Hanes and Isherwood[12] and the other procedures mentioned above, will facilitate the rapid analysis of compounds obtained by the degradation of nucleic acids and in synthetic work in this field.

My thanks are due to Drs. D. M. Brown, C. A. Dekker, D. T. Elmore and W. S. MacNutt for the gift of samples: to Prof. A. R. Todd for his encouragement, and to Glaxo Laboratories, Ltd., for a grant during the tenure of which this work was carried out.

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University Chemical Laboratories,
Cambridge.
July 11.

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* Present address: Radiation Laboratory, University of California, Berkeley 4, California, U.S.A.

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[3] Wyatt and Elgen, *J. Biol. Chem.*, 177, 989 (1949); 181, 109 (1949).

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FORTHCOMING EVENT

Thursday, December 27

BRITISH PSYCHOLOGICAL SOCIETY, EDUCATION SECTION (in collaboration with the CONFERENCE OF EDUCATIONAL ASSOCIATIONS, in the Great Hall, King's College, Strand, London, W.C.2), at 2.30 p.m.—Dr. G. Brock Chisholm: "Social Responsibility, or Toward Maturity".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PHYSICAL CHEMIST (experience in instrumental analytical work and with isotopically labelled substances is desirable) as a Senior Research Officer in the Laboratory of Human Nutrition—The Director, University Laboratory of Human Nutrition, Churchill Hospital, Oxford (December 31).

READER IN THE DEPARTMENT OF GEOGRAPHY in the Research School of Pacific Studies—The Administrative Officer in the United Kingdom, Australian National University, 27 Russell Square, London, W.C.1 (December 31).

SENIOR LECTURER or LECTURER IN BACTERIOLOGY, a SENIOR LECTURER or LECTURER IN RADIOLOGY, and an ASSISTANT LECTURER IN PHYSICS, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 31).

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics, preferably with some years research experience) at the Road Research Laboratory, Harmondsworth, Middx., for work on the physical properties of bituminous road binders and surfacing materials—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting A.313/51A (December 31).

ASSISTANT LECTURER (graduate in physics, chemistry or metallurgy) IN DENTAL MATERIALS—The Registrar, The University, Manchester 13 (January 1).

CHIEF TECHNICAL OFFICER (with a University degree in agriculture, and wide experience of hill and upland farming and of the Highland area in particular) for the Hill Lands (North of Scotland) Commission—The Ministry of Labour and National Service. Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting G.402/51A (January 1).

LECTURER IN PHARMACOLOGY in the Medical School, Dundee—The Secretary, The University, St. Andrews (January 1).

BIOCHEMIST (with research experience) to work on problems connected with tissue metabolism and the metabolism of cancer producing substances—The House Governor, Royal Cancer Hospital, Fulham Road, London, S.W.3 (January 9).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in engineering, or corporate membership of the I.C.E., I.M.E. or I.E.E.) in the Royal Naval Scientific Service at the Underwater Countermeasures and Weapons Establishment, Havant—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4108/52 (January 10).

LECTURER IN MINERAL DRESSING AND ASSAYING in the Department of Chemical Engineering, University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 12).

RESEARCH OFFICER (with a University honours degree in science, with chemistry or biochemistry as major subject, or equivalent qualifications) IN THE DIVISION OF FOOD PRESERVATION AND TRANSPORT at the State Abattoirs, Homebush Bay, N.S.W., to investigate the chemical constitution of plant and animal lipoids, and study changes in lipoids during storage—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3663 (January 12).

SCIENTISTS II or III, for research in the telecommunications and light electrical engineering fields (Ref. TT/400), and ELECTRONIC ENGINEERS (Scientific Technologist, Grade I, or Senior Scientific Technologist), to design and construct electronic devices for research (Ref. TT/401), at the Central Research Establishment, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (January 12).

LEVERHULME RESEARCH STUDENTSHIP for research into some aspect of the history or archaeology of London—The Secretary, London Museum, Kensington Palace, London, W.8 (January 15).

MATHEMATICIAN to assist in the preparation of problems for an electronic computing machine (the EDSAC)—The Director, University Mathematical Laboratory, Free School Lane, Cambridge (January 15).

NUFFIELD RESEARCH CHAIR OF MECHANICAL ENGINEERING at the New South Wales University of Technology—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (January 19).

PROFESSOR OF GEOLOGY, and a PROFESSOR OF ZOOLOGY—The Registrar, The University, Reading (January 21).

CHAIR OF CHEMISTRY at the Royal Cancer Hospital—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 22).

ASSISTANT EXAMINERS OF PAPER AND OFFICE REQUISITES (with such *training* in chemistry and physics as will enable them to investigate faults in paper of all kinds and stationers' sundries, and to carry out tests appropriate to the examination of supplies for the public service), H.M. Stationery Office—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 206/52 (January 31).

COW AND GATE FELLOWSHIP for research into problems associated with nutrition in infants and children—The Registrars, The University, Manchester 13 (January 31).

PHYSICS GRADUATE, to assist in isotope tracer research (radioactive elements and mass-spectrometer)—The Professor of Physics, The University, Reading (January 31).

CHAIR OF ANATOMY—The Secretary, Queen's University, Belfast (February 20).

ASSISTANT LECTURER, Grade B (with an honours degree in physics) IN THE DEPARTMENT OF PHYSICS—The Principal, Sir John Cass College, Jewry Street, London, E.C.3.

ASSISTANT METEOROLOGISTS in Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27118/5/51.

GRADUATE IN PHYSICS OR PHYSICAL CHEMISTRY in the Division of Biophysics and Optics—The Director, National Institute for Medical Research, Mill Hill, London, N.W.7.

MATHEMATICIAN or MATHEMATICAL PHYSICIST (with a good honours degree and, preferably, some knowledge of the theory of elasticity) for research in applied mechanics—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

PHYSICIST or MECHANICAL ENGINEER (honours degree in physics or mechanical engineering essential, good knowledge of applied mechanics and/or mechanical properties of metals necessary) to lead a team engaged on research into the mechanics of wire and bar drawing, and the mechanical properties of drawn wires and bars—T Personnel Officer, British Iron and Steel Research Association, 11 Lane, London, W.1, quoting 'Wire Drawing'.

PHYSICISTS and ELECTRICAL ENGINEERS (Scientific at an R.A.F. Signals Experimental Establishment in Ministry of Labour and National Service, Technic Register (K), Almack House, 26–28 King Street quoting A.380/51A.

PRINCIPAL METALLURGIST IN THE BRANCH, Windscale Works, Sellafield, work of laboratories engaged on resear active materials—The Ministry of Sup (Production), Risley, Warrington, Lan

PRINCIPAL METALLURGISTS (with a degree in physics, physical chemistry qualification; responsible post-gradua fundamental investigations is essential) tories, Culcheth, Warrington. (a) to be work of laboratories engaged on studies geneous equilibria, using methods of ph graphy, X-ray crystallography and ele supporting studies for research work on p chemistry, surface chemistry and deformatio responsible for research into pyro-metallurgical p responsible for research into powder metallurgy— Supply, Division of Atomic Energy (Production), Risley, Lancs, stating post applied for and quoting Ref. 273.

SCIENTIFIC ASSISTANT for greenhouse experiments, of the experimental work with sand cultures in com vestigations on the mineral nutrition of crops, at the R Long Ashton—The Secretary, The University, Bristol.

SENIOR EXPERIMENTAL OFFICERS and EXPERIMENTAL THE RESEARCH AND DEVELOPMENT BRANCH to unde mental work on a wide range of problems in organic an chemistry, chemical engineering, experimental physics, m heat transfer, welding of non-ferrous and ferrous materials, biology, at laboratories at Culcheth, Sellafield and Salwick— Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for and quoting Ref. 276.

SENIOR LECTURER IN MATHEMATICS—The Principal, Royal Technical College, Salford 5.

SENIOR SCIENTIFIC OFFICERS (with a first- or second-class honours degree in chemistry, physics or metallurgy, or equivalent qualification) IN THE RESEARCH AND DEVELOPMENT BRANCH to undertake research work on a wide range of problems in organic and inorganic chemistry, physical chemistry, thermo-chemistry, surface chemistry, physics, physical metallurgy, mechanical properties of metals and the melting and casting of metals, at laboratories at Culcheth, Sellafield and Salwick—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 270.

REPORTS and other PUBLICAT

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Other Countries

Optische Werke C. Reichert A.G., Wien. Reichert, in Memoriam Carl Reichert, 26t 2 plates. (Wien: C. Reichert A.-G. Co., 1951.)

Conference on the Origin and Con Nova Scotia Department of Mines, Nov June 21–23, 1950, Crystal Cliffs, Nova Scot fax. Nova Scotia Research Foundation, 1951

Smithsonian Institution: Bureau of American 144: The Northern and Central Nootkan Tribes. Pp. 480+5 plates. (Washington, D.C.: Govern 51.) 1.50 dollars.

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LEADERSHIP IN THE WELFARE STATE

SEVEN years ago, in "The Price of Social Security", Mrs. Gertrude Williams directed attention to new functions of the trade unions in the social service State under conditions of full employment, as well as to the new demands made on the Civil Service. The late Prof. H. J. Laski, in his book "Reflections on the Revolution of our Time", had already examined some of the implications of social security for the work of trade unions and professional associations, and stressed the part such bodies could play in improving productivity as well as standards of professional practice, of education and of welfare generally.

In conditions of full employment and social security, the protective or negative functions of professional bodies must decline in importance and these positive functions become more significant. The trade unions in Great Britain have, however, shown few signs that they have grasped the significance of this change or the scope of the opportunities for constructive work in fostering technical development and industrial re-organization, and in building and strengthening the new social order opening before them. That the welfare of the members of the trade unions depends in increasing measure on the welfare of the country as a whole has not always been remembered. When Political and Economic Planning published its studies of British trade unionism in 1948, it was recognized that the basic character and aims of the trade union movement were still unaltered: the protection and advancement of the interests of its members were its primary, and sometimes its exclusive, concern, in spite of the experience of co-operation with government and the profound change in the relation of the movement to the rest of society. The studies afforded little evidence that the trade unions were adapting their outlook and practice to the fulfilment of their new role.

This negative outlook persisted in the lectures which Prof. Laski himself delivered in the United States in March–April 1949, just a year before his death. Published last year under the title "Trade Unions in the New Society", these lectures show little trace of the conception of positive functions which Laski had outlined eight years earlier.

To one set of current problems Prof. Laski did direct attention. These are the problems which arise out of the relations of trade unions with nationalized industry. Here he was concerned more especially with the participation of the unions in the management of a nationalized industry. The criteria he suggests are of particular interest in the light of the wider and fuller examination, made recently by the Acton Society Trust, of the practical difficulties which the unions experience once an industry is nationalized and which appear to limit their ability to co-operate in the successful running of the industry, and the implications of nationalization policy for their future role.

Published under the title "The Future of the Unions"*, this is a most disturbing study deserving the attention of all professional bodies having relations with such industries, as well as of those who are concerned with the future and efficiency of productive industry. Even the inter-union problems discussed have their interest for the scientific worker. Such problems have not merely led to disputes over demarcation questions as a result of the efforts of certain nationalized industries to integrate and rationalize their services, or over recognition matters in relation to the 'closed shop': the changed circumstances of former employers and senior executives under nationalization have led to the emergence of what have been termed 'management unions'. Many such men have felt the need for an organization which would represent their interests to the highest level of management and negotiate wage or other agreements. Sometimes professional associations have transformed themselves into negotiating bodies; sometimes new associations have been established for the purpose. But the development which has resulted in the unions representing three main bodies of employees—manual; clerical, technical and administrative; and managerial—has increased the possibility of disputes.

This is notably true in the field of negotiations and joint consultation, nor are the possibilities of friction diminished by the traditional suspicions of the manual workers' unions of clerical and supervisory unions, and now of the new managerial unions. There is little indication that those associations of professional and technical workers which have become affiliated to the Trades Union Congress have been able either to abate such suspicions or instil a more positive and enlightened attitude to present problems.

The modern trade union official must now have sufficient knowledge of the industry to deal with the very wide range of problems which arise in consultation, and he must be able to discuss those questions with management experts instead of merely tabling demands. Defects in union leadership can, in fact, have just as serious repercussions on industrial efficiency as defects in management; but nothing like enough attention has yet been given to this question either inside or outside the unions. It was just indicated by Mr. S. G. Raybould in his recent book "The English Universities and Adult Education"; but the implications for trade unionism of the new educational policy and particularly of the freer access to universities were not considered. No policy of education for leadership, however, can avoid having regard to this issue: it would be fatal to industrial harmony and efficiency if none of the first-rate minds of each generation found their way into the trade union movement or received the intellectual training which enabled them to develop their gifts and use them to the fullest advantage in the service of the unions.

The reason for viewing the situation disclosed by this inquiry with such concern is that little or no attempt has been made by the unions to prepare in advance to meet the difficulties just discussed, and to dispel the lack of realism in the thinking of their members about nationalization and participation in management without having regard to the wider responsibilities involved. The warnings of Laski and others appear virtually to have been ignored, and there is little evidence on the basis of this inquiry that the unions have even begun consideration of the very considerable programme of training and education required.

This, to put it bluntly, is dereliction of leadership, and such dereliction will not fail to bring its own retribution. If the unions, in nationalized industry or elsewhere, continue to ignore the positive aspect of their functions, they may well find themselves unable to exert their traditional protective functions effectively.

The only way in which a union can secure a real increase in wage values for its members is by an increase in efficiency or productivity, or both. The only alternative is an intensifying inflation in which the value of wages increasingly falls behind the advance in prices. Under present conditions, even more than when Laski made the point in his Sidney Hillman lectures, a union in asking for better conditions must establish that there is increased output per man-hour or an obvious increase in the worker's responsibilities in a particular trade, and must put the full emphasis on the first. Only the prompt recognition of these responsibilities and opportunities will enable the unions to safeguard the standards already attained, still more to move from an era of security into one of abundance.

This is essentially a task for the trade unions themselves, and though some union leaders have already shown a clear grasp of what is at stake, the inquiry carried out by the Acton Society Trust provides little evidence that the task is being attempted on a wide basis and will be accomplished in time. The association of the Trades Union Congress with the industrial training courses commenced at Ashridge this year is a much more hopeful sign. Grounds for optimism are also to be found in activities of the Workers' Educational Association, and thi
Association may well come to play a decisiv
the general educational work which mus
recognition and analysis of these proble
unions.

There are other bodies too, like the A
Trust, which can assist in the process by formu
clearly the principles which should govern the relatio
between management and workers in a nationaliz
industry, and the series of studies being made by t
Trust are clarifying some of the issues and indicat
some of the principles which should find acceptan
Studies already made have endorsed the soundne
of some of the principles which Laski suggested should govern the management of a nationalized industry, notably in regard to decentralization, to methods of promotion and dismissal, and the provision of adequate organs of consultation for explaining at
level decisions which affect workers, so as to co
them that their views have been seriously
before the decisions are given effect.

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* Nationalised Industry Series, 8: The Future of the Unions. Pp. iii+32. (Claygate: Acton Society Trust, 1951.) 2s.

The more management can do to make such principles fully operative in industry, to associate workers with the formulation and operation of post-entry schemes of training, with welfare schemes and the like, the easier should be the task of the union officials in educating their members and readjusting ideas and policies. There may be some doubts as to how far it is possible, as was advocated by Laski, to elicit the direct co-operation and understanding of the workers in research, and his last point as to political qualifications for executive office in a nationalized industry is liable to be misconstrued and might well be abused in practice. Neither point should be rejected out of hand and without mature consideration, for both could affect strongly that climate of opinion within and without an industry and so powerfully affect its efficiency. The Acton Society Trust itself in a recent study showed how far we are yet from solving the problem of the right use of scientific and technical experts.

There is thus a whole range of problems to which, from outside the trade union movement, the man of science, the technologist and the administrator can contribute much to help the trade unions to find their solution. Even if the unions are late in recognizing these problems, there is a large measure of goodwill on which they can count. Some scientific workers and professional men are, moreover, members of trade unions and may be able to play a part from within; though this study of the Acton Society Trust leaves it at least a little doubtful whether their influence is likely to be either so effective or so beneficial as when exerted from outside. At least it is clear that professional associations need to clear their minds as to their functions and relations with the nationalized industries, and with other bodies where any attempt may be made to apply the policy of the 'closed shop'. Whatever the general attitude of the scientific worker to membership of a trade union, he should be vigilant to see that his own particular professional associations are awake to all the implications of the new situation, and prepared to make their full contribution to the service of society to-day.

BRAINS AND MACHINES

Doubt and Certainty in Science

A Biologist's Reflections on the Brain. By Prof. J. Z. Young. (The B.B.C. Reith Lectures, 1950.) Pp. viii+168+8 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1951.) 7s. 6d. net.

THE eight B.B.C. Reith lectures, which Prof. J. Z. Young broadcasted in 1950, have now been published in book form; they deal with the working of the brain, with processes of learning and communication, and with the development of human society. Their title belies both their scope and character. They are not concerned with any abstract discussion of scientific method, nor does Prof. Young try to illuminate empiricist philosophy with lessons drawn from the laboratory. The brain, he points out, [illegible] continually searching for fresh information about [illegible]ythm and regularity of what goes on around
us". It is this characteristic of human act
which he refers as doubting. Once significa
resemblances are found, a "system of law" e
When this happens certainty results.

The first lecture sets the stage. Prof. Young
briefly explained how the man of science work
the point that man owes his pre-eminence to
that he has developed the power of commu
to a far greater extent than have other anima
cerebral background of this special characte
Prof. Young's particular theme, and his expo
planned so as to avoid the pitfalls of dualism
use of animistic models. In place of the latter
analogies in the world of man-made machines.

The second, third and fourth lectures deal
conduction of the nerve impulse and the
brain functions. Prof. Young introduces the
of cybernetics, and shows how Dr. Wiener's
tion of regulation by 'feed-back' applies t
bodily processes—the analogy being valid i
as feed-back mechanisms maintain the body
steady state and tend to produce actions that
any deviation from this state". Thus "info
provided by each of the receptors tends to
an action by the body that is appropriate to k
life system stable in the light of the change t
receptor reports". Prof. Young takes the
a step further by suggesting that information
vey to other people in our societies is also "an
designed to have some regulating effect".

The second big analogy which he expound
likeness of the brain to a giant modern calc
machine. Such machines 'store' memory, an
with lightning speed. When their kind of mec
is combined with devices that permit of seek
avoiding reactions, it is possible to design '
missiles that can decide between correct and in
responses. This, it may be supposed, is the
brain also operates when it compares one thi
another. Prof. Young pursues this analo
points out that "the major problem is to und
the pattern of activities in the brain by wh
input is fitted with the memory, and produ
action". In his account of the learning pro
leans heavily on Hebb. He describes how peop
blind, who are given their sight by means of
intervention, have "to learn to see the worl
do", because "they have no models with w
compare the input, no mould or filter that
used to select the significant features of visual
ence and produce appropriate words and other
responses". Further, he accepts Hebb's usefu
that repeated stimulation by any pattern of ex
sets up a closed system of excitation between
cells that have become associated during a pr
learning, and that as a result a physical t
ultimately left in the brain.

The final four lectures are more general a
cursive. The fifth speculates about the or
language and of society. The sixth deals w
development of scientific thought, and Prof.
observes that physics can now be regarded as
with the relations between "a man world
servers" and "the reports of what they observe"
sequently, he suggests "a new phase is at h
which a common science of physics and biolo
be necessary". The seventh lecture consid
development of ideas in the biological field.
concluding talk, Prof. Young discusses the
of the concept of evolution on that of individ
elaborating the thesis of the 'continuous' ch

of experience, in which the individual is merely a point in a stream of biological time.

It says much for Prof. Young that an effort is needed to remember that his lectures were designed not for an audience of specialists but for a million or more radio-listeners. If it were not for the danger of this confusion, the only task of a reviewer would be to praise an enthusiastic and highly individual piece of popularization, which imparts new design and colour to a subject that has long been a favourite for general writing. It is difficult not to regret, however, that Prof. Young has had to compress so many of his ideas—a shortcoming which he has tried to remedy by adding five short chapters of comments—and also that popularization has sometimes demanded of him excessive simplification and emphasis.

The major pitfall of simplification derives clearly from the stress of analogies. Modern medicine and biological science forged ahead, as Prof. Young reminds us, when, following the example of Descartes and Harvey, increasing use was made of physical models, and when bodily processes began to be analysed and interpreted in terms of mechanism. The value here, following the lines of Prof. Young's thesis, is that the comparison of "something unknown with something already known makes it possible to talk about the unknown". But the danger is that analogies have the habit of either becoming, as Prof. Young warns, a trap for the unwary to believe that they understand fully when they do not, or, what he could have added, mere figures of speech. Prof. Young argues that man's special characteristic is his capacity for communication, and he develops this thesis in relation to the central feature of cybernetic thought, self-regulation, and to Hebb's views of the changes that take place in the brain as learning proceeds. These two ideas become loosely articulated into one major notion—the brain as a giant calculating machine containing fifteen thousand million cells as opposed to the twenty-three thousand valves possessed by the biggest calculating machine so far built. The analogy obviously helps to drive home a possible way of looking at some cerebral functions. And if the analogy between the working of *A* the brain and *B* the machine were complete, in the sense of an exact correspondence, it would, of course, follow that the brain and the machine were no different from each other. But the analogy is not complete, and its emphasis unfortunately obscures three essential differences: first, that the maintenance of a steady state of behaviour is scarcely compatible with an ever-active learning process and an ever-expanding horizon of experience; second, that the sphere of action of the calculating machine is completely predictable, whereas only by an act of faith could we suppose that the same is true of our brains; and third, that the mechanical brain clears itself of all its memory between tasks or runs, whereas the run of a living brain, and its memory, to all intents and purposes last a lifetime. These differences are every bit as vital as any similarities that can be found between artificial and real brains. It begs the question to imply that the reason why the analogy between them is not more complete is, on one hand, ignorance, and, on the other, the immensely greater complexity of the brain relative to the machine. That is where analogies run the danger of becoming mere figures of speech. If, as the reader is told, we do not know much yet about what goes on in our brains, it can only be figurative to suggest at the same time that "it is possible to use our knowledge of brain functioning to understand even the highest activities of man".

Reference to cybernetic and corresponding models does not illuminate the important facts that the process of learning is itself something that is learnt; that every perceiving individual is an active agent who transforms his percepts—and not just a passive receiver of stimuli emanating from a fixed external world; and that the living brain is self-organizing. It is interesting to note that these ideas, to which Prof. Young directs attention, had also been expressed by William James seventy years ago or more—and probably by many others before him—without the help of analogies drawn from modern communication engineering. "Practical utility," wrote James[1], "wholly determines which parts of our sensations we shall be aware of, and which parts we shall ignore. We notice or discriminate an ingredient of sense only so far as we depend upon it to modify our actions. We *comprehend* a thing when we synthesize it by identity with another thing . . . as soon as we have learned how to behave towards it, and how to meet behaviour which we expect from it." Further, in another essay, James spoke of the indomitable desire "to cast the world into a more rational shape in our minds than the shape into which it is thrown there by the crude order of our experience"—and notes that the world has shown itself "plastic to this demand of ours for rationality". Even if his words do sometimes imply the kind of dualism which Prof. Young avoids, William James would probably have therefore held that cybernetics, like "the latest breeze from the physiological horizon" which he scorned, added little to what was known before about processes of thought. The paradox to-day is that cybernetics makes one feel that some new and completely revolutionary idea about the working of the brain is going to spring at us from some hidden corner, whereas the fact is that cybernetic models scarcely help us to understand how the 'output' of the cortex is controlled or how the 'input' fibres are related to the cortical cells, two essential questions which, Prof. Young reminds us, still remain open. Cybernetic ideas will contribute to the solution of these problems only if, like these Reith Lectures, the interest they excite attracts to the experimental study of the brain research workers who, as Prof. Young tells us, are badly wanted at the present time, and whose recruitment would be more than merited by the importance of the subject.

S. ZUCKERMAN

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[1] James, William, "The Will to Believe" (New York: Longmans Green and Co., 1923).

MORE NEW SYSTEMATICS

Grundlagen und Methoden einer Erneuerung der Systematik der höheren Pflanzen

Die Forderung dynamischer Systematik im Bereiche der Blütenpflanzen. Von Dr. Franz Buxbaum. Pp. xi+224. (Wien: Springer-Verlag, 1951.) 44*s*. 6*d*.

THERE are many signs of a renewal of interest in botanical (and zoological) taxonomy. The practical importance of reliable and easily workable systems of classification is acknowledged by all who need to know with what organisms they are working and wish so to express the results of their experiments or observations that they can be tested and used. The methods of systematic botany are being gre
improved: nomenclature is (one hopes)

stabilized, descriptions on the whole are more adequate, types are more carefully chosen and more definitely designated, more and better preserved material is available than formerly, and new data from ecology, genetics and cytology are being incorporated. The development of the ecological and cytogenetical branches of botany is now influencing taxonomic theory, and taxonomists are being forced to consider the basic principles of biological classification. It is not yet possible to foretell what changes, in practice and in theory, will result from the synthesis of old and new; but, with the natural, and defensible, conservatism of taxonomists, they are more likely to come gradually than to take the form of an abrupt revolution. The introduction of new methods and outlooks is being accompanied by an overhaul of those long established. On the whole, taxonomists have every reason to be proud of their products, in spite of criticism from outside their ranks—criticism which is often more connected with the ignorance of the critics than with errors of taxonomists. Well-informed criticism, however, is to be welcomed.

In the present work by Dr. F. Buxbaum there is much that commends itself to both the practical and the philosophical systematist. Unfortunately, the author has apparently had no opportunity to consult more than a very few of the large number of books and papers published in Britain and the United States during the past dozen years or so on the subjects with which he deals. Thus, there is no reference to Huxley's "The New Systematics" or to the various symposia of which accounts have been printed in the *Proceedings of the Linnean Society* and elsewhere. Probably as a result of relative isolation from contemporary arguments on plant taxonomy, the work can scarcely be considered as a full summary of the up-to-date position in the systematics of the higher plants. Nevertheless, the conclusions of a sincere and thoughtful worker must be of considerable value even if one cannot accept all of them. One must agree that the need for better definitions and for making precise and stabilized terminology is felt by many taxonomists. A modern Lindley or Asa Gray would find much to revise. Even so, it may be noted in passing that Dr. Buxbaum on page 43 uses 'rudiment' when from the context he obviously means 'vestige'. Rightly, he says that in place of naming varieties, etc., a clear comprehension of the range of variation of all varying characters should be the aim.

Dr. Buxbaum's concept of plant taxonomy is that it should be 'dynamic', and by this he means that it should be based on 'progressions' or changes in the genom; but in practice, he says, those changes with a morphological expression must be used. Only direct progressions lead to a step-by-step evolutionary advance, while those without direction give especially variability within a species or genus, most often only in the lower categories. A great deal is made of the concept of 'types'. One must regret that this last word is used with such different meanings in biology; and here is intended not the concrete types by which botanical nomenclature is made precise, but the "Summe aller, der betreffenden Kategorie innewohnenden Formgesetze und Entwicklungstendenzen". A 'type' is not an actually existing phenomenon nor is it identical with a progression, but as a rule is the sum total of unequal but more or less equally directed progressions which determine the course of developnt.

s sounds very nice and is valuable in so far as ects attention to the fact that the phylogenetic relationships of existing taxa can only be traced backwards in the past. The practical difficulties remain: How can 'progressions' be traced with reasonable certainty in the almost complete absence of relevant fossil evidence in the angiosperms? Cytogenetical researches are throwing some light on probable directions of evolution in a few groups, mostly at or about the species level, but little is said about these in the present work. It is, of course, easy—sometimes far too easy—to arrange series of specimens, whether of organs or of organisms, and to postulate that they represent evolutionary or dynamic progressions. Possibly they may, sometimes; but, as other series can be arranged with the same materials, to call any such phylogenetic is an act of faith. This is not to say either that such series-making has no uses or that phylogenetic speculation is in itself to be condemned. What is needed is more phylogenetic research based on fossils and cytogenetics.

Dr. Buxbaum accepts (p. 71) the usual idea that the lower taxonomic cat[illegible]ies in the course of development give rise to the higher. He does not discuss Guppy's reverse view or the possibility of both having some measure of truth. His definition of a 'genus' is worth quoting as it is typical of his point of view: 'Die Gattung ist die Gesamtheit aller Arten, die durch die Einheit ihres morphologischen Typus (Gattungstypus) als stammesgeschichtliche Einheit erkannt wurden" (p. 101). He says that the species concept is a fiction—"die Species keine natürliche Realität ist, d.h. keine unveränderliche und scharf begrenzte Grosse darstellt". Surely, since a genus consists of species, the same conclusion must be reached for this taxon and for other 'higher' taxa also. Dr. Buxbaum has much of value to say regarding the difficulties of applying any concepts of taxa in attempting to make order out of what would otherwise be a chaotic mass of isolated data. He contends that the most important basis of the new phylogenetics is the morphological "Typusforschung": "Der morphologische Typus und seine Entwicklungstendenzen ist das leitende Prinzip der höheren Systematik".

It is obvious that Dr. Buxbaum has been much influenced by the works of Troll on plant morphology. It would be very useful to have a summary of these published in English—particularly of some of the most recent.

That systematic botany is being rejuvenated is evident in many new activities; but its future 'progression' or 'progressions' cannot yet be definitely or fully perceived. In its orthodox form it has well fulfilled a wide range of purposes, theoretical and practical. Possibly for giving latitude and longitude in degrees over the realm of the plant kingdom it will always be of use; but to find position precisely in minutes and seconds a new scheme may be necessary. Taxonomists must certainly take evolutionary concepts more into account. It is becoming increasingly clear, from taxonomic research itself, that, for certain purposes at any rate, we have to abandon the conception of taxa as rigidly definable classes arranged as a hierarchy of species, genera, families, etc., created and maintained as such, whether by the methods of "Paradise Lost", by Linnæus and more recent taxonomists, or by mutation and natural selection. 'Progressions' and 'tendencies' may be vague and difficult to visualize and describe; variations, 'reticulations', and correlations can be dealt with by modern statistical and, to a certain extent, experimental methods. We have as yet no better general scheme of biological classification to replace that which is now in general use and which is dignified by its long record of service. To seek something better is a sign of future progress; to discard what we have until it be found and tested would be foolish. In so far as Dr. Buxbaum's criticisms of orthodox taxonomic theory and practice and his suggestions for improvements help in the search, they will be widely welcomed by taxonomists.

W. B. Turrill

APPLICATIONS AND PRODUCTION OF QUARTZ CRYSTALS

Quartz Vibrators and their Applications

By Dr. P. Vigoureux and C. F. Booth. (Published for the Department of Scientific and Industrial Research.) Pp. xii+371+64 plates. (London: H.M. Stationery Office, 1950.) 30*s*.

THIS book on "Quartz Vibrators" is based on the 1939 edition of "Quartz Oscillators" by P. Vigoureux, but has been made much more comprehensive by revisions and additions of new material on the methods of selecting quartz and producing quartz resonators. Stimulated by the enormous demands for quartz units for frequency stability and for selective purposes which arose during the Second World War, the production of quartz crystals became an important industry. The present book can be considered as a very complete exposition of British practice.

The first few chapters discuss the physical properties of quartz, the occurrence and examination of quartz crystals and give a short exposition of piezoelectric phenomena in crystals. These equations are next applied in deriving the properties of the longitudinal resonator and the thickness resonator. The equivalent electrical circuit for the crystal is used in discussing the stability of a Pierce-type crystal oscillator. The various types of low-coefficient crystals used in oscillators and filters are discussed. The simplest modes of motion and methods for mounting such crystals are described. An excellent chapter discusses the ageing phenomena in quartz crystals and describes methods for getting rid of gross defects. A fine-scale frequency-ageing phenomenon still remains, and it is this effect which produces an ultimate limitation to the accuracy of quartz crystal clocks. The degree of success in producing stable oscillators is discussed, and a day-to-day stability of 1 part in 10^8 is demonstrated. This is ample except for the most exacting primary standards. The use of crystals is described in producing the very selective filters used in the long-distance carrier and coaxial cable systems. A short chapter discusses the use of quartz crystals in under-water sound equipment and in ultrasonics. The remainder of the book is devoted to a very complete discussion of the various methods of sawing, orienting, lapping, etching, plating and mounting quartz crystals.

Several differences between British and American practices may be noted. A number of methods for determining orientation, such as etch pits and cleavage planes as well as X-rays, have been used in British practice, whereas only X-rays have been used in American practice. This latter method has recently been improved by the use of the double-crystal spectrometer, which improves the accuracy with which an angle can be determined. In the field of under-water sound, synthetic crystals such as ammonium dihydrogen phosphate are largely used in American practice in place of the more expensive and less-available quartz crystals.

The book is a very well-written account of the uses of, and manufacturing processes for, quartz crystals. The theories of filters, oscillators and resonators are well presented. The printing is excellent, and many photographs illustrate the manufacturing processes. The book deserves to be purchased by every user and manufacturer of quartz crystals.

W. P. Mason

ANÆSTHETICS

The Mode of Action of Anaesthetics

By T. A. B. Harris. Pp. xii+768. (Edinburgh: E. and S. Livingstone, Ltd., 1951.) 42*s*. net.

THIS book gives a most illuminating account of the mode of action of anæsthetics in man. Dr. T. A. B. Harris has gone to great efforts to give a very accurate and up-to-date account of the way different anæsthetic drugs react when administered to a human being, and has written a brilliant synopsis of the observations which have been made by pharmacologists, physiologists, physicists and biochemists of the mode of action of anæsthetics during the past thirty years.

To undertake a task such as Dr. Harris has done in his book is formidable; yet he has succeeded in giving a clear, concise and intelligent account of the action of anæsthetics in man, while at the same time providing an interesting and stimulating synopsis.

Because of the importance stressed by Dr. Harris of a sound knowledge of the action of anæsthetics, and the body's response to them, his book will be a most valuable contribution to the science and practice of anæsthesia. Only by assimilating all that is known about the pharmacology of a drug can it be given wisely and with maximum safety to the patient, and give favourable operative conditions for the surgeon.

Briefly, the text is divided into four parts. The first deals with the action of narcotics, while in the second a full description is given of inhalation and non-volatile anæsthetics. Part 3 is devoted to the correlation of the level of anæsthetic depression of the nervous system with anæsthetic sleep, loss of sensation and loss of muscle movement and muscle tone, with a special reference to the use of *d*-tubocurarine chloride in clinical anæsthesia. The last section discusses metabolism during anæsthesia and the dominant action and side actions of anæsthetics on individual organs and systems, and closes with a chapter about anæsthetic explosions.

Dr. Harris's book is outstanding; hence it is difficult to choose any one section for special commendation. The whole is full of valuable information, is thoroughly reliable, and forms an up-to-date guide to the administration of anæsthetics. It will certainly arouse and stimulate much interest among anæsthetists, and is an ideal book for reference, having an extensive bibliography of two hundred and seven references. To the student of anæsthesia (and all anæsthetists are life-long students) this book will prove of considerable value, since the information it contains should to a large extent help to nullify mistakes. For candidates who have yet to obtain the diploma of anæsthesia, this work should prove of very great assistance for Part 1 and Part 2 of [illegible] examination.

H. Roy Bla

SCIENCE AND TRIBAL ART

By WILLIAM FAGG

An exhibition of "Traditional Art from the Colonies", held recently in the Art Gallery of the Imperial Institute, London, was, for the discerning public, an outstanding achievement of the Festival Year, even though it was too modestly advertised; its interest lay not only in the fact that it was the best display of tribal (and especially African) art, selected and arranged as 'art', that has ever been held in Great Britain, but also in the many problems which it offered for solution by scientific disciplines that have no normal connexion with the world of art. I am not now thinking of ethnology and archæology, in which æsthetic studies have, or ought to have, a key place, and which are not sciences in the full sense, but rather of some of the natural sciences, from which important—and perhaps in some cases as yet unsuspected—contributions may be demanded in the next few years.

There is a sense in which all true art—all art, that is to say; which fulfils art's immemorial function of improving upon and 'harmonizing' Nature (in the spirit of the Indo-Aryan root from which both 'art' and 'harmony' are derived)—is, like science itself, inductive. I mean that it proceeds from the particular to the general, beginning from human and other forms and stylizing or generalizing them. It is doubtful whether the *trompe l'œil* schools of art, the photographic realists who aim at nothing more than precise recording of the object, can be called artists at all in any strict sense; some of them, indeed, seek on the contrary to crystallize general ideas in terms of the particular, using purely naturalistic representations to illustrate 'literary' concepts (such as "Love Looked Out") in a manner which we may perhaps erm deductive. The method of true art, as of poetry d music, is surely to bring the mind's centres of ociation into play, and this it does by generalizing ings to a point where the spectator is reminded, subconsciously, of other more-or-less related things. Of all kinds of art none demonstrates this aim more clearly than that of the tribal peoples, among whom disciplined stylization is most highly developed; an ancestor figure from Africa may show not a mere portraiture of the deceased individual's features, but rather an abstraction of some of the qualities which are conventionally attributed to the tribal elders, alive or dead; and this quality of generalization is, of course, also found in the finest classical and renaissance art, transcending the naturalism which is their most obvious characteristic.

A further lesson which may be drawn from such an exhibition as the one at the Imperial Institute is that, whereas in the classical tradition of art only one kind of image, a broadly naturalistic one, is permissible, in tribal art no such single canon can be postulated. The possibilities of stylization are clearly unlimited, and in this exhibition there were well over a hundred different styles, in each of which a whole new world of art has been created, internally coherent and completely convincing even to the uncomprehending Western eye; it is meaningless to try to arrange them in order of artistic value or to suppose that there an be an ideal method of stylization.

he greatest problems involved in the scientific y of tribal art are those concerned with its origins and the historical processes by which it is developed (a task in which study of the social milieu of present-day tribal art is by no means irrelevant). The most obvious way in which the natural and physical sciences can be of use is in the dating of excavated pieces, and here geology is naturally most prominent. In the whole field in which African sculpture is found—a field bounded roughly by the Sahara, the Great Lakes and the Kalahari—the oldest art form to which any date has been assigned on reasonably scientific grounds is the terra-cotta sculpture of which traces have been coming to light during the past eight years around the village of Nok, south of the Central Plateau of Nigeria; the few examples in the exhibition were enough to show that sculpture was in a highly developed state in Northern Nigeria many centuries ago. The pottery figurines, most of them fragmentary, are generally found at a depth of about 25 ft. in alluvial tin-bearing deposits which geologists have recently dated provisionally to the second half of the first millennium B.C. Geological dating is still very difficult in West Africa, whereas in North, East and South Africa elaborate successions have been drawn up with fairly general agreement and are being constantly refined. The dating of the Nok culture is based on a correlation of the deposits in which it is found with the Nakuru Wet Phase of East Africa; but much further pure research in West African geology is needed before the theory can be considered established, and it must also be noted that even a fully successful correlation of East and West African deposits in a geological sense would not necessarily establish synchronism. There is a good prospect that archæology will prove as helpful to geology as geology to archæology.

The great majority of the exhibited sculptures were in wood, and we may note the possibility that dendrochronology, developed with such success in the south-western part of the United States, may be found to work in West Africa also; but little or no study of the formation of tree rings seems to have been carried out there as yet. Simple identifications of the woods used by carvers may, however, be of great value in technological study and also, no doubt, in the identification of styles. It may be worth mentioning that an effort is to be made to test the application of the radiocarbon method of dating to fossil trees found in the Nok deposits with the terra-cotta sculptures.

Metallurgy and chemistry are of particular importance in West African studies because of our dependence on bronze castings for most of our knowledge of art traditions older than about a hundred years (a life span seldom exceeded by wood carvings). The exhibition at the Imperial Institute included some of the most important pieces of bronze and brass work from the Guinea coast, including several of the famous bronze heads from Ife (flown from Nigeria) and representatives of all periods of the related work of Benin, beginning almost certainly before the first arrival of the Portuguese. Already it appears probable that brass (copper alloyed with lead or zinc or both) or virtually pure copper was normally used until the Portuguese introduced the true tin bronze. The opportunity afforded by the brief presence in Britain of these Nigerian treasures has been taken to carry out further scientific research upon them in the research laboratory of the British Museum.

It is now accepted that science has a great part to play in the critical study and treatment of European art; one may instance Dr. H. J. Plenderleith's part in the detection of the van Meegeren forgeries of Vermeer, or the elaborate techniques used in the cleaning of old paintings. Tribal art demands comparable methods: difficulties are involved in the cleaning and preservation of such things as ancient bronzes of superb patination or recent wood-carvings painted in earth colours or infested with woodworm; and forgeries are far from uncommon in the European market (though they are fast being lost to the United States). Science has yet to say the final word on the authenticity of what is probably the most famous of all West African bronzes, the "Olokun" head of Ife in Yorubaland; the results of a preliminary critical examination were given in *Man* of January 1949, and it is hoped that it may soon be sent to England again for a further period of study; meanwhile, it appears to be a skilful replica of the head seen by Frobenius in 1910.

There is, however, one form of scientific investigation—involving biology and applied mathematics—which, so far as I know, has never yet been attempted in the field of tribal art, or probably in any artistic field at all, and one can only briefly mention it in this article. It is concerned with what I may call the mathematical basis of distortion in the interests of art, and for that reason tribal art is clearly the most promising field, and classical art, in which distortion of natural forms is practically excluded, the least promising. There is, indeed, one minor form of European art—caricature—in which distortion and exaggeration play almost as characteristic a part as they do in tribal art; and in the best caricature it would doubtless be found that the exaggerations of a given physiognomy bear a definite and coherent (though not an absolutely precise) mathematical relation to its natural proportions—for example, a politician with a prominent forehead and chin and a somewhat 'dished' profile might find these features carried by the caricaturist's pen to lengths impossible in Nature, and yet, because the relation between the parts remains the same, the distortions render him more rather than less recognizable by the general public. It is possible to express this phenomenon mathematically by means of a series of exponentially curved co-ordinates similar to those employed by Mr. R. Guley Lewis in an article on "Co-ordinates as a Clue to the Morphology of Human Profiles" in *Man* of April 1949 (though that article had no reference to art). The same principles could be profitably applied to much tribal sculpture, in which exponential curves may be found directly represented, besides being followed, unconsciously, in the distortion of other forms. It might be found that the carvers who conformed most closely to D'Arcy Thompson's principles of growth and form were also those recognized as the greatest masters both by their own people and by European critics, and in that case a great step forward in objective criticism would have been taken. I looked forward to some guidance in this connexion when the Institute of Contemporary Arts recently held an exhibition entitled "Growth and Form" and inspired by D'Arcy Thompson's book; but I was disappointed to find that little serious effort had been made to relate his work to the world of art, though it is certainly of great interest that it should be brought to the attention of artists at all. Yet anyone with a scientific as well as an artistic bent who went on from that exhibition to the display of tribal art at the Imperial Institute might well find many a bell rung in his mind by their exotic forms and volumes.

A PHILOSOPHY OF NUTRITION

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On many occasions in recent years attention has been directed to the increasing food requirements of the world following the rapid and continuing growth in population and the desire in all countries for a higher standard of living. The dangers arising from soil erosion have also been stressed, leading as it does to a substantial decline in food production. Several writers have presented a dismal picture of progressive starvation in some regions of the world. Others have adopted a less pessimistic point of view and have suggested that the way to safety lies in an active programme for the efficient conservation and the fuller utilization of the natural resources of the world, together with the development of sparsely populated countries.

In relation to this last point, a question of great importance is whether or not there are sources of foods indigenous to certain countries but perhaps little known in Western Europe or on the North American continent. This is a problem which for the past eight years has been the subject of investigations by Dr. R. H. Harris and his colleagues at the Massachusetts Institute of Technology, who set themselve[illegible] the task of analysing the foods grown and eaten [illegible] Mexico and other countries of Central America. T[illegible] research programme involved: (i) the collect[illegible] and analysis of a large number of edible plants; (ii) the examination of methods of food preparation and the determination of the composition of prepared foods; (iii) a survey of dietary habits; and (iv) a clinical and biochemical investigation of nutritional status.

The work of the Massachusetts group has been characterized by its thoroughness and by the range of analyses carried out over a very wide area; it has already had far-reaching consequences and has led to a new outlook on nutritional problems in the countries concerned. In Mexico City, laboratories have been established at the National Institute of Nutrition for the development of a food analysis programme to be integrated with clinical surveys. Even more striking is the foundation of an Institute of Nutrition of Central America and Panama, an experiment in international co-operation of prime importance in that the central laboratories opened in Guatemala City in 1949 will serve all the countries of the region.

The purpose of the present review is to outline some of the findings of the American group and to relate them to results of investigations in Africa and Asia.

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Composition of Indigenous Foods

Mexico and Central America[1]. The collection of food plants in Mexico and Central America was carried out by a botanist, experienced in taxonomy, who obtained more than a thousand samples distributed as follows: Mexico 393; Honduras 200; Guatemala 230; El Salvador 273; Nicaragua 51; Panama 4; Costa Rica 154.

Often several samples of the same species of a plant were collected from different regions in a country, and in the area as a whole there was further duplication which enabled information to be obtained regarding the variations which can occur in the composition of any one plant under different soil and climatic conditions.

One specimen of each plant was placed aside for detailed botanical identification, and full records were made regarding its use as a food. Samples of the edible parts of a second specimen were macerated, treated with suitable preservatives and dispatched by air to the Massachusetts laboratories, where analyses were carried out for moisture, crude fibre, ether extract, nitrogen, phosphorus, calcium, iron, ascorbic acid, thiamine, riboflavin, niacin and vitamin A (as carotene). Control experiments established that no significant quantities of even the most unstable nutrient (ascorbic acid) were lost in the intervals between sampling and analysis.

Many of the plants examined, including species and varieties unknown as food sources in the United States and not previously analysed, were found to contain high levels of certain nutrients (see Table 1). Moreover, varieties of some plants were higher in nutritive value than corresponding varieties grown in the United States. Thus the standard tables of food composition based on plants grown in temperate zones cannot necessarily be used for the calculation of tropical and semi-tropical diets without the possibility of significant errors.

The survey of the composition of crops was extended to include studies of prepared foods and, although these are by no means complete, information of value has already been obtained. Harris[2] has examined the *tortilla*, the 'daily bread' of Mexico which is prepared from Indian corn (maize) by a relatively complicated process. The maize is soaked in a 1 per cent lime suspension and is heated to 80° for twenty to forty-five minutes, after which the mixture is allowed to stand until the following day. The liquid is then decanted off, the maize is washed two or three times with water, the resulting *nixtamal* is finally ground in a mill and the pulverized *masa*, in units of about 50 gm., is shaped into thin cakes and cooked on an iron plate. The original maize and the intermediate and final products were analysed (see Table 2), and it was found that the calcium content of the *tortilla* had increased twenty-fold compared with the original maize, because of the lime treatment.

TABLE 1. COMPARISON OF NUTRITIVE VALUE OF FOOD PLANTS IN CENTRAL AMERICA AND THE UNITED STATES

	Minimum value as basis of comparison (mgm./100 gm.)	No. of food plants above minimum value		No. of Central American food plants above U.S. maximum
		United States	Central America	
Nitrogen	2,500·0	8	20	1
Calcium	100·0	12	29	6
Iron	3·0	19	51	10
Carotene	2·0	14	32	3
Thiamine	0·2	16	42	5
Riboflavin	0·2	13	34	1
Niacin	2·0	13	31	0
Ascorbic acid	75·0	7	48	20

TABLE 2. ANALYSES OF *Tortilla*
Mean values (mgm./100 gm. dry weight)

	Maize	*Nixtamal*	*Tortilla*
Calcium	9	169	190
Phosphorus	275	294	317
Iron	2·7	3·3	3·7
Carotene	0·18	0·15	0·10
Thiamine	0·39	0·35	0·33
Riboflavin	0·09	0·10	0·10
Niacin	1·90	1·80	1·67

The average daily consumption of *tortilla* is of the order of 280 gm. but may be as high as 700 gm., and it is therefore an important source of both calories and minerals, and is a by no means negligible source of some vitamins. Thus these studies provide an interesting demonstration of the importance of local custom and show how false conclusions may be drawn from surveys which do not include methods of food preparation. Another item in the diet of the Mexican Indian is a fermented drink, *pulque*, obtained from a cactus; it provides various minerals and vitamins—especially ascorbic acid. Its use was at one time prohibited; but the resulting illnesses necessitated the removal of the ban[3].

Africa, Asia and Australasia. The activities of the Massachusetts group were extended to China at a stage in the Second World War when it seemed likely that American troops would be stationed there and would require food grown on Chinese soil. Harris[4] was able to demonstrate the high nutritive value of many plants and food preparations analysed.

There is a miscellaneous and not always readily available literature on gardening methods and on plants indigenous to Asia and Africa, and in some cases analyses have been carried out. Yet until recently there was not, perhaps, a sufficient appreciation of the wide variations likely to be found in crops grown in different regions; on the whole, there was a tendency to accept standard Western analyses, and furthermore to regard indigenous foods as of secondary importance.

There were notable exceptions to this attitude, as may be seen from the review of Gangulee[5] and from the work of Aykroyd[6] and his colleagues in India, of Rosedale[7] in Malaya and of Platt[8] in Nyasaland. Abundant evidence of the newer outlook was revealed at the conference of the Nutrition Society on Colonial Problems[9] in March 1946; but at that conference Platt expressed the opinion that the information available on native foods "is approximate and is reasonably satisfactory only for territories largely dependent on imported foods or for those which have more highly developed economies or well-staffed departments of agriculture". On the same occasion, Firth stated how surprised he had been to discover in 1939 that in spite of the excellent surveys in Singapore—extending to 1,000 families—most of these studies were urban; "very little work had been done among the peasants" and "there was not a single full-scale nutritional study in a rural area in Malaya".

Testimony in favour of the importance of native foods has been provided by medical officers who were in prisoner-of-war camps in Asia. Reed has contended that "there is much to be learnt about edible plants which grow easily and the unusual foods which effectively helped to save our lives", and Allen and Scott MacGregor[10] have endorsed this point of view. Stannus[9], from his experience in Africa, has affirmed, "it is not enough to deal only with the main staples and one or two other constituents in the diet. Results are likely to be erroneous unless investigators have an intimate acquaintance with the native and his daily life. Account must be taken of the occasional snack of dried oily fish . . . the fried grasshopper, the raw sugar cane, the assortment of green leaves which the women know so well how to select and cook and, last but not least, the mug of native beer."

During the post-war years, Platt[4] and other members of the staff of the Human Nutritional Unit of the Medical Research Council have stressed the importance of dietary surveys and have published analyses of tropical foods. Parallel action has been taken by Australian workers[11] in New Guinea, and the newer information has been reviewed by Nichols[12]

Nutritional Surveys

The studies of food composition carried out by Harris have been correlated with investigations of the nutritional status of children and adults in Mexico City and elsewhere. One team of workers who had previously conducted surveys in the United States reported that a group of 1,000 poverty-stricken Mexican children showed evidence of a nutritional status superior to that of a group of 760 middle-class children in Michigan, and this surprising conclusion was confirmed by other investigators who examined different age groups in both urban and rural communities. In all cases the incidence of detectable malnutrition was low, although the diets included few, if any, of the ordinary foods common in Europe and the United States[8].

Harris and his colleagues do not suggest that no improvements are necessary; they believe that the people are living on diets which are fairly well balanced in respect to proteins, minerals and vitamins, although the actual amount of food available may be inadequate. 'Balanced starvation' does not necessarily result in the typical histological and biochemical changes indicative of malnutrition; the effects of what has been described as 'hollow hunger' may be seen in the mental outlook of a people, and notably in a disinclination to make physical effort.

The American workers have presented a more optimistic picture of the nutritional state of the people of Mexico than might have been expected; so, too, warnings against excessive pessimism have been given by Stannus[9], who has pointed out that from the bare figures of a nutritional survey in Africa, the whole population in some regions might be expected to be suffering from malnutrition, although observations reveal that this is not so. Cathcart[13] has also suggested the need for a cautious interpretation of the results of surveys, affirming that "any diet can be regarded as defective if you put your standards high enough".

Food and Population

The surveys of diets and nutritional status, taken in conjunction with the laboratory findings of food composition, point to the conclusion that many countries should be able to raise nutritional standards and to promote a positive health policy, on the basis of improvements in agriculture leading to a greater production of certain crops of special value. Harris believes that it is necessary to recognize the importance of dietary patterns which vary from one country to another, and indeed from one area to another in the same country. These patterns are the results of age-old experience and accumulated wisdom, and any drastic and sudden change may lead to widespread malnutrition. Modifications have taken place and perhaps should take place, but any recommendations for changes should be made only with the full knowledge of both the immediate effects and later consequences.

For long periods of time communities have existed and have increased and multiplied without our newer knowledge of nutrition, and dependent almost entirely on indigenous crops and to a lesser extent on animals. The indigenous foods of many areas, when judged by the tests of history and also of vital statistics, must contain within themselves the nutrients essential for growth and reproduction. There may be specific deficiencies in some areas; there may be food shortages because of over-population or crop failure; there may be problems following industrialization and the growth of large towns, but rural communities are usually able to thrive.

It is evident that a distinction must be made between basic nutritional concepts which have universal significance and secondary concepts, such as the primacy of animal proteins and the necessity of milk and orange juice which may not have world-wide application. Certain dietary programmes which may be ideal in Western Europe or in North America may be unsuitable or impossible in other regions. Thus as part of any campaign for improved agriculture in under-developed countries, there must be a plan of education in which the theory of nutrition is taught and also its practice, with the proviso that diets recommended should be based as far as possible on the existing habits of the people rather than chosen from a typical European or American diet sheet.

Much remains to be done in Central America and elsewhere to correlate clinical and laboratory investigations. The establishment of minimum dietary standards for minerals and vitamins in terms of indigenous crops is but one aspect of the programme. Further and more difficult tasks are the determination of the biological values of the proteins available in these crops and the assessment of the relative quantities of fats, carbohydrates and proteins that can be obtained from the sources available and included in a diet of adequate calorie content. Clearly the implementation of a programme on the above lines will involve extensive laboratory work on crops and food products in many regions, and this must be carried out using standard methods and techniques so that the results obtained in different centres may be comparable.

It is good to know that groups of workers, one concerned with the 'good neighbours' south of the United States' border, others concerned with the Asiatic Dominions and the African territories, have by different routes come to somewhat similar conclusions in the recognition of indigenous dietary patterns and of indigenous agriculture as a basis of sound nutrition. When the existing facts are more generally known, if the results are extended and confirmed, if there is a more adequate recognition of the value of mixed proteins from plants, then there may be some recession in that pessimism which has become so common in the consideration of the world's food supply.

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OBITUARIES

Prof. C. J. van der Horst

PROF. C. J. VAN DER HORST died in Johannesburg on Oct. 10. He was born in Holland on May 11, 1889, and educated in that country, studying under Profs. Hugo de Vries and Max Weber in the University of Amsterdam. His thesis for the doctorate was on the structure of the brain in fish. On graduation he was appointed chief assistant to Prof. Sluiter in Amsterdam, and there wrote a monograph on the corals of the *Siboga* expedition. He soon returned to neurology, working with Judson Herrick in Chicago, and becoming sub-director of the Institute for Brain Research (Herseninstitut) in Amsterdam in 1925 under its director, the late Prof. C. U. Ariëns Kappers. Van der Horst was thus a zoologist of unusually wide interests and knowledge when he was appointed senior lecturer in zoology in Johannesburg in 1928 under the late Prof. H. B. Fantham. There he soon established a reputation as a man of scientific distinction, of sound judgment, and of great personal charm. Thus it was natural that he should succeed to the chair of zoology in 1932, when Prof. Fantham accepted the chair of zoology in McGill University, Montreal.

In the meantime, van der Horst had turned his attention to the Enteropneusta, soon becoming recognized as the authority on those animals. His review of the group in Bronn's "Tierreich" is an original and lasting contribution to systematic zoology.

Then, at a relatively mature age, following the example of his illustrious fellow-countryman, A. A. W. Hubrecht, van der Horst turned to the study of mammalian embryology and began to collect developmental material of many of the rarer and more interesting South African mammals, gradually building up magnificent collections of the elephant shrew (*Elephantulus*), the golden mole (*Eremitalpa*), *Pedetes* and other forms. The first fruits of this work appeared in a series of papers (1940–46) in collaboration with Dr. J. Gillman, in which the authors elucidated the reproductive cycle of *Elephantulus*, providing detailed descriptions of the ovarian and uterine changes and valuable discussions of the mechanism of ovulation and the history and functional significance of the corpus luteum. They showed that *Elephantulus* far surpasses all other mammals in the number of ova shed at each ovulation (up to 120 or more), and that out of this large number only two eggs become implanted and survive (one in each uterus). In two outstanding papers on the early development of *Elephantulus* (1942, 1943) van der Horst showed that it displays features of very great interest, some of them, indeed, unique; for example, the attainment of a vesicular blastula already in the four-celled stage and the formation of the embryonal knot from amœboid cells detached from the blastocyst wall. In later papers, he described for the first time early stages in the development of the golden mole and the first phases of placental development in the aardvark (*Orycteropus*); and in a highly important paper (1949) he showed that the placenta of the tree-shrew (*Tupaia*) is not hæmo-chorial, as Hubrecht believed, but belongs to the more primitive endothelio-chorial type, a discovery of significance in view of the discussions as to the systematic position of the tree-shrews. His last contribution (1950) provides a detailed account of the placentation of *Elephantulus*, together with an interesting discussion of the relevant literature. The contributions he has made to mammalian embryology show how very greatly we must regret that his work in this field has come to so untimely an end.

Prof. van der Horst's influence on the development of zoology in South Africa has been great; the courses given in his department have presented the subject as a whole, extending far beyond the comparative anatomy which was his own field. Thus, impressed with the impossibility of teaching students who had no access to the sea, van der Horst found an island off Lorenço Marques to which he took students, living in camp and working in a temporary hut. This course proved so successful that a year ago the Portuguese Government built a permanent marine station on the island for the use of the University of Johannesburg, in effect as a tribute to van der Horst himself, an account of which by Mrs. Tattersall will be found in *Nature* of December 1, p. 946. It is to be hoped that the station will be permanently associated with his name.

Prof. van der Horst was one of the kindliest and most generous of men, and his unexpected death will be felt with a deep sense of loss not only by his colleagues in South Africa but also by his many friends in Great Britain and other European countries. He was elected a corresponding member of the Zoological Society of London in 1943, and in 1950 was awarded the Linnean Gold Medal of the Swedish Academy of Science, an honour he greatly appreciated. He was a member of the International Institute of Embryology (1948) and a Foreign Member of the Royal Netherlands Academy (1950) and of the Norwegian Academy of Science (1951). His wife and daughter survive him, and to them we offer our sympathy.

Mr. F. O. Barlow

FRANK OSWELL BARLOW, well known for his casts and restorations of fossil human skulls, died at Merston, Sussex, on November 12. In August 1896, when fifteen years old, he entered the Geological Department of the British Museum (Natural History) as an unpaid learner in the workshop. In 1908 he there succeeded his father as "mason" (as the chief preparator was then called). Caleb Barlow had been in the Museum since 1874, developing, modelling, casting and mounting fossils, mainly vertebrates.

His son carried on the same kind of work with great distinction for forty-five years, until he retired in 1941.

During 1903–4 Mr. Barlow spent a year in the Fayum (Egypt) excavating Cænozoic vertebrates with Dr. C. W. Andrews, and afterwards made restorations of the most important finds, such as *Arsinoitherium*. He developed Sir Arthur Smith Woodward's collection of Pliocene mammal remains from Pikermi, Greece, and many other famous specimens, including *Archæopteryx*. His last major work at the Museum was to carry out the difficult task of restoring the head of the Triassic amphibian *Cyclotosaurus* from mere cavities in the rock.

To the outside world, he was best known for his work in palæoanthropology, and particularly for his modelling of Smith Woodward's restoration of the Piltdown skull. He is one of the figures seen standing behind Sir Arthur Keith in the painting by John Cooke, R.A., illustrating the Piltdown controversy (1913), which now hangs in the rooms of the Geological Society of London. He was not placed on the pensionable staff of the Museum until 1921, and, like his father, he had worked in his spare time with the firm of R. F. Damon and Co., which he eventually took over, and developed on the anthropological side. For many years he provided scientific institutions all over the world with casts of the chief specimens of fossil men, produced with unparalleled skill and fidelity. His stock of moulds has now been taken over by the Wenner-Gren Foundation in order that his work may be continued.

Mr. Barlow will be remembered by all who knew him for his personality, his massively imposing figure, resonant voice and courteous approach. He was a man of wide culture, as his conversation revealed. He had an extensive knowledge of literature and, like his father, he was musical. His rich bass voice was for many years heard in male voice choirs, and he sang at coronations and other special occasions in Westminster Abbey. He spent his last decade in the pleasant half-timbered Old Parsonage at Merston near Chichester.

W. N. Edwards

NEWS and VIEWS

Queen's University of Belfast

At the Queen's University of Belfast three appointments to chairs have recently been made as follows.

Agricultural Botany : Dr. P. A. Linehan

The whole of Dr. P. A. Linehan's working career has been with the Department of Agricultural Botany in Queen's University and with the Botany Division of the Ministry of Agriculture, Northern Ireland; he has held simultaneous appointments in these two bodies, the most recent being reader and head of the Division, respectively. Dr. Linehan was part-time chairman at the Ninth International Seed Testing Congress, held in Washington, D.C., in 1950, and is a member of various technical committees on seed-testing. He was a foundation member, has been honorary treasurer, and is at present a member of the executive committee and editorial board of the British Grassland Society.

Comparative Pathology : Dr. H. G. Lamont, O.B.E.

After being engaged for a number of years in veterinary and pathological research, Dr. H. G. Lamont was appointed in 1931 to be head of both the Veterinary Research and Dairy Bacteriological Divisions of the Ministry of Agriculture, Northern Ireland; at the same time he was made a lecturer in both veterinary science and dairy bacteriology in Queen's University, and in 1947 was promoted to be reader in veterinary science. In 1941 he was awarded the D.Sc. degree of the University for a thesis on "Observations on Aujeszky's Diseases in Northern Ireland", a neurotrophic virus disease of domestic animals. Dr. Lamont is a member of the Agricultural Research Council committee on pig disease, tuberculosis and tuberculin. and mastitis. He was created an O.B.E. in 1950.

Pure Mathematics : Dr. S. Verblunsky

Dr. Samuel Verblunsky goes to the chair of pure mathematics in Queen's University in place of Prof. T. G. Room, who was unable to take up the appointment (see *Nature*, April 21, p. 630). Dr. Verblunsky was born in London and was educated at Magdalene College, Cambridge, where in 1927 he was a Wrangler with distinction in schedule *B*, later becoming a Rayleigh prizeman and Allen scholar of the University. He was for nine years a lecturer at the Manchester College of Technology and then was appointed to a lectureship at Queen's University, being promoted reader in 1950. He is author of a book on "An Introduction to the Theory of Functions of a Real Variable".

Pittsburgh Award of the Pittsburgh Section, American Chemical Society : Dr. W. A. Gruse

The Pittsburgh Section of the American Chemical Society has announced that the Pittsburgh Award for outstanding service to chemistry has been made to Dr. W. A. Gruse, administrative fellow of the Petroleum Refining Fellowship at the Mellon Institute, Pittsburgh. The Award is in recognition of Dr. Gruse's activities as a technical administrator and acknowledged expert in the field of petroleum chemistry, and more particularly for the work of his Fellowship, financed by the Gulf Research and Development Co., which has resulted in fundamental improvements in the refining of petrol, lubricating oil, waxes and other petroleum products. After graduating at Johns Hopkins University and taking his Ph.D. at the University of Wisconsin, Dr. Gruse taught for some years, and then served in the Chemical Warfare Service during the First World War. He became a fellow of the Mellon Institute in 1919 and a senior fellow in 1923, and then in 1945 took up his present appointment at the Institute. During the Second World War he was awarded a Certificate of Merit from the United States Office of Scientific Research and Development, and the Distinguished Service Award of the Ordnance Department. Dr. Gruse has been very active in the American Chemical Society, having been first secretary of the Petroleum Division in 1921, and chairman of the Pittsburgh Section during 1943–44; he is chairman of the Committee on Automotive Engine Oils of the American Society for Testing Materials.

Part-time Work in Chemical Engineering

The would-be chemical engineer is in the unfortunate position of having to acquire a knowledge of the fundamental principles of both chemistry and engineering before he can embark on the application of these principles to the design of plant and the development of processes. This preliminary work cannot be greatly curtailed, and consequently the training of a chemical engineer is bound to take longer than that of a pure chemist or an engineer. The Institution of Chemical Engineers published some years ago a scheme for a full-time degree course in chemical engineering extending over four years; but, in view of the great shortage of chemical engineers, it has been felt for some time that degree courses alone are not sufficient and that a valuable method of increasing the supply of chemical engineers would be the establishment of part-time courses. The difficulty has been to devise such courses without making them of inordinate length. The Institution has now put forward a method of instruction in the form of a pamphlet entitled "Scheme for a Part-time Course in Chemical Engineering" (pp. 23; London: the Institution, 1951; 2s.). This is described, perhaps optimistically, as a three-year course with an "endorsement year" for entrants already holding Ordinary National Certificates in chemistry or mechanical engineering. It is quite clear, however, that the course is really one of four years, as, without the endorsement year, it would be very incomplete; with the endorsement year, the course is admirable and, on paper at least, equivalent to the degree course. Detailed syllabuses and the approximate times spent on each subject are given, which, though only suggestions, will undoubtedly prove of great value to those who are considering the possibilities of such a course. It should be noted that the times given include laboratory work. In addition to the purely formal matter, the pamphlet abounds in brief remarks on the underlying principles of the teaching and the emphasis to be placed on different subjects; it is worth reading for these alone.

Weather Artistry

Three recent articles by L. C. W. Bonacina in the Royal Meteorological Society's monthly periodical *Weather* deal with the picturesque effects of weather, especially cloudscapes. The first, "The Scenery of Devonshire in Relation to Weather and Climate" (May 1951), is a rapid tour through the coastlands, valleys and moors in sunshine, shower, frost, fog and snow. In "London's Picturesque Cloud Scenery" (November 1951) we read how, in the built-up areas of south-east England, man may play havoc with the beauties of hill and woodland, but the sky is ortunately beyond his reach. Even the pearly ondon smoke haze may add to the beauty of altering glints of silvery or golden sunlight seen to rfection as they steal across the Thames". London gs are rather tactfully passed over. The remaining icle, "Turner as a Weather Painter, a Centenary preciation" (July 1951), which is illustrated by oductions of "The Wreck" and "Snowstorm", is ilful analysis of the weather symbolism in Turner's erings of cloud and sea, and the effects of sun- and haze on vistas of mountains. In fact, as Bonacina points out, instantaneous detail of l weather in paint is almost impossible for an to realise; he can only reproduce the spirit of pidly changing scene. Turner's cloudscapes not be perfect meteorology, but they are locent art.

ing Colonial Raw Materials

Colonial Office publication, "The Processing ial Raw Materials", by Charlotte Leubuscher (pp. 186; London: H.M.S.O., 1951; 10s. net), it is pointed out that the root causes why processing industries have not developed in many tropical countries are general economic backwardness and low standards of living. Prospects for the establishment of processing industries are brightest for materials such as oilseeds and cane sugar, which have a local market or where such a market might easily be established. There is less likelihood that processing factories can be successfully established for materials such as cocoa or sisal for which the markets are almost entirely outside the producing countries. Often a producing territory provides too small a basis for the development of an efficient industry. The market in this event would have to be regional, but it does not follow that the most advantageous situation for a processing industry will necessarily be in the country producing the bulk of the raw material. In other words, it is likely that the tendency for industries to be attracted by the markets where their output is sold will assert itself also in the tropics. This is exemplified by the comparatively advanced industrial development of Trinidad within the West Indian region and the industrial importance of Singapore where raw materials from the Malayan hinterland and Indonesia are processed on a large scale.

Soil Survey of Great Britain: Report for 1950

The Soil Survey Research Board of the Agricultural Research Council has recently published report No. 3 of the Soil Survey of Great Britain (pp. 36+3 plates; London: H.M.S.O., 1951; 3s. net). This report summarizes the progress made during 1950 and gives brief descriptions of new series found. It also includes an obituary of Prof. G. W. Robinson, chairman of the Board, who died during the year. The broad classification of previous reports has been retained; this follows current international practice, with subdivisions to take into account differences in drainage and in the rocks from which the soils are formed. The classification is shown by tables, and this should assist in the recognition of soils developed on the same rocks in those parts of Britain which have not yet been mapped. During the year a further 327,000 acres have been surveyed, and work has continued in Lancashire, Yorkshire, Banffshire, Kincardineshire and Angus, Roxburghshire and Ayrshire. The survey of a sheet around Cambridge has been started with the view of obtaining information about the Fenland soils. The sheets covering Anglesey and the Glastonbury (Somerset) sheet have been completed and are being prepared for publication, and the Wem (Shropshire) sheet is in an advanced state of preparation for publication. Soil maps and reports of the north of Banffshire and the north-east of Aberdeenshire are almost ready for printing.

Science Abstracting: Final Report of the Paris International Conference

The final report of the International Conference on Science Abstracting, convened in Paris by the United Nations Educational, Scientific and Cultural Organization during June 20–25, 1949, has now been issued (pp. 192+10 plates. Paris: Unesco; London: H.M.S.O., 1951; 12s. 3d. net) and gives a clear idea of studies and discussions out of which the recommendations of the Final Act of the Conference (see *Nature*, 164, 998; 1949) emerged; the Final Act is given in the appendixes to the report. These appendixes also include, among other documents, the declaration on fair dealing in regard to copying from scientific periodicals and the guide for the preparation of synopses, issued by the Royal Society in April 1949, and the recommendations and resolutions adopted in June 1949 by the Interim Co-ordinating Committee on Medical and Biological Abstracting, as well as a bibliography. The ten chapters of the report review briefly the preliminary report and its preparation; types of abstract and the scope and nature of abstracting services; the authorship of abstracts; methods of publication, including costs, arrangement and the desirability of common bibliographical rules; methods of distribution, including the use of offprints and microfilms and means of reducing the time-lag; the selection of abstracts, including indexing systems and the classifications on which indexing systems are based, and the mechanical selection of documents; language problems and the value of translations; the distribution of articles and abstracts by subject; the co-ordination of abstracting services; and the future organization of science abstracting. The report is thus a useful commentary on the Final Act, indicating the trend of responsible opinion on the question, not merely of abstracting but also of the dissemination of science information in the scientific and technical world generally. It is a reference work which should facilitate understanding of, and co-operation in, a difficult field.

Determination of Earthquake Azimuths from Observations at a Single Station

PROF. W. HILLER, of Stuttgart, in a paper entitled "Über die Bestimmung des Azimuts von Fernbeben aus Oberflächenwellen" (*Gerlands Beiträge zur Geophysik*, 61, Heft 4, 221–231, Leipzig; 1950), has published details of a method of finding the azimuth of an earthquake from observations at one station. Prof. Hiller states that in many earthquakes the *P* waves are only feebly recorded, or indeed may not be recorded at all, so that the determination of azimuth by means of *P* waves is not possible in these cases. In most earthquakes the surface waves are strongly registered. If one has at one's disposal a record of an earthquake on each of three components obtained with instruments having as nearly as possible the same constants, it is possible to find those positions in the surface waves which indicate the arrival at the observatory of pure Love waves or pure Rayleigh waves. The direction of oscillation of the Rayleigh waves is then used to give the azimuth of the epicentre. (In a Rayleigh wave the motion of the earth particle is in the form of an ellipse in the plane containing the vertical and the direction of the earthquake epicentre to the observatory. The motion of the particle in the ellipse is towards the epicentre at the top of the ellipse.) Prof. Hiller has applied this method with success to hundreds of cases in which the seismograms from the Stuttgart Galitzin–Wilip instruments were used; and illustrated examples are given in the paper.

Bibliography of Seismology

Nos. 6, 7 and 8 of Vol. 14 of the Bibliography of Seismology, published by the Dominion Observatory, Ottawa (Ottawa: King's Printer), contain 438 items of pure and applied seismology. The intense interest in microseisms appears to have passed its peak in 1948–49, since in Nos. 5 and 6 of the Bibliography no fewer than twenty-eight items referred to microseism whereas in Nos. 7 and 8 nineteen items were so listed. The mathematical aspects of seismic waves still attract attention, and it appears that a renewed interest in seismographs exists; in Nos. 5 and 6 of the Bibliography nine items were concerned with instruments, whereas in Nos. 7 and 8 twenty items referred to seismographs. There is no doubt that a need is now felt for several instruments designed to work in prescribed conditions and to record particular seismic phenomena, as distinct from one instrument designed to record as many seismic waves as possible. Item 7,407 in the Bibliography refers to one of the latest problems in earthquake waves, namely, "The *T* Phase of Shallow Focus Earthquakes", by Ivan Tolstoy and Maurice Ewing (*Bull. Seis. Soc. America*, 40, No. 1; January 1950). This *T* phase appears to be a feature of submarine earthquakes and may be of use in giving a warning of tsunamis. Recent theoretical work mentioned (Item 7,200) is "On the Nature of the Earth's Interior" by W. H. Ramsey (*Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, 5, No. 9; October 1949) and refers to work on the calculated effects of pressure on the atomic constitution of materials within the earth. In this connexion reference may also be made to Dr. Ramsey's article in *Nature* of October 20, p. 676.

Apia Observatory, Western Samoa: Report for 1941

THE annual report for 1941 of the Apia Observatory, Western Samoa (pp. 170; Wellington, New Zealand: Government Printer, 1950) has only recently been issued. Observations during that year were made in the following geophysical subjects: terrestrial magnetism, seismology, meteorology, atmospheric electricity and tides; details are given in tabular matter or otherwise. Preliminary remarks at the beginning of the various sections describe the instruments and provide other relevant information. Hourly scalings of heights of the tides, automatic recording being made by means of the portable tide-gauge No. 11664, together with times and heights of high and low water, were sent, as usual, each month to the United States Coast and Geodetic Survey in Washington, D.C. The resident staff included the acting director, Mr. H. B. Sapsford, and four professional assistants, and in addition there was a locally recruited staff of ten.

Announcements

PROF. EUGÈNE DARMOIS, professor of physics the University of Paris, has been elected a memb of the General Physics Section of the Paris Acade of Sciences in succession to the late Prof. A Cotton.

IN Memorandum No. 25 of the Medical Rese Council, "The Social Consequences of Pne coniosis among Coalminers in South Wales" Dr. P. Hugh-Jones and Dr. C. M. Fletcher don: H.M. Stationery Office, 1951; 1s. 9d. methods of studying the connexion between and disease and the physiological assessm shortness of breath are discussed. The two dealing with the improvement of human perfo by laboratory studies include a valuable p Sir Frederic Bartlett on the laboratory and human activities, and papers dealing with the of warmth on comfort and efficiency [illegible] studies of the effects of heat and [illegible] in machine design.

UNIVERSITY COLLEGE, SOUTHAMPTON

DEPARTMENT OF ZOOLOGY

PROF. J. Z. YOUNG, professor of anatomy, University College, London, opened the new Department of Zoology at University College, Southampton, on December 5. In an address before the opening ceremony, which was attended by representatives of universities and other bodies, Prof. Young pointed out that although there are many reasons for the study of zoology, the most important is to satisfy our urge to become acquainted with the animals around us. He emphasized the richness of animal life still to be found in the British Isles, and suggested that the great abundance and variety of life in freshwater ponds and streams, and even more especially in the sea, should merit our particular attention. With the importance of the fishing industry in Great Britain, it is clear that the study of marine life is of very considerable practical value. Prof. Young expressed the hope that the new Department would study animals in relation to their environment. At the same time experimental zoology, experimental embryology, anatomy and other methods of approach, he said, are essential to the study of the animal as a whole. In this connexion he welcomed the emphasis which is being placed in the new Department on comparative physiology. Even man and his environment may be regarded as a proper subject (though admittedly a very complex one) for zoologists to study. Thus the zoologist should be prepared to extend his thinking to anthropology and related subjects. But whereas on one side the study of zoology may march with philosophy, on the other hand it is just as needful, if we are to understand the working of animals fully, to enter the fields of biochemistry and biophysics. Zoology is therefore a fundamental science and at the same time an all-embracing subject requiring the most severe mental discipline. He hoped, therefore, that in Southampton zoology would not be too narrowly interpreted. The new and well-equipped laboratories, he said, mark an important step in the development of the subject with which Southampton can make a real contribution to biological studies.

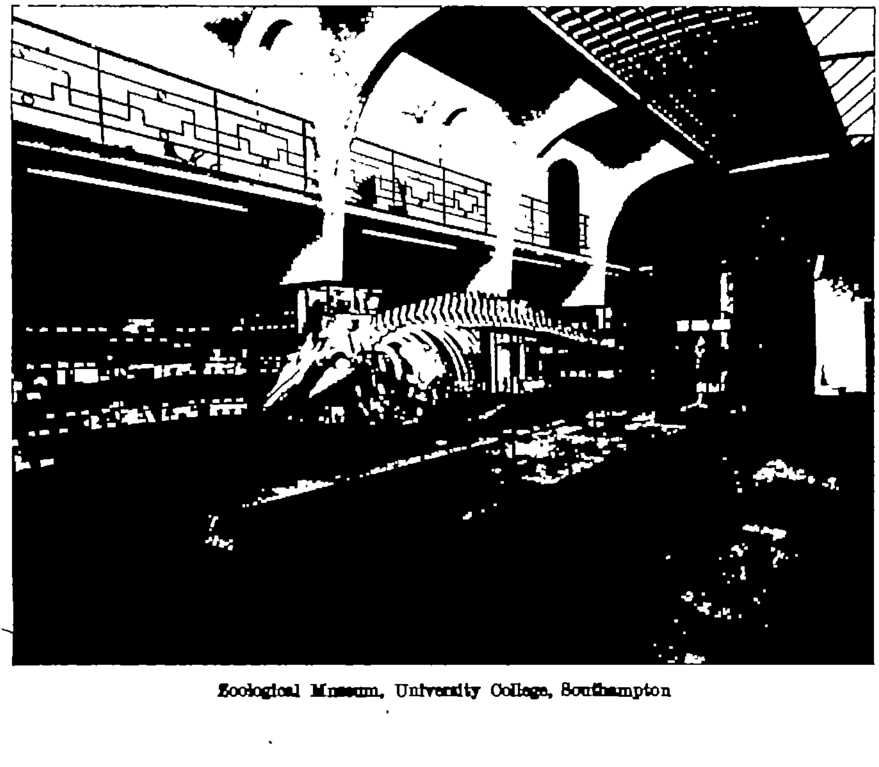
The new Department is a well-designed building of two floors, built of brick, and some 130 ft. long. It has been added to an existing block which once housed both the Geology and Zoology Departments, and between the old and new buildings a new zoological museum has also been erected.

The whole Department has been supplied with teak benching, and care has been taken in planning extensive cupboard, shelf and drawer accommodation. All laboratories and private rooms have been provided with ample electric power points. It has been possible also to provide microscopes, low-power binocular microscopes and general equipment for each laboratory in numbers sufficient to make each almost a self-contained unit.

On the ground floor the new Department houses a well-equipped physiology laboratory. This includes benches designed for kymograph work, as well as chemical and embedding benches and a smoking and fume cupboard. Near by is a dark room reserved for physiological work. Apart from general equipment, the physiology laboratory is furnished with recording apparatus, refrigerators, a Spekker photoelectric absorptiometer, direct-reading balances and a respiration bath.

Across the corridor from the physiology laboratory there is a well-ventilated and lighted animal house with stocks of 'pure line' rats, mice and guinea pigs housed in racks of metal cages. Special heated aquarium sinks also maintain a colony of 250 South African toads (*Xenopus*). These are being used mainly for research on the pituitary and the physiology of colour change. The mammal stocks are used for research into growth hormone, adrenocorticotropic hormone and other endocrine gland effects, and also as stock for teaching purposes. Both the animal house and the nearby preparation room, which is fitted with a large tiled dissecting slab and work bench, have concrete floors to facilitate washing.

There is a cold room of generous proportions which is capable of giving constant temperatures (c. ±0·5) from 0° C. up to room temperature. This is made possible by a large refrigerating unit and a system



Zoological Museum, University College, Southampton of fans and ducts to circulate the cold air. The room is insulated throughout by a double layer of cork, faced with white polished asbestos boarding. Daylight is admitted by a vacuum-insulated window; but the room can rapidly be converted into an experimental dark room with controlled lighting. Three large concrete tanks with heating units have been built into the cold room so that constant-temperature baths at different temperatures can be operated at any one time.

An aquarium room with compressed air supply is also situated on the ground floor. Both the aquarium and cold rooms are already in use for experimental work on marine and freshwater animals. The aquarium room includes two large slate storage tanks for living animals, in addition to the usual small tanks.

The new building is equipped with a departmental photographic dark room and a small developing room. Equipment in the photographic room includes an optical bench with photomicrographic apparatus and an enlarger for both micro-film and ordinary-size negatives.

The ground floor also has three lecturer's rooms, a technician's room, a large research room occupied by two postgraduate students and a room equipped with sterilizing ovens and an autoclave. Store rooms for glassware, chemicals, general equipment and one for nets and other ecological apparatus complete the ground floor. A small lift for goods serves both floors of the building.

On the upper floor, apart from the professor's room, two lecturer's rooms and a research room, there are three laboratories, two of which, planned to accommodate about thirty students each, form part of the old block. The remaining new laboratory has been planned as a 'final honours' room, designed to take a dozen students. Each student has ample bench and cupboard accommodation, and the room has also been fitted with a small lectern and blackboard so that it can be used as a lecture and discussion room.

There is a small lecture theatre, capable of seating some sixty students and fitted with an epidiascope which can be sunk into the lecture bench, and also a departmental library equipped with steel shelving to take about four thousand volumes and with study space for about a dozen students. This library houses the majority of the zoological books in the College, and also includes a good selection of full runs of the more important journals in both zoology and physiology.

The new departmental museum, of modern design, measures some 70 ft. × 35 ft. It is lighted by a glass roof supported by four main reinforced concrete arches spaced along the length of the room. A narrow gallery, with 'Lenscrete' panels in the floor to increase the lighting, runs along three sides of the museum and is reached from the upper floor of the Department. The concrete arches mark off bays at the ground-floor level of the museum, and glass display cases, 7 ft. 6 in. high, framed with Australian walnut and bronze fittings, have been placed around the walls and bays. Heating units have been sunk into the lower parts of the cases.

The sliding glass panels give excellent views of the collections displayed. Both the day lighting and the fluorescent lighting, hidden largely in the glass roofing, have been specially planned to minimize reflexion from the glass of the cases.

The museum collections are arranged phylogenetically and include dissections and skeletal preparations, many of which have been made by students of the Department as part of their course work. Many specimens have also been generously given by other departments and museums. It is hoped that the museum, though designed primarily as a teaching museum for the Department, will also serve as a centre for the colleges and schools in the area, since Southampton lacks a municipal natural history museum.

The gallery has at present only storage cases housing a large part of the smaller specimens used for general class purposes; but it is hoped that further display cases will be added there in the near future.

The centre of the museum is occupied by a few of the larger exhibits, including an 18 ft. long skeleton of the pilot whale, *Globicephala*, which was prepared last year in the Department from one of the specimens stranded on the beaches at Dunbar. While the present collections are mainly systematic and morphological, ecological and other exhibits are planned for the future.

The new Department was viewed by visitors after the opening ceremony, and demonstrations of the research work now in progress were laid out in the lecturer's and research rooms. They included physiological studies on the endocrine glands, studies on the growth of *Mytilus* and the infection of *Mytilicola*, and factors concerned in the hatching and ecology of *Chirocephalus*. Studies on the respiration of marine Copepoda, and of growth of bones in trout, and some ecological investigations on streams and ponds, and on beech-woods were also demonstrated.

The Department emphasizes ecological work, with the sea and the New Forest area (with its varied streams and woodland) only a few miles away. A small boat is operated in Southampton Water by the Department. At the same time, ecological work is combined so far as possible with experimental zoology. The facilities available for comparative physiology have been planned with the aim of developing this subject both as regards teaching and research.

Students also exhibited some of the dissections and preparations and special studies which they have in progress as part of their normal degree work.

BRITISH FOOD MANUFACTURING INDUSTRIES RESEARCH ASSOCIATION

OPENING OF NEW LABORATORIES

LADY ENGLEDOW, wife of Sir Frank Engledow, Drapers' professor of agriculture in the University of Cambridge, on November 8 cut a ceremonial ribbon stretched across the entrance and declared open the fine new laboratories at Leatherhead of the British Food Manufacturing Industries Research Association.

The Association was formed in the beginning of 1947 by the amalgamation of two much older research organizations. Although nominally only in its fifth year, its work, which covers a broad (and ever-widening) field of food processing and preservation, is a continuance of research that has been developed during the past thirty-two years. In 1919, the British Association of Research for the Cocoa, Chocolate, Sugar Confectionery and Jam Trades was formed as the result of the co-operation of manufacturers in these three fields. Premises were fitted out as laboratories in Holloway, and research commenced under the directorship of T. Macara. In 1925 a further group of food manufacturers, mainly concerned with meat and fish products, set up the British Food Manufacturers' Research Association, at the same address and under the same director of research.

The two organizations continued to work in close association, but retaining their separate entities, until 1946, when amalgamation was decided on and plans drawn up for the construction of new laboratory premises at Leatherhead. In the meantime Mr. Macara had retired and had been succeeded as director of research by Dr. L. E. Campbell. At the first general meeting of the new Association, held in March 1947, Sir Frank Engledow was elected president, an office he still holds. The new laboratories were completed towards the end of 1950. Dr. Campbell relinquished his post in May of this year to join the United Nations Food and Agriculture Organization in Rome, and Dr. F. H. Banfield, who had been deputy director since 1948, took over as director of research.

On the opening day and on the day following, the laboratories were open for inspection by members of the Association and those interested in food research. Between four and five hundred visitors attended and studied the exhibits arranged in the laboratories to illustrate the work and scope of the Association. With a floor area of more than 19,000 sq. ft., the building has been planned on modern lines and the laboratories laid out and equipped in a most up-to-date manner. There are general laboratories accommodating teams of laboratory workers, specialized laboratories such as that devoted to micro-biological investigations, a number of small laboratories housing one or two research workers, a large technical laboratory equipped for carrying out a range of factory processes on a small scale, and a spacious library containing some thousand books and ninety periodicals. The staff numbers about sixty, including some thirty graduates.

The work of the Association is balanced to cover the interests of the various groups of member firms. These groups include manufacturers of bakers' prepared materials, cocoa and chocolate, jam, margarine and compound cooking fats, meat and fish products, pickles and sauces, sugar confectionery, and various miscellaneous products, such as jelly tablets, starch and flour preparations, lemon curd, etc. Research being undertaken falls into two main categories: fundamental research, such as the investigations of problems connected with the rancidity of fats, and research into specific problems arising in connexion with particular manufacturing processes.

Of the general apparatus and equipment displayed on the two days that the laboratories were open, mention may be made of the exhibits designed to illustrate the various methods for the estimation of moisture in foods, the recording of the colour of foodstuffs, the measurement of the strength of gels, the measurement of the viscosity of chocolate and the use of refractometers in factory control. Among the demonstrations of application were the determination of air in margarine, the examination of the aerating properties of egg albumen and its substitutes, detection of fermentation in foodstuffs, measurement of particle size with particular reference to particles of sugar in chocolate, and the study of the properties of starch gels and pastes. For the last-mentioned purpose two viscometers were shown, the Shirley consistometer and the corn industries viscometer. Another instrument recently installed is the Unicam photoelectric absorption spectrophotometer with application to the estimation of vitamin A in marine animal liver oils. Other investigations being undertaken by the Association which were fully demonstrated to visitors were those in connexion with the effect of various methods of cooking on the digestibility of meat proteins, the shrinkage of meat and fish pastes in jars, the sedimentation of sauces, the preparation of gelatine from pork rinds, and the corrosion resistance of stainless steels and other alloys to the action of fruit juices, pickling brines and similar products.

In the micro-biological laboratory both the desirable and undesirable activities of micro-organisms in the preparation of manufactured foods are under investigation. Among desirable activities is the part played by bacteria in the curing of bacon in brine, and in the brining of vegetables. The growth of micro-organisms in pickles or canned goods or of mould on jams is, however, clearly undesirable. Strawberries preserved for jam-making in sulphur dioxide are sometimes subject to a breakdown as the result of the activity of enzymes, and investigation into the exact nature of this action is a subject of research.

A short account of the work of the Association would not be complete without mention of some of its other manifold activities. The suitability of fruits for commercial jam manufacture is one important item, and samples of jam prepared in the laboratories were displayed for inspection by visitors. In the entomological laboratory the means for the identification and control of pests liable to infect raw materials are under continual review, as are the methods of controlling rodents.

Analysis of foodstuffs plays a most important part in food manufacture. The extensive laboratory at Leatherhead devoted to this purpose is fully engaged in the testing of new official methods and the development of methods of analysis suitable for routine factory control. The part played by the Association in assisting members to conform to the standards demanded by modern conceptions of purity in foods, and with the food laws of the countries to which their goods are exported, is of the greatest help to members.

GEOLOGY AND MINERAL RESOURCES IN THE BRITISH COLONIES

THE first number of the second volume of the quarterly bulletin issued by the Mineral Resources Division, Colonial Geological Surveys, which has recently been published by H.M. Stationery Office, gives further evidence of the valuable work being done by the expanded Geological Surveys of the Crown Colonies, and of the advantages gained from the limited measure of central organization which came into being after the Second World War.

Much space in this volume is devoted to an article on Sierra Leone, by J. D. Pollett, director of the Geological Survey Department of the Colony. The benefits of government-sponsored geological investigation are here illustrated particularly well. Although the first survey of the Colony, during 1918–21, failed to find any minerals of economic value, the investigations by Dr. N. R. Junner while director from 1928 onwards revealed high-grade iron ore, industrial diamond deposits, chromite, ilmenite and alluvial gold. Of these the first two mentioned have now reached major importance, more than 11,000,000 tons of hæmatite and 10,000,000 carats of diamonds having been exported during 1930–49.

Sierra Leone is mainly underlain by rocks of Pre-Cambrian age, of which approximately half the total area is granite. This is intrusive into metamorphic rocks, the schists, gneisses and granulites of the Kasila Series, the Kambui Schists and the Marampa Schists. The granite is overlain by folded unfossiliferous sediments, the Rokell River Series, and these in their turn are covered unconformably with bedded arenaceous rocks believed to be equivalent to Grès Horizonteaux of French Guinea, where fossil evidence indicates a Middle Silurian age. The primary iron-ore deposits consist of schistose specular hæmatite in the Marampa Schists, and banded iron-formation in the Kambui Schists. Near the surface, intense lateritic weathering has produced dense secondary hæmatite. The Colony peninsula is underlain by a banded noritic complex, including troctolite and gabbros, apparently lopolithic in form, and having other features in common with the great Bushveld lopolith in South Africa, including the presence of platinum.

Maps showing the geology and distribution of mineral localities on a scale of 1 : 1,000,000 accompany Mr. Pollett's article. Surveying of the Colony on the 1 inch : 1 mile scale has now begun with the expanded staff made possible by a grant from the Colonial Development and Welfare Scheme.

Under "Notes and Abstracts" an account is given of one of the first results of the recent effort to interest home university geological workers in Great Britain in problems of Colonial geology. A visit by Drs. J. Sutton and Janet Watson to Tanganyika to examine the granites and basement rocks is described in some detail; Prof. W. Q. Kennedy visited Uganda.

The issue also includes articles on British Somaliland and on photogeology, and a laboratory report on glass sand from Nigeria. Reports from the various Geological Survey units indicate that geological work of considerable scientific interest as well as economic value is in progress in many parts of British Colonial territories.

K. C. DUNHAM

PALATABILITY OF BIRDS' EGGS

IN a paper submitted to the Zoological Society of London (*Proc. Zool. Soc. Lond.*, 121, Part I), Dr. Hugh Cott describes the results of an investigation into the relative acceptability of the eggs of twenty-five species of birds, belonging to ten orders, as illustrated by the feeding preferences of the hedgehog (*Erinaceus europæus*). In each of 332 experiments, one of four animals used as tasters was presented with a choice between two egg-samples. Possible disturbing factors such as differences in egg-size or shell-coloration, and those due to spatial arrangements of the samples, were eliminated by the use of raw egg, offered in equal quantities, and by the successive reversal in position of the egg-species matched within a particular group of experiments, or as offered to a particular experimental animal.

The reliability of the experimental method and the degree of consistency of hedgehog discrimination was checked by repetition experiments (between the same species-pair), both for the same and for different individuals; and by linking and overlapping experiments (between pairs of egg-species more or less widely separated in the edibility series). In general, the results show the hedgehog to be sensitive to differences in the relative palatability of the eggs offered, and to be consistent in its preferences and aversions; these show a broad agreement with those of man for the egg-species considered.

The experiments, which fall into groups carried out with sixty species-pairs, afford a basis for the arrangement of the several species in a provisional hierarchy of preference. The species fall broadly into three grades, and in descending order of acceptability are as follows: (*a*) palatable—kittiwake, eider, razorbill, gannet, domestic fowl, lapwing, common tern, coot; (*b*) intermediate—wood-pigeon, little owl, rook, puffin, magpie, jackdaw, hobby, kestrel, little grebe, buzzard, arctic tern, ringed plover; (*c*) distasteful—blackbird, chaffinch, sedge-warbler, whitethroat, linnet.

It is believed that the preferences shown by hedgehogs are likely to correspond with those of other egg-eating animals, and that, within the limits of the series examined, they afford a satisfactory basis for consideration of the data in general terms. The wide range in specific edibility rating found to occur within certain orders suggests that relative acceptability may be largely independent of systematic status; however, the low mean edibility rating for passeriform species indicates a trend towards nauseousness within this order. No close or obvious connexion has been traced between relative acceptability of the egg and feeding habits of the parent; nor is the quality of the egg at all constantly related to that of the flesh in the species examined.

Yet the experimental results also point towards correlations between relative acceptability and various other ecological factors likely to influence susceptibility to attack by predators. First, there is a broad direct relationship between palatability of the egg and size of the parent. Secondly, the distribution, in terms of acceptability, of species having colonial and solitary nesting habits, respectively, shows a marked tendency for eggs of the former to be more, and those of the latter to be less, palatable. Thirdly, consideration of egg-palatability in relation to nest-site indicates that eggs laid in open nests in moderate growth or low herbage may be relatively distasteful as compared with those laid in various other situations. Fourthly, a general correlation is shown to exist between coloration of the shell and palatability of its contents. Broadly, cryptic eggs tend to belong to the higher edibility grades and distinctively marked eggs to the lower edibility grades.

Cott has also assessed the several species in terms of relative vulnerability, account being taken of such factors as size, weapons of defence, powers of offence, availability of the clutch, general habits, sociability and coloration. A general inverse correlation is shown to exist between the degree of vulnerability and that of acceptability—the most palatable eggs being those laid by non-vulnerable species, the most nauseous by those that are (otherwise) highly vulnerable. It is suggested that the facts point towards an adaptive interpretation of distastefulness in eggs, considered as a deterrent to attack; and that the distinctive coloration of nauseous, but otherwise vulnerable, eggs may have a warning or recognitional value in relation to potential predators.

may be inferred, therefore, that it was less common in the British Isles, though there are enough contemporary references to show that some centuries ago quails were much more numerous and widespread here than they are now.

Towards the end of the twelfth century, for example, Giraldus Cambrensis reported "coturnices hic plurimi" in Ireland. In fifteenth-century literature the term "bevy of quails" occurs repeatedly. In 1466 quails (a hundred dozen) figured in the banquet given for Archbishop Nevill of York at Cawood, and in 1422 quails were included in the coronation feast of Henry VI.

In the sixteenth and seventeenth centuries significant references to quails are numerous: none of the English game-laws (eight up to 1714) mentions quail. But the birds were evidently an esteemed article of diet, and it may be inferred that up to 1700 the quail was a familiar bird in both Great Britain and Ireland and was usually regarded as rather a speciality for the table and probably diminishing, but still plentiful enough to be worth the bird-catcher's attention.

There are remarkably few direct references to the quail in the eighteenth century; but it is doubtful whether it diminished much. At the beginning Morton noted that "it comes into the sandy and warmer soil" of western Northants "at least a fortnight before it settles in the colder clayey part of the county".

There was undoubtedly a marked and progressive decline of quail in Britain in the first half of the nineteenth century; but this was accompanied by a marked increase in Ireland about 1845–50, when several nests could be found in one field. The subsequent decline, perhaps delayed until about 1865, was so marked that by the 1880's quail had almost totally disappeared from Ireland.

In 1865 More assessed the status of quail in Britain on the basis of questionnaires and concluded that "there are few counties in which the quail is considered to breed annually". In the remaining counties of Great Britain the quail was classed as "occasional". It seems that by about 1865 the quail in England had reached nearly the low ebb to which it fell in the twentieth century except for an occasional 'good' year.

To-day, systematic bird reports are produced annually for nearly thirty English counties. Quail records in these reports can be supplemented from the occasional county avifauna and from other records. These figures show that 1936 was the worst year in the twentieth century, the next worst being 1935 and 1940. Except for 1946 every year from 1944 onwards shows a more widespread recording of quail than any year before 1944.

In the present century there have been in the British Isles no quail years so outstanding as 1870 and 1893; but, allowing for various factors, it is probably true that at least twice as many quail visited Britain in 1947 as in any other year this century. 1947 was also a peak year in Belgium, Switzerland, Sweden and Holland.

Most of the records of quail in Britain are from areas of chalk, greensand and oolite. Of the eight most favoured counties six are dominated by these formations, and in them, as in Yorkshire, a very high proportion of the localities named in the quail records are calcareous. It is doubtful how far this correlation is due to preference for these soils and how far to preference for associated land-use.

Throughout its range the quail is a bird of open country, frequenting annual herbaceous growth, so that the deforestation of Europe must greatly have increased the area the bird can inhabit. There has been conflict of opinion about the effect of the subsequent agriculture. For example, in Norfolk the bird was said to like "rough fens", and its nineteenth-century decline has been attributed to the break-up of "coarse tussocky land". Others take the view that the decline of the quail was associated with "the great reduction in acreage of arable". Certainly the increase in quail since 1942 has accompanied a great increase in arable; but it must be recalled that in the first half of the nineteenth century, when arable was expanding in both Great Britain and Ireland, the quail was declining in the former as markedly as it was increasing in the latter.

While some have thought that clover fields are the favourite habitat of the quail, most observers believe that corn-fields are most frequented. Corn has been given as the quail's first preference in Germany, in Savoy and in Holland.

In Britain the prevalence of quail in corn as compared with other crops is likely to be accentuated by modern developments. On one hand the practices of grass-drying and silage-making lead to earlier cutting of some of the forage crops: on the other hand, increase in autumn-sowing of corn results in a bigger proportion of the area under corn being able to offer adequate cover to quail as soon as they arrive.

It is doubtful whether the decline of the quail population in the British Isles, which had to some extent a parallel in Western Europe as a whole, was due to changes in agricultural methods and in particular to the introduction of the mowing machine; human predation has probably been the most important factor in the decline of the quail population. Up to a few years ago exploitation on both sides of the Mediterranean was merciless in both spring and autumn, and the birds were not even left alone during the breeding-season. From Egypt alone, as late as 1913, 1,858,000 quail were exported; with a general fall in the quail population the Egyptian exports in the years 1930–34 varied between 285,000 and 580,000, more than half the birds being captured as they were travelling north to breed. In 1937, import of live quail earlier than July was prohibited in both the main consuming countries, France and Britain, and the spring taking of quail was prohibited in both Egypt and French North Africa. The traffic in quail stopped in 1939 on the outbreak of war and has not been resumed.

Protection of quail visiting Britain has been inadequate and illogical. A hundred years ago, the stock had already been so reduced that no more should have been shot. Yet the quail still can be shot during the close season by owners and occupiers of land on their own land in nearly half the counties of England, including Berkshire, Cambridgeshire, Gloucestershire and Wiltshire, four of the seven counties in which quail are most likely to occur. The proposed new bird-protection legislation should stop these anomalies.

Moreau also discusses certain problems of quail biology and shows that information on the life-history of the quail is full of gaps and of conflicting information. In particular, investigation is needed into the relations of the sexes; it seems probable that mated males call little and that polygamy cannot be the rule. Though considerable attention has been given to the subject of the migration of the quail, it is far from being understood.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Statistical Methods in Anthropology

IN their interesting letter in *Nature*[1] on statistical methods in anthropology, Dr. J. Bronowski and Mr. W. M. Long suggest that the reason why Prof. Zuckerman's findings were at odds with those based on classical comparisons was that he had compared each measurement separately instead of using the comprehensive test provided by the discriminant function. They took as an example the discriminant function calculated from measurements on forty human and forty-four chimpanzee lower milk canines. This gave a wide separation in the ranges of the two groups and conclusively indicated (*a*) that the Kromdraai and Taungs milk canines are not those of chimpanzees and (*b*) that they fall within the human range.

As it appeared to us unlikely (though not, of course, impossible) that a discriminant function would reveal such a distinct separation when a comparison of the individual measurements gave no indication of differences, we asked Prof. Zuckerman if he could furnish us with his measurements on this tooth. These consisted of four measurements, the labial height (H_1), the lingual height (H_2), the maximum anterior-posterior dimension (L), and the labial-lingual breadth (B), on twenty human teeth and twenty-seven chimpanzee teeth, together with data for four fossil lower canine milk teeth for each of which two or three of the above measurements were available.

A full analysis of these data was performed, calculating discriminant functions on all combinations of two, three and all four of the measurements. The results of this analysis are shown in condensed form in the accompanying table, with the exception that measurement H_2 has been omitted, since it was not available for any of the fossils. The first column of the table shows the measurements on which the discrimination is based, and the second the separation of the groups in terms of the mean difference d divided by the estimate of the standard deviation of a single individual within groups s, a plus sign indicating that the chimpanzee has the larger mean measurement or function. The remaining columns show the differences d_1 and d_2, divided by s, of each specimen from the means of man and chimpanzee respectively. If errors in the population means, variances and covariances are ignored, values of d_1/s or d_2/s greater than 1·96 or 2·58 indicate probabilities of less than 1 in 20 or 1 in 100 that the specimen belongs to that group on the evidence of that measurement or function. Errors in the means, etc., may here be substantial, but are progressively reduced as the amount of basic data is increased.

It will be seen that all three measurements for *Paranthropus robustus* (the Kromdraai skull) are similar to those of man, but are significantly different from those of the chimpanzee. For *Paranthropus crassidens* both measurements are similar to those of man, and the B measurement is very significantly different from that of the chimpanzee. We may therefore conclude that these teeth are definitely not those of chimpanzees, and resemble those of man, at any rate in these measurements. The measurements of *Plesianthropus transvaalensis* are close to those of the chimpanzee, but the differences from those of man are not fully significant. In all these cases the values of the discriminant functions merely confirm these findings. For *Australopithecus africanus* (the Taungs skull) the discriminant function indicates a close similarity to man, whereas the L measurement shows an almost significant divergence, suggesting in conjunction with the B measurement that the specimen may belong to neither group.

This last specimen provides an example of an important point which has not been mentioned by Bronowski and Long, and which is quite distinct from their point about fakes. A discriminant function, as its name implies, is designed to enable objects known to belong to one of two groups to be assigned to the correct group. If used for classifying an object that does not belong to either group, it may erroneously indicate that the object belongs to one of the groups, whereas other evidence from the measurements may show quite conclusively that this is not the case. An examination of the value of each individual measurement of the object to be classified in relation to the means and standard deviations of the corresponding measurement for the two groups is an essential first step in avoiding errors of this kind.

In our example, H_1 is the best single measurement for discrimination. If we have a collection of specimens which, in fact, belong to one or other of the groups and rely on this one measurement, it will classify 69 per cent at the 1 in 20 level (43 per cent at the 1 in 100 level), leaving the remainder in doubt, while the discriminant function on H_1 and B will classify 85 per cent and 63 per cent respectively. If those which are doubtful are assigned to one [illegible]other group, depending on which mean is the cl[illegible] the percentage misclassification will be 14 per[illegible]ing H_1 alone and 9 per cent using H_1 and [illegible]e-maining variates, H_2 and L, give a negligible incre[illegible]e in power of discrimination.

The power of discrimination between man and chimpanzee revealed by these results is much less than that obtained by Bronowski and Long from their data. It is clear from the diagrams published in the communication in *Nature* from Le Gros Clark[2] that it is the combination of the two anterior-posterior measurements used by Bronowski and Long which gives the very sharp discrimination, due to the difference in form of the two groups of teeth. It is very probable that a comparison based on the

Measurements	d/s	*Par. robustus*		*Par. crassidens*		*Pls. transvaalensis*		*A. africanus*	
		d_1/s	d_2/s	d_1/s	d_2/s	d_1/s	d_2/s	d_1/s	d_2/s
H_1	+2·15	−0·36	−2·50			+1·46	−0·09		
L	+1·68	−1·40	−3·09	+0·72	−0·97	+1·78	+0·10	+1·93	+0·25
B	+1·95	−0·65	−2·60	−1·71	−3·65			−0·91	−2·86
H_1L	+2·36	−0·89	−3·25			+1·88	−0·48		
H_1B	+2·66	−0·63	−3·30						
LB	+2·08	−1·05	−3·13	−0·89	−2·97			+0·18	−1·90
H_1LB	+2·67	−0·72	−3·39						

The molecular relationship between the breakdown of hæmoglobin and the production of carbon monoxide that would be expected from this hypothesis can, in fact, be demonstrated experimentally. The amount of carbon monoxide exhaled per day by a subject was calculated from repeated determinations of the concentration of carbon monoxide in the expired air during several days, and from the average respiratory volume. This came to 6·8 mgm. carbon monoxide per day, while an approximate estimation of the amount of hæmoglobin broken down in one day (calculated from the total hæmoglobin and an average life-span of the erythrocytes of 120 days) was 4 gm. The relation between these values is 1 : 590, while the relation between the molecular weights of carbon monoxide and of hæmoglobin is 1 : 600, if the latter is calculated for each hæmin group.

The endogenous formation of carbon monoxide and its relation with hæmolysis and internal hæmorrhage[4] may be explained on the assumption that carbon monoxide is liberated in connexion with the *intra vital* breakdown of hæmoglobin.

A detailed account of these investigations will be published in *Acta physiologica Scandinavica.*

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Enzymatic Conversion of the Stereoisomers of *Iso*Leucine to the Corresponding α-Keto-Acids

THE optical isomers of α-keto-β-methylvaleric [illegible] have been prepared by enzymatic oxidation of [illegible] corresponding D-amino-acids[1]. The keto-acid [illegible]rs (and their 2,4-dinitrophenylhydrazones) pre-[illegible] by enzymatic oxidation of D-*iso*leucine and [illegible]o*iso*leucine exhibited optical rotations which [illegible]e equal in magnitude and opposite in direction[1,2]. Furthermore, from microbiological studies (to be reported in detail elsewhere), a purity of at least 98 per cent may be assigned to the lævorotatory isomer of α-keto-β-methylvaleric acid prepared by enzymatic oxidation of D-*iso*leucine. These findings indicate that the configuration about the β-carbon atom is not measurably altered by enzymatic oxidation of the D-amino-acids or during isolation of the keto-acid.

It has now been found that oxidation of the L-isomers of *iso*leucine and allo*iso*leucine by L-amino-acid oxidase of snake venom, or transamination between these amino-acid isomers and α-ketoglutaric acid catalysed by a soluble hog's heart preparation, leads to similar results, that is, formation of optically active keto-acid isomers which have been isolated as the 2,4-dinitrophenylhydrazones. The experiments with snake venom oxidase were carried out essentially as described for those with D-amino-acid oxidase, except that crystalline beef liver catalase was added to prevent further oxidation of the keto-acids. In the transamination reactions, which did not go to completion, the α-keto-β-methylvaleric acid formed and the residual α-ketoglutaric acid were precipitated by addition of 2,4-dinitrophenylhydrazine. The hydrazones of α-keto-β-methylvaleric acid and α-ketoglutaric acid were separated by counter-current distribution using ethyl acetate and aqueous sodium carbonate as the solvents. The hydrazones were recrystallized from water, dried, and characterized by nitrogen analysis and melting point. The specific optical rotations of the 2,4-dinitrophenylhydrazones of α-keto-β-methylvaleric acids formed by enzymatic action from the four isomers of *iso*leucine are given in the accompanying table; within experimental error, the values are in good agreement.

ENZYMATIC FORMATION OF α-KETO-β-METHYLVALERIC ACIDS FROM FOUR ISOMERS OF *iso*LEUCINE

Substrate	Enzyme	$[\alpha]_D^{26}$ of resulting keto-acid hydrazone*
D-*iso*Leucine	D-Amino-acid oxidase†	− 16 7°
L-*iso*Leucine	L-Amino-acid oxidase‡	+ 17·3°
L-*iso*Leucine + α-ketoglutarate	Transaminase§	+ 16·7°
D-allo*iso*Leucine	D-Amino-acid oxidase	+ 16 7°
L-allo*iso*Leucine	L-Amino-acid oxidase	− 17·1°
L-allo*iso*Leucine + α-ketoglutarate	Transaminase	− 16 4°

* Specific rotation of the 2,4-dinitrophenylhydrazone of α-keto-β-methylvaleric acid (2 per cent solution in ethanol; 2 dm. tube).
† Hog's kidney acetone powder extract.
‡ *Crotalus adamanteus* venom.
§ Prepared from hog's heart.

These results demonstrate that the optical configuration about the β-carbon atom of the four isomers of *iso*leucine is maintained during enzymatic oxidation and transamination, and that a reversible α-β-unsaturation leading to loss of asymmetry at the β-carbon does not occur. However, the possibility is not excluded that reversible α-β-unsaturation may be enzymatically directed so as to preserve the configuration of the β-carbon atom.

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Transmission of Natural and Synthetic Mica in the Ultra-Violet

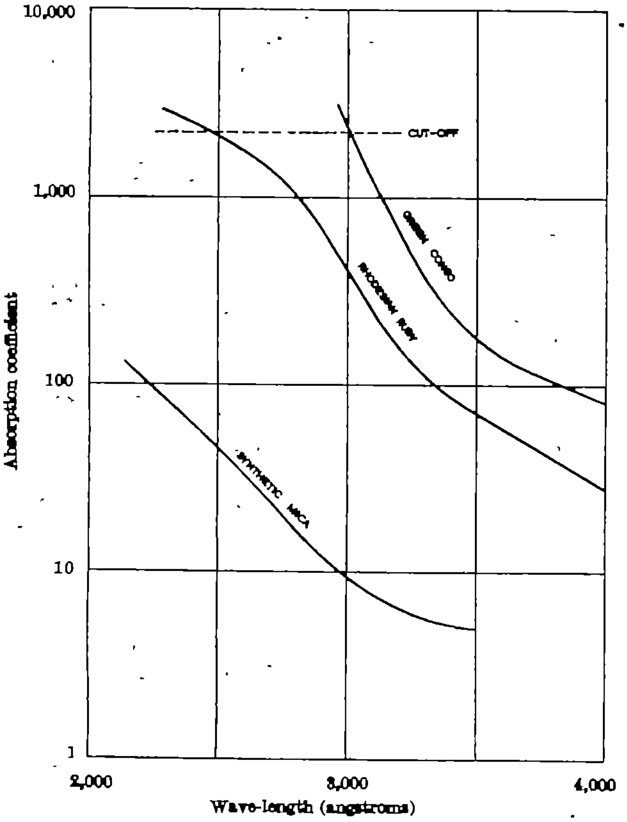
THE various minerals belonging to the mica group are all characterized by the ease with which they cleave. The reason for this behaviour is found in their structure, which consists in all cases of a double sheet of linked silicon – oxygen tetrahedra of the hexagonal type $(Si_4O_{10})^1$. One in every four silicon ions is replaced by aluminium in most of the natural occurring micas (phlogopite, muscovite, biotite), thus giving the basic $AlSi_3O_{10}$ units; these are firmly bound by the incorporation of aluminium, magnesium and iron ions and hydroxyl groups. The double sheets are weakly linked by potassium ions, and it is along this plane that cleavage takes place. The most important micas conform to the idealized formulæ:

Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$
Phlogopite	$KMg_3(AlSi_3O_{10})(OH)_2$,

but a multitude of substitutions can take place; for example, the magnesium can to some extent be replaced by iron, which gives biotite:

$$K(MgFe)_3(AlSi_3O_{10})(OH)_2.$$

Attempts to synthetize mica were first made more than fifty years ago, but it has been difficult to grow



large crystals. The best results to date appear to have been achieved with synthetic phlogopite, where the hydroxyl group has been replaced by fluorine, that is, $KMg_3AlSi_3O_{10}F_2$[2].

Little information is available on the transmission of natural mica in the ultra-violet[3]. Hausman and Krumpell state that the limit of transmission is 2900 A. and that the green variety absorbs highly, ruby mica least. Transmission measurements have been carried out in this Laboratory on a number of samples of natural micas of different origin, all of which had a very high transmission in the visible region, and also on a water-clear sample of fluorine phlogopite, kindly lent to us by Dr. Middel. The absorption coefficient μ ($I/I_0 = \exp - \mu l$, where I_0 is incident beam, I is transmitted beam, l is thickness in cm.) is shown in the accompanying graph for samples of green Congo, Rhodesian ruby and synthetic mica; due allowance has been made for reflexion losses. These measurements show that the absorption of synthetic mica is much less than that of the natural mica available. This may possibly be ascribed to the low iron content (less than 0·05 per cent) of the synthetic mica we investigated, and, in fact, analysis of the iron content of the samples of natural mica confirmed that the absorption coefficient at 3000 A. was approximately proportional to the iron content. This difference in iron content would also account for the higher ultra-violet absorption of the green variety.

Mica sheets of 10–20 microns thickness are strong enough to be used for windows in vacuum tubes, and vacuum-tight seals both to glass and chrome-iron metal can be made by a simple method[4].

The horizontal line drawn in the graph shows the short-wave cut-off based on a thickness of 10 microns and 10 per cent transmission; for Rhodesian ruby and green Congo mica the limits are respectively 2500 A. and 3000 A. Synthetic mica transmits well below 2000 A.

Synthetic mica can be used, therefor[illegible] a window material with high ultra-violet tra[illegible]ission for vacuum devices such as photocells, el[illegible]ron multipliers, Geiger–Müller counters, ther[illegible]piles, etc. Devices with such windows can be used [illegible] processed at very high temperatures, since the sy[illegible]hetic mica will stand temperatures greater than 1,0[illegible]° C. without deterioration, compared with the t[illegible]perature limitation of muscovite at about 500° C. a[illegible] phlogopite at 800° C.

I wish to thank Mr. J. A. M. van Mo[illegible] and the Directors of Philips Electrical, Ltd., for per[illegible]ission to publish this communication.

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July 19.

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Standing Waves in Low-Energy Electron Beams

IN some work here on the focusing of rotational[illegible] symmetrical electron beams in the energy-rang[illegible] 20–70 volts, we have come across cases of standing wave patterns in the electron emission from th[illegible] cathode which may be of interest to valve designe[illegible] and others working on the properties of low-ene[illegible] electron beams.

In the case of 'normal' beam formation [illegible] electron distribution over the cross-section as re[illegible] by a scanned slit arrangement is usually a sm[illegible] curve having a peak current density on the axis[illegible] falling continuously with distance from the axis [illegible] the way to the periphery of the beam. It generally has a Gaussian form.

At low energies, however, there are marked changes. Here, the current to a series of concentric collectors placed transversely at some fixed distance from the emitter, while showing a smooth curve over the cross-section, has a core which appears to approximate to Gaussian form, whereas the tail exhibits a more or less uniform distribution over a considerable portion of its length.

The simple space-charge theory determined by the constancy of the space-charge factor ($V^{3/4}/I^{1/2}$) is found to break down under the following conditions: (*a*) energies less than 20 volts; or (*b*) high emission densities. Both these are connected with effects in the 'virtual' cathode, for example, potential depression. There appears to be an optimum cathode temperature which controls the emission density for both 'semi-hollow' and 'hollow' beams, that is, for those in which the axial emission is less than that off the axis, and where it is practically zero, respectively. The conditions in the 'virtual' cathode are significantly changed by alteration in temperature, which alters emission density, emitting area and initial electron velocity. Fig. 1 shows how the current in the

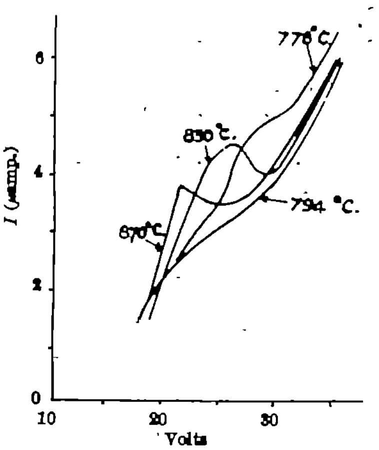

Fig. 1

peripheral region of the beam varies with energy at different temperatures. The total emission characteristic also contained small portions of reverse slope between 20 and 30 volts, which were detected by consecutive measurements at voltages very close together—and were repeatable. The remarkable changes of slope in the 20–30-volt region appear to be connected with changes of state in the cathode emission for particular fields, or to corresponding changes in charge density in the virtual cathode. In fact, the explanation for this kind of anomalous behaviour is much on the same lines as that given by Klemperer[1] from his observations on the splitting of high-energy electron pencils into 'elementaries'. These he attributed to standing-wave patterns in the space charge near the cathode. He quotes C. S. Bull for the suggestion that oscillations set up in the space charge might react on the cathode emission by producing regions of high and low intensity over the emitting surface, and, in fact, this is found to be so on a simple interpretation of the distribution patterns shown in Fig. 2, for a series of energies from 18 to 24 volts. At a higher accelerating voltage ($V = 30$) the current density falls away smoothly from a maximum on the axis.

The periodic character of the fluctuations in emission over the surface is consistent with the assumption that standing waves are present in the space charge. Their formation depends critically on changes in energy over a limited energy-range of about 10 volts. Inside this range, the conditions which make the centre of the cathode either a node or an antinode are extremely sensitive to energy variations—a difference of 2 volts is sufficient to change from one type to the other, as is clear from the graph. The wave-length appears to be of the order of 0·1 mm.

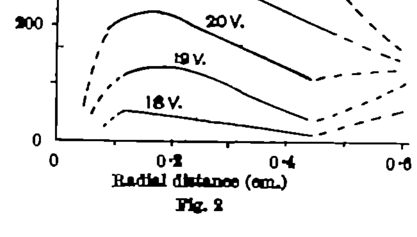

Fig. 2

It is interesting to record that one of us (L. J.) found a similar 'abstraction' of current in a high-energy beam (2 kV.), produced by a conventional electron gun, when certain field conditions were introduced.

It is hoped to publish fuller details of this work in due course.

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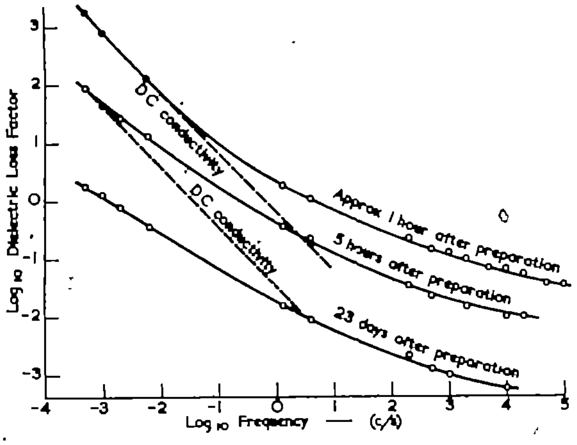
Low-Frequency Dielectric Absorption and Direct-Current Conductivity in Quinol

The large dielectric absorption at low frequencies recently observed[1] in crystalline long-chain alcohols has been shown to be probably due to a hydrogen bonding of the hydroxyl groups to form chains. Hydrogen-bonded hydroxyl groups are also present in the dihydric phenol quinol, according to a structure proposed from X-ray crystallographic data[2], but in this case the hydrogen bonds form regular hexagons. With such a structure the resultant dipole moment should be zero and the compound should give no dielectric absorption. However, in recent measurements in this laboratory, considerable low-frequency absorption was observed in three samples of quinol crystallized from water, ethanol and methanol respectively. This absorption decreased with time of storage at room temperature, as shown in the graph (p. 1122) of the results for the sample crystallized from water. The curves are similar in shape to those obtained previously for *n*-hexadecyl alcohol[3], in which the dielectric absorption was attributed to the presence of extensive hydrogen-bond chains, and it seems likely that the results for quinol can be similarly explained.

Measurements with samples prepared at different intervals from the same batch of crystals gave results similar to those shown in the diagram. This suggested that the absorption may not have been present originally in the crystalline quinol, but resulted from the preparation of the sample for measurement. In this process the crystals were ground to a fine powder and then pressed at about 10,000 lb. per sq. in. to form disks. Experiments on the effect of re-grinding and re-pressing aged disks indicated that it was the grinding process which led to the dielectric absorption.

To explain these results, it is suggested that the grinding causes a partial breakdown of the crystal structure followed by a rearrangement in which hydrogen-bond chains are formed. These give rise to the large dielectric absorption. Also this hydrogen-bond chain structure is unstable in quinol and in time reverts to the hexagon formations of the original crystal, with a consequent decrease in the dielectric absorption.



Dielectric absorption at 20° C. in quinol crystallized from water

Evidence that structural breakdown of quinol does occur on grinding was obtained by previous workers[4], who found that sulphur dioxide trapped in the quinol crystal lattice is partially liberated by grinding.

The large dielectric absorption of quinol crystallized from water was accompanied by appreciable direct-current conductivity. This was also observed in the samples obtained from ethanol and methanol respectively. Quinol crystallized from methanol gave an initial conductivity about 5,000 times larger than that of the other samples. This may be related to its different structure and composition[2]. It is less compact, and its crystal lattice contains entrapped methanol molecules which would escape on grinding and possibly take part in hydrogen-bond chain formation. High direct current conductivity has been reported by previous workers with other hydrogen-bonded structures, and is considered to be due to combined proton transition and dipole rotation[5].

The sample disks were measured between mercury electrodes. Bridge methods were used at frequencies greater than 1 c./s. At lower frequencies the dielectric loss factor was calculated from the anomalous charging current measured at different times after the application of a D.C. potential[6].

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Commonwealth Scientific and
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Australia. July 12.

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Spectra of Flames burning with Oxides of Nitrogen

We have taken spectrograms of pre-mixed gas flames of hydrogen, ammonia, carbon monoxide and hydrocarbons burning with nitrous oxide, nitric oxide and nitrogen dioxide, respectively. The overall spectra of the hydrocarbon flames are very similar. CH-, CN-, NH- and OH-bands are present, and so also are the C_2-bands. The latter are quite strong in many flames (especially acetylene), but are generally weaker than the C_2-bands in hydrocarbon – oxygen flames. We found no evidence of the CO-fourth positive bands in any of these flames, however strongly our plates were exposed. This band system was reported by Behrens and Rössler[1] in a benzene – nitric oxide flame. In the region of the spectrum where this band system of CO should occur, we obtained strong NO-γ-bands.

The flames of hydrocarbons burning with nitrogen dioxide have a double inner cone. The first inner cone emits a continuum of yellow light, and the second, which is separated from the first by a dark space, emits blue light containing C_2-, CH-, CN-, NH-, OH- and NO-bands. In absorption spectra, the NO_2-bands disappear in front of the first inner cone, and if benzene is taken as the fuel, the ultra-violet bands of benzene disappear at the same position as the NO_2-bands. NO-γ-bands appear in absorption in the first inner cone and disappear again in front of the second inner cone. There is no doubt that both nitrogen dioxide and benzene decompose in the first inner cone. Some interaction between them also occurs, as it is possible to adjust the flame in such a way that the second inner cone blows off and the first cone burns alone, though with diminished flame velocity. Under these conditions a large amount of nitric oxide can be detected in absorption in the exhaust gases. This is normally consumed in the second inner cone.

The hydrogen – nitrogen dioxide flame has only one inner cone, and burns more rapidly than a saturated hydrocarbon flame with nitrogen dioxide. It seems that the nitrogen dioxide readily decomposes in the flame, and that the subsequent reaction of hydrogen and oxygen is sufficient to account for the high flame velocity. Nitric oxide does not seem to participate in the reaction, and consequently the flame does not reach its theoretical temperature. This is confirmed by various observations; for example, the OH-emission from the inter-conal gas is only about one-hundredth of that of a hydrogen/oxygen flame.

The hydrogen – nitric oxide flame has a very low speed, although it has a higher temperature than the hydrogen – oxygen flame, which is very fast. Thermal decomposition of nitric oxide is probably the rate-determining process. This decomposition is very slow and will only take place at very high temperatures. The process is feasible in the hydrogen – nitric oxide flame because the velocity is low and sufficient time is available.

In contrast to the hydrogen flame, the ammonia – nitric oxide flame burns readily and with a greatly increased flame speed. Strong NH-bands are emitted which scarcely appear in the spectra of the hydrogen flame. The presence of this radical may be responsible for the different behaviour of the ammonia flame. NH-radicals may be able to decompose nitric oxide and provide an alternative path of low activation energy for the production of oxygen. Hydrocarbon – nitric oxide flames have velocities which increase in the same order as the increasing C_2-, CH- and NH-band strengths, and it seems that nitric oxide again decomposes by radical reactions.

We are indebted to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

B. B. Fogarty
H. G. Wolfhard

Royal Aircraft Establishment,
Farnborough. June 29.

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A New Method for Measuring the Atomic Heats of Gases

In a previous communication in *Nature*[1], a method was described by which the atomic heats of various gases could be determined from the aspects of heat transfer through the gas. The method has recently been modified to take into account the dependence of the accommodation coefficient upon the pressure of the gas at very low pressures.

In the absence of convection, the rate of heat loss Q corrected for radiation from a uniformly heated thin platinum wire lying along the axis of a cylindrical tube can be represented in terms of the gas pressure P by an equation due to Knudsen and others in the form:

$$Q = 2\pi r_1 LP\,(R/2\pi MT_2)^{1/2}(\beta + \tfrac{1}{2})\alpha_P(T_1 - T_2), \qquad (1)$$

in which the mean collision path is greater than, or comparable with, the distance between the wire and the internal surface of the tube. In (1), βR represents the molecular heat of the gas, α_P the coefficient of accommodation, T_1 and T_2 the temperatures of the wire and tube surfaces respectively, r_1 the radius and L the length of the wire, and M the molecular weight of the gas.

Values of α_P calculated from (1) at very low pressures are found to vary considerably with the pressure up to the region in which the temperature-drop effect operates and throughout which the values of α_P are independent of the gas pressure. In this latter range of pressures the modified Fourier's relation is represented[2] by:

$$\frac{1}{Q} = \frac{\log (r_2/r_1)}{2\pi r_1 KL\theta} + \frac{1}{P\theta A}\left(\frac{T_1{}^{1/2}}{r_1} + \frac{T_2{}^{1/2}}{r_2}\right), \qquad (2)$$

where the term A is defined by:

$$A = \frac{R^{1/2}2\pi\,(\beta + \frac{1}{2})2\alpha L}{(2\pi M)^{1/2}(2 - \alpha)}.$$

If the temperature of the wire is kept constant over both ranges of pressures, and if α_P is known as a function of pressure and temperature, β can be calculated. Equation (1) must be modified, using the Langmuir adsorption equation:

$$\theta/N_0 = bP/(1 + bP),$$

where θ denotes the number of lattice spaces per square centimetre of the wire surface which are occupied by gas molecules at a pressure P and temperature T, and N_0 denotes the total number of lattice spaces per square centimetre. The effect of accommodation may be considered as being due to the extent to which the lattice spaces are occupied by molecules. Hence we may write for α_P, following Amdur[3],

$$\alpha_P/\alpha_\infty = \theta/N_0 = bP/(1 + bP), \qquad (3)$$

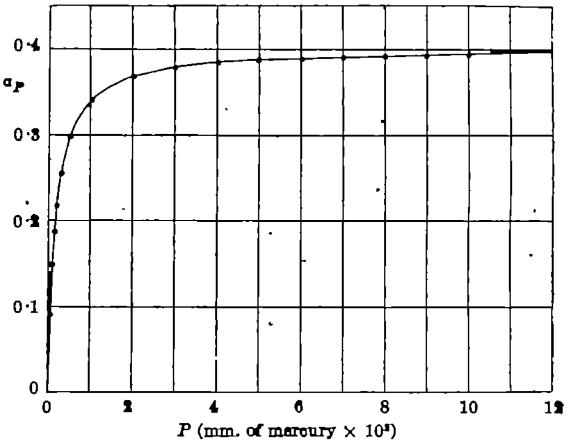
where b is a function of temperature and α_∞ denotes the coefficient of accommodation over the temperature-drop range of pressure.

Equation (1) may now be written in the form:

$$\frac{P^2}{Q} = \frac{1}{2\pi r_1 L(R/2\pi MT_2)^{1/2}(\beta+\frac{1}{2})\alpha_\infty(T_1-T_2)}\cdot\left(\frac{1}{b} + P\right),$$

from which P^2/Q is found to satisfy a linear relation with P. At the same time, $1/Q$ has been found to satisfy a linear relation with $1/P$ over the temperature-drop range of pressure at the same wire temperature as in (1).

It is therefore possible to determine β and α_∞ and also a value of b. The accompanying graph shows the variation of α_P with P as quoted from equation (3) by the substitution of α_∞ and b for hydrogen at a wire temperature of 19° C. From the graph it appears that α_P rises very sharply with P at very low pressures. The table shows observed values of α_∞ and β for a number of gases at laboratory temperatures.



Gas	H_2	N_2	O_2	He	Ne	A
β	2·49	2·50	2·49	1·49	1·49	1·50
α_∞	0·40	0·81	0 80	0·42	0 78	0·84

The method has also recently been applied in order to investigate the decrease of the rotational energy of hydrogen, oxygen and nitrogen at very low temperatures.

It is hoped to publish a detailed account later.

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Quantitative Paper Chromatography

Fisher, Parsons and Morrison[1], discussing quantitative paper chromatography, found an interesting relationship between spot-length or spot-area and the logarithm of spot content for certain amino-acids and the sugars xylose and arabinose. They suggest that the relationship may be of general applicability to sugars.

Using Longenecker's method[2] for ascending chromatography (somewhat modified), with 500-ml. and 1-litre jars and papers 5 mm. wide, measuring spot-length instead of spot-area, an attempt has been made to confirm this work using saturated *n*-butanol–water mixture (water-poor phase) as solvent and sucrose as the sugar. Spraying was carried out with the phloroglucinol reagent mentioned by Horrocks in his paper[3]. Spot-length instead of spot-area was chosen for measurement because maximum elongation can fairly easily be measured with practice on narrow papers, and the work was intended for rapid assessment of quantitative differences. Sucrose was chosen in preference to xylose or arabinose for investigation, because it is of more interest in studying the nutritional requirements of plants and gives a clear yellowish-brown stain on a very pale background with phloroglucinol spray.

It has been found that for a spot-content of more than 100–250 µgm. of sucrose (depending upon the conditions mentioned later), the linear relation between spot-length and logarithm of spot-content breaks down, and a much truer representation is found by the logarithm of spot-content bearing a linear relation to the *logarithm* of spot-length. This has been tested and found to hold true over a range 4–450 µgm. of sucrose. It may be noted that at low concentrations of sugar, either the logarithm of spot-length or spot-length itself will tend to give a linear relation with the logarithm of spot-content.

In addition, an investigation of the factors determining the length of stain has been attempted, and there are indications that increase of temperature decreases absolute stain-length while increase in the time of running of the chromatogram has the opposite effect. Increase of the time allowed for equilibrium to be reached before running the chromatogram also increases absolute stain-length. For all the combinations of controlled temperature (35–40° C.), length of run, and time of equilibrium so far tested, the graphs of logarithm of stain-length against logarithm of spot-content have been parallel within the limits of experimental error. On the subject of slow attainment of equilibrium conditions, the recent paper of Müller and Clegg[4] can be consulted.

This work has been carried out as part of the programme in plant physiology of this Section. It is intended to publish a fuller account elsewhere.

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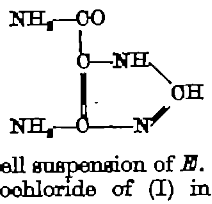
Ribosidation of 4-Amino-imidazole-5-carboxamide by *Escherichia coli*

It has already been shown[1,2] that 4-amino-imidazole-5-carboxamide (I) is a precursor of the purines in *E. coli*; a purine-requiring mutant of the organism grows in a medium containing this substance. On the other hand, it has been observed[3,4] that synthetic 4-amino-imidazole-5-carboxamide is little utilized by a growing culture of *E. coli*. The following observations will eliminate this apparent discrepancy.



(I)

(1) When a cell suspension of *E. coli B* is incubated with the hydrochloride of (I) in *M*/15 phosphate buffer (*p*H 7), and the supernatant is added to the purine-requiring *E. coli* mutant, a growth-enhancing effect is observed which is five times as great as that of the hydrochloride of (I).

(2) The supernatant containing the new factor was lyophilized and the concentrate subjected to paper chromatography according to Carter[5] in 5 per cent potassium dihydrogen phosphate – *iso*amyl alcohol and developed by diazotization. Incidentally, the presence of the original amino group in the new factor was thus established. While the hydrochloride of (I) has R_F 0·68, a new spot of R_F 0·63 was observed. The activity of the new spot was established by the bio-autographic technique of Winsten and Eigen[6].

(3) The fraction containing the new substance showed a positive orcin test and a colour reaction with diphenylamine[7] which exceeded that of the blank, indicating the presence of deoxyribose. The ultra-violet spectrum showed a shifted absorption maximum (2600 A.) as compared with the hydrochloride of (I) (2680 A.).

It seems thus established that 4-amino-imidazole-5-carboxamide is converted by *E. coli* into a glycoside.

(4) It has not been finally established whether the new substance is a nucleoside or a nucleotide. According to Carter[5], nucleotides cannot be chromatographed by means of butanol. Since the new spot could also be obtained in butanol, it seems likely that the new substance is a nucleoside (deoxyriboside of (I)). A similar substance may have been encountered by Friedman and Gots[8] in their recently reported experiments.

(5) In connexion with the mechanism of the conversion of (I) into purine bases, the following observation appears to be of interest. When (I) is added to a cell suspension of *E. coli* in phosphate buffer (*p*H 7) containing 0·2 per cent glucose, the diazotizable amino group disappears, and a substance is formed which has the activity of a nucleoside (it is eight times as active a growth factor for the purine-mutant as the hydrochloride of (I)). It appears that the catabolism of glucose can supply to the glycoside of (I) the C_2 atom of the purine system[9,6].

The question has often been asked[9] whether (I) is utilized as such or in the form of a glycoside. From the observation made here, and those reported recently by Greenberg[11] and by Schulman and Buchanan[12] for pigeon's liver preparations, it seems that the purine bases are formed via their ribosides and ribotides, and that in (I) the pyrimidine ring is closed only after ribosidation has occurred. According to S. E. Kerr *et al.*[13], however, adenine and guanine are incorporated by rapidly growing yeast into ribonucleic acid much *better* than the corresponding nucleosides and nucleotides.

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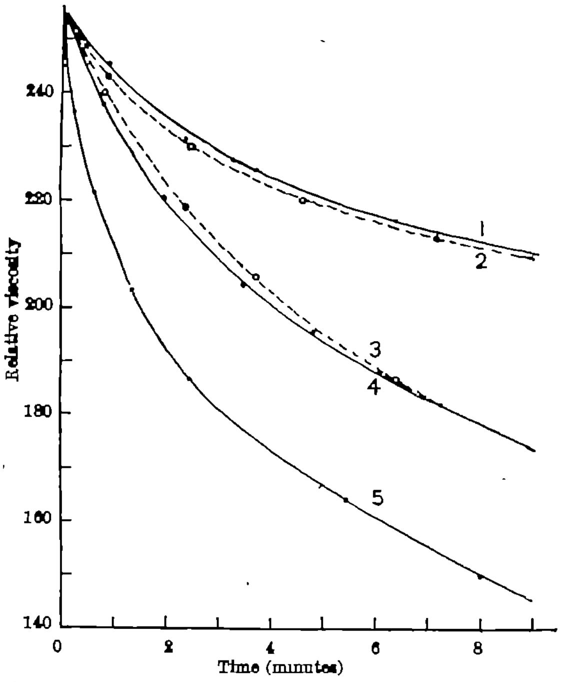
Effect of Histamine on the Activity of Hyaluronidase

M. Fabinyi and J. Szebehelyi[1] have reported that histamine neutralizes the inhibition of hyaluronidase with heparin. We had already dealt with the problem of the influence of histamine on the system hyaluronic acid – hyaluronidase – hyaluronidase-inhibiting agents. Since we had not observed any effect of histamine at that time, we decided to repeat our investigations. Unfortunately, the communication by Fabinyi and Szebehelyi gives no information as to the source of their hyaluronic acid and hyaluronidase, or the concentrations used in their investigations; and we have received no reply to a request for further information.

In our latest investigations we used as substrate highly purified hyaluronic acid (from umbilical cords) as well as a fresh, watery extract from umbilical cords. A hyaluronidase preparation by Armour Laboratories, Chicago, and a testicular extract from guinea pigs were used as enzymes. As inhibitory agents we used partly heparin (Hoffmann–La Roche, Basle) and partly fresh human serum. Viscosity measurements were carried out with a viscosimeter of the Ostwald type at a temperature of 37° C. McIlvain's citrate buffer, together with sodium chloride, *p*H 7·0, were used as solvents. The concentrations of heparin and serum were chosen with the view of producing a distinct, but not complete, inhibition of the hyaluronidase.

We find that the time-curves for the reduction of hyaluronic acid in the presence of heparin and histamine (the latter up to 20 mgm. per cent) coincide with the control without histamine. Histamine *in vitro* has therefore no marked influence on the system hyaluronic acid – hyaluronidase – heparin.

According to Swyer[2], there is also *in vivo* merely an additional effect but no reciprocal action between hyaluronidase and histamine.



Decrease of viscosity of a solution of hyaluronic acid by means of hyaluronidase. Curve 1, with heparin (8·5 mgm. per cent); curve 2, with heparin (8·5 mgm. per cent) and histamine (14·7 mgm. per cent); curve 3, with heparin (2·1 mgm. per cent) and histamine (14·7 mgm. per cent); curve 4, with heparin (2·1 mgm. per cent); curve 5, without heparin and histamine

We conclude that Fabinyi and Szebehelyi's view that histamine causes an enzymatic depolymerization of tissue mucoids by favouring the action of the hyaluronidase, inhibited by heparin, is untenable.

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Response of the Isolated Rat Diaphragm to Repeated Stimulation

Gans and Miley[1] showed that skeletal muscle of the adrenalectomized animal is easily fatigued *in situ*. Ingle[2] used this property of the adrenalectomized rat as a basis for the assay of cortical hormones, and he has more recently shown[3] that cortisone also increases its resistance to fatigue. Schweitzer[4] attributed this readiness to fatigue to a fall in blood pressure due to the loss of the adrenals. The fatigue has also been attributed in part to impaired neuromuscular transmission[5], but Walker[6] opposes this view.

The response of the isolated rat diaphragm to frequent stimulation through the phrenic nerve, and the effect of cortisone and of deoxycorticosterone acetate on this response have been investigated. Normal and salt-treated adrenalectomized rats of about 150 gm. were used.

Phrenic nerve-diaphragm preparations, suspended in Krebs's solution (with 5 mgm. calcium ions per 100 ml.) at 38° C. through which a gas mixture of 95 per cent oxygen and 5 per cent carbon dioxide was bubbled, were stimulated through the nerve to give a maximal response with a current duration of 200 µsec. at a frequency of 12/min. After a steady height of contraction had been reached (1–2 hr.), the rate of stimulation was increased to 2/sec. for 5 min., and then restored to 12/min.

In the preparation from normal rats, the twitch tension immediately after the 'fatiguing' stimuli was usually about 68 per cent of what it was immediately before. Experiments carried out throughout the day at intervals gave similar results. After a period of rapid stimulation, the twitch tension never recovered its original height unless the fluid in the bath was replaced; even then recovery was usually incomplete. Similar preparations from adrenalectomized animals gave similar results (see table; cf. Ramey *et al.*[7]).

The effect of adding cortisone or of deoxycorticosterone acetate to the bath fluid was tried. Four separate experiments, as described above, were carried out on each preparation, the periods of rapid stimulation (2/sec.) being separated by an interval of 1 hr. The bath fluid was changed after each experiment.

PER CENT DECREASE IN TWITCH TENSION DUE TO RAPID STIMULATION (2/sec. for 5 min.)

	Exp. 1 control	Exp. 2 with drug	Exp. 3 control	Exp. 4 with drug
Normal	32	34 *C*	31	44 *C*
Adrenalectomized	35	35 *C*	37	34 *C*
Normal	26	24 *D*	14	25 *D*
Adrenalectomized	35	38 *D*	31	29 *D*

C = Cortisone. *D* = Deoxycorticosterone acetate

About 30 min. before the second and fourth experiments, the drug to be tested was introduced into the organ bath. The solutions of cortisone and of deoxycorticosterone acetate were prepared by diluting the proprietary preparations (Merck and Co., and Dale respectively) with 20 per cent alcohol, so that 1 ml. contained 500 and 100 μgm. of the drug respectively. The volume of fluid in the bath was 55 ml. 1 ml. of 20 per cent alcohol had no effect on the twitch tension. The results show that the drugs did not influence the 'fatigue' process.

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Protective Action of Methylamine against X-Irradiation

Colter and Quastel[1] have shown that many amines (benzedrine, ephedrine, tyramine, methylamine, dimethylamine, ethanolamine and histamine) act as competitive anticholine oxidases, and protect choline oxidase against the inactivating effect of nitrogen mustard. It is well known that irradiation with X-rays has many effects in common with mustards. Accordingly, we tried the least toxic of these amines as protector in mice against a lethal dose of X-rays.

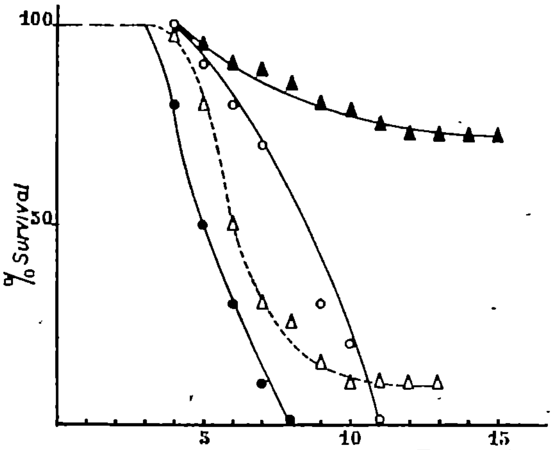
Mice of pure breed (C 57 black), four to six months old, were exposed to X-rays in groups of ten, in a cardboard box 10 cm. × 10 cm. Physical constants: 250 kV., 18 mA., copper filter 0·25 mm., focal distance 50 cm., field 150 cm.², mean output 90 r./minute.

A first control group of mice received a single lethal dose of X-rays. A second group was injected intraperitoneally with methylamine (2 mgm.) neutralized in water solution; this dose is well tolerated. A third group was irradiated just as the controls, immediately after an intraperitoneal injection of 2 mgm. methylamine.

Forty controls received either 700 r. or 850 r. All the mice irradiated with 700 r. died between the fifth and the tenth day after irradiation; those which had received 850 r. died between the fourth and the eighth day.

In the group of fifty animals injected and irradiated with 700 r., the mortality (from the fifth to the twelfth day) was small; 73 per cent of the animals survived (see graph).

The mice injected with methylamine and irradiated with 850 r. died between the fourth and eleventh day, later generally than the controls; only 7 per cent survived. An injection of 2 mgm. or 2·5 mgm. of methylamine did not protect any animal against a dose of X-rays greater than 850 r. A dose of 2 mgm. methylamine injected 5 or 15 min. after the end of the irradiation (700 r.) shifted the mortality curve slightly to the right.



○, 700 r.; ▲, 2 mgm. methylamine and 700 r.; ●, 850 r.; △, 2 mgm. methylamine and 850 r.

Thus, just as it has been shown with sodium cyanide and sodium azide[2,3], the action of methylamine is one of pure protection: the substance must be present in the body during the irradiation; it becomes ineffective if given after irradiation.

Our observations offer a new fact in favour of the similarity of action of mustards and X-rays, which has been emphasized recently (for a review, see Bacq[4]).

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Protective Action of Ethyl Alcohol on Irradiated Mice

EARLIER unpublished work on the effects of ethyl alcohol on cells *in vitro* suggested to us the possibility that alcohol might modify the response to X-rays. With the present-day interest in agents which may modify the systemic effects of radiation, it was thought worth while to carry out experiments on the influence of alcohol on the lethal effects of whole-body irradiation in mice.

Pure-bred mice of the "A" strain six to eight weeks old were used. In a preliminary experiment, ethyl alcohol was diluted with saline to a concentration of 10 per cent by volume and the solution administered orally in two doses each of 1 ml., the first given 80 min., and the second 20 min., before irradiation. An equal number of control mice were treated similarly with saline. All the mice were then given 700 r. X-rays, a dose which is lethal to the "A" strain. The results are shown in Table 1.

Table 1

Treatment	Number dead	% Mortality
Saline followed by 700 r.	22/22	100
Alcohol followed by 700 r.	14/22	63

re extensive experiments were then carried out, as a criterion the difference in L.D.50 determ- y the probit method for control and alcohol- d mice. For this determination four or five vels were chosen which could be presumed to t the 50 per cent lethal dose for this strain of One group of alcohol-treated and one group rol mice were irradiated at each dose-level.

figures obtained in one experiment are shown le 2; they demonstrate a rise in the L.D.50 vith alcohol treatment (1·5 ml. 10 per cent , given as two doses before irradiation).

Table 2

	Number of mice	L.D.50	Stand. dev. of L.D.50
cohol	110	625 r.	13·3 r.
line	109	564 r.	8·7 r.

e difference here is highly significant ($p > 10^{-4}$). protective effect of alcohol was also examined the point of view of the lengthening of the time vival of mice which die within the time-span of periment (thirty days).

s been found from other experiments that at t and above the L.D.100 level the mean l-time of mice decreases inversely with dose. ean survival-time was calculated for two ex- ts. In one, mice were irradiated with 690 r., econd with 700 r. In the first experiment the urvival-time for saline-treated controls was ys, that for alcohol-treated animals being ys. In the second experiment the figure for was 9·0 days, compared with 12·1 days for -treated mice. The difference in both cases ificant ($p = 0·05$).

vould therefore seem that the administration hol prior to radiation increased the dose re- l to kill 50 per cent of the mice, and extended e of non-survivors.

protection was obtained when the 10 per cent l solution was given after radiation in two 1 ml. immediately after radiation followed by one hour thereafter.

parison of the protective effects of equal es of 10 per cent or 5 per cent alcohol showed both concentrations were protective, but that ifference in protection value between them was ignificant.

an attempt to compare the protective effect ohol with that of cysteine, using the same strain ice, it was found that an intravenous dose of gm. cysteine per mouse seemed to have a rather er effect than oral alcohol in the doses used. We not tried the effects of higher doses of alcohol. e protective effect of alcohol is probably un- ed to its anæsthetic effect. Although the majority ice given 1·5 ml. of 10 per cent alcohol were red unconscious, this was rarely the case for given the same volume of 5 per cent alcohol.

rthermore, we have tested two other substances sthetic doses for protection: (*a*) nembutal nously, 1·3 mgm. per mouse, (*b*) ethyl carbam- peritoneally, 20 mgm. per mouse. Neither substances altered the L.D.50. This was rprising in the case of ethyl carbamate, as been found to lessen the lethal effect of cells *in vitro*.

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Microspheres of Organic Substances

SPHERICAL particles of glass ranging in diameter from about one micron upwards, which can be prepared by the method of Bloomquist and Clark[1], have found a wide range of usefulness, for example, as adsorbents of known surface area[2], as material for the study of 'fluidization' of beds of particles[3], and in electrokinetic measurements on cataphoresis and sedimentation velocity[4,5]. For many such experiments, particularly the electrokinetic ones, it would be desirable to be able to use microspheres of substances other than glass. I have found that it is possible to obtain many organic compounds in microspherical form, provided that they melt below 100° C., and are more or less insoluble in water. The substance to be used is mechanically stirred at a very high rate with thirty to forty times its weight of water, at a temperature 10–15° above the melting point of the substance, thus producing an unstable emulsion of liquid drops in water. This is then run rapidly into a large excess of cold water, producing solid spherical particles of the substance. Some degree of control over the size of particle obtained can be exercised by modifying the rate and time of stirring. In this way, microspheres of naphthalene, octadecane, *m*-dinitrobenzene, cetyl alcohol, stearin, stearic acid, and several other organic compounds have been prepared. These particles are used in the study of the electrokinetic properties of organic compounds by the method of electroviscous sedimentation[6].

Most of these particles keep indefinitely under water, but if allowed to dry off, some of the softer ones tend to lose their shape. Some aggregation may also occur on drying, and the particles are then difficult to redisperse, so that it is advisable to store them under water so far as possible.

It should prove feasible to apply this method to low-melting inorganic substances, using non-aqueous liquids as dispersing media.

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An Isopod, *Asellus meridianus* Racovitza, with Low Chromosome Number

IN the past fifty years, several papers have described the chromosomes of Isopoda, and the numbers for twenty-seven species have been recorded. Most of this work has been done by Vandel[1,2]. The numbers range from 6 to 60 taking the group as a whole, but some families may show less variation than others[3]:

Haploid numbers:	6,	7,	8—	16,	17—	24—	27,	28,	29,	30,	31—	34—	60
Flabellifera	1												
Epicaridea			1										
Asellota		1	3				1						
Oniscoidea			3	1	1	2	2	6		1	1	1	1
Valvifera								1	1				

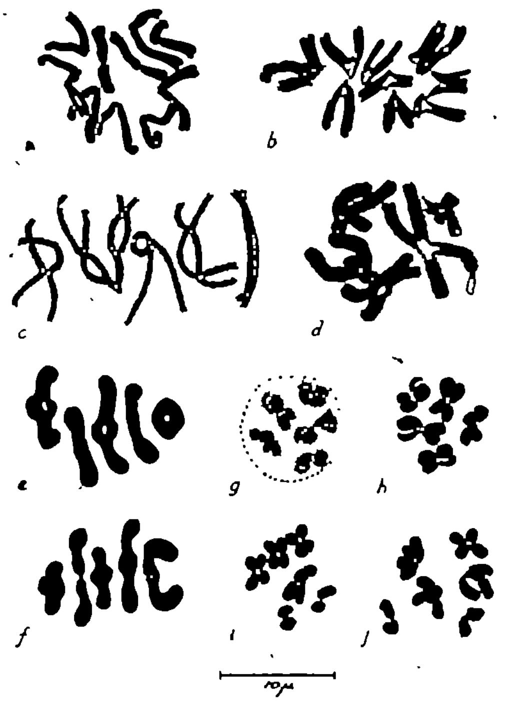
Vandel[1] has studied two species of *Asellus*, *A. aquaticus* and *A. meridianus*, both with $2n = 16$. According to him, *meridianus* has only v-shaped chromosomes and at metaphase I he finds 8 bivalents and a 'chromatoid-body'. He further states that his *meridianus* is identical with the species as it was first described by Racovitza[3].

The systematics of Asellota has become very complex in the past thirty years owing to the large number of species and subspecies described (Chappuis[4]). I therefore took great care in identifying the British *Asellus meridianus*; it corresponds in every detail with the original description by Racovitza. The chromosome number of the British *Asellus meridianus* Racovitza, however, is $n = 5$, the lowest number recorded for the Isopoda.

We are then faced with the possibility that a species has morphologically identical forms on the Continent and in England, but the chromosome numbers of which differ specifically. Since it is apparently easier to find racial differences than complete homology in this genus (Chappuis[4]), some mistake has probably been made.

The five chromosomes are median and submedian, ranging in size from 5·5 to 10 μ at mitotic metaphase. In embryonic tissue the chromosomes can be studied in detail. One chromosome pair has a terminal heterochromatic block in the short arm and what appears to be a secondary constriction in the long arm. The constriction is only clear in some cells, but a certain precocity in chromatid separation in the distal part can frequently be seen.

The heterochromatin in the short arm organizes the nucleolus. At telophase two nucleoli are formed which later fuse. Consequently, in prophase th heterochromatic ends are frequently found in imity when the nucleolus has disappeared.



(*a*) Somatic mitosis from embryo; big autosome at 9 o'clock showing split chromatids distally to secondary constriction. (*b*) Early anaphase; homologous chromosomes at 9 and 2 o'clock with secondary constrictions and terminal heterochromatin. (*c*) Diplotene bivalents drawn separately. (*d*) Diakinesis; animal heterozygous for heterochromatin. (*e*) and (*f*) Metaphase I; spermatogenesis. (*g*) Interkinesis. (*h*) Prometaphase II, normal. (*i*) and (*j*). Same; abnormal with one split univalent

It is not possible to detect any differe chromosome morphology between the embr one must conclude that no distinguishab chromosomes are present. One embryo about sixty) was heterozygous for the t heterochromatin.

In male meiosis the nucleolus persists at phase I in about 10 per cent of the cells. The c frequency appears to be about 1·7 per biva diplotene (twelve cells) and 1·1 at metaphase cells). Some caution must be exercised with to the diplotene frequency because centric p (and stickiness) is not uncommon. This is presu the reason why some chromosomes are seen tc fallen apart before metaphase II. They ma be univalents which divided at first division this is not likely since the univalent frequenc be low.

The material is very well suited for experi work, particularly with water-soluble chemic the early spring (March) the smaller fem found attached underneath the males, a which they maintain even when the embr well advanced in development. Underne female in the brood-pouch, about eighty emb found beautifully synchronized in developme brood-pouch can easily be opened and the e reared separately for experimental series. T easily penetrated by chemicals; for exa 0·025 per cent colchicine solution gives c c-mitosis after four hours.

S. MU

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July 16.

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Nature of Ovarian Dermoid Cyst F

THE fat which accumulates in the ovarian de cyst has long attracted interest. Sotnitchewsk 1880, suggested that this fat was analogous to s and since that time it has been assumed by workers that the two substances are identic assumption that receives support from the logical evidence of the presence of sebaceous g in the cyst walls. Many studies of the compo of this fat have been made[1], but these are incon and have been concerned largely with the un ifiable matter present. During the course of of the composition of human sebum[2], a supp fat from a dermoid cyst became available, opportunity was taken to compare the co of the cyst fat with that of sebum.

The general properties of the dermoid cy shown in Table 1, together with the corr figures, obtained by MacKenna, Wheatley a all[3], for human sebum. The non-saponifia was fractionated chromatographically, and are summarized in Table 2, together wit of similar studies on human sebum[4]. fractions of the dermoid cyst fat, with

l. GENERAL PROPERTIES OF OVARIAN DERMOID CYST FAT COMPARED WITH THOSE OF HUMAN SEBUM

	Dermoid cyst fat	Sebum
point	33·8°	35–37°
No.	55·6	53–83
o.	0·6	59–78
rol (total)	3·6 per cent	2·7–5 9 per cent
gen	nil	0·42–0·49 ,,
rus	nil	nil
)	0·6 per cent	22–32 per cent
mbined)	70·2 ,,	28–41 ,,
matter	27·3 ,,	27–36 ,,

hydrocarbon fraction, appear to be almost
al with those obtained from human sebum.
ydrocarbon fraction of the cyst fat, however,
red to consist of practically pure squalene, with
trace of n-paraffins, whereas the corresponding
n from human sebum contained less than
cent of squalene, the remainder consisting
ally of n-paraffins, probably mainly of penta-

COMPARISON OF THE FRACTIONS OF THE UNSAPONIFIABLE OF DERMOID CYST FAT WITH THOSE OF HUMAN SEBUM

Nature	Dermoid cyst fat (per cent)	Sebum (per cent)
Hydrocarbons	13·2	37–46
n-Alcohols and oxidized squalene	56·3	17–25
Cholesterol	11·8	14–19
Unidentified sterol and oxidized squalene	7 8	4–11
Unidentified	7·8	6–13

results obtained show that the dermoid cyst
fers significantly from human sebum. The free
acids, so characteristic of human sebum, are
completely absent from dermoid cyst fat.
trace of n-paraffin is present in the cyst fat,
very much larger amount of n-alcohols (prin-
eicosanol) is present. In general, however,
ferences between the two fats are quantitative
than qualitative, and this suggests that the
id cyst fat may be sebum in which the process
mation has not gone to completion.

ther studies of this cyst fat are now being made
effort to identify completely the constituents
unsaponifiable matter, in the hope that this
ation will help the studies of human sebum
esent in progress. Fuller details will be pub-
elsewhere when these studies are complete.

wish to thank Dr. Magnus Haines, of the Chelsea
pital for Women, for kindly supplying the sample
varian dermoid cyst fat, and Dr. R. M. B.
kenna and Prof. A. Wormall for their interest
elp in this work.

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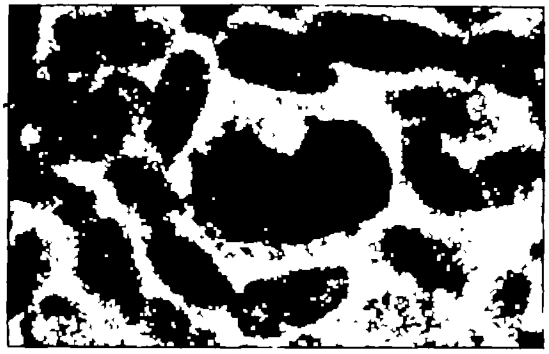
The Eosinophil Cell as seen in the Llama

THE increasing clinical use of substances of the cortisone group raises many new questions in the field of hæmatology, and it is considered that observations made in the animal kingdom, particularly in regard to the aspect and behaviour of the eosinophil cell, should help towards a greater understanding of the physiology of this cell in mammals, and therefore in the human being, and perhaps also of the problems arising in therapeutic practice.

Wishing to confirm my observations of the eosinophil cell, as seen in the camel[1], by making further investigations on an animal of the same family, I obtained, with the generous co-operation of the Zoological Gardens, London, some blood slides from the llama. The slides were stained with May–Grunwald–Giemsa, and it was expected that the red blood corpuscles would be elliptical as in the camel. Instead, however, the corpuscles were found to be much more elongated than in the camel, the length varying considerably, some red blood corpuscles being up to twice the length of others. Moreover, the granules of the eosinophil cells were also elongated, some actually appearing to be more like rods.



Peripheral blood from the llama showing the granules of the eosinophil cell, some being very elongated and rod-like. Notice in the background the different sizes of the red blood corpuscles

The llama, therefore, confirms what appears to be a rule in the eosinophils of mammals, namely, that the characteristics of the eosinophil granules bear a definite relationship to the characteristics of the red blood corpuscles in the same mammal, particularly in shape. Cases of ovalocytosis in human beings show this same relationship very clearly. This further confirmation, afforded by investigation of the llama's blood, gives added weight to my interpretation of the physiological function of the eosinophil cell as a precursor of red blood corpuscles. It should be possible to watch the cycle of red blood corpuscle secretion in the spleen of the llama with a series of eosinophil cells showing, in their cytoplasm, the growth of granules to the size of fully developed red blood corpuscles, before being shed into the blood circulation, in the same way as this has been observed in a thyroid hæmorrhagic cyst in human beings, and in the spleen of the camel.

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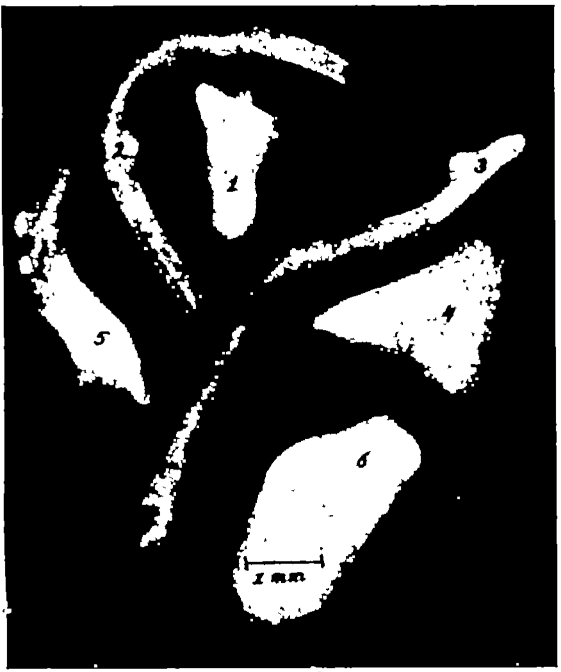
Christie H

Differentiation of Skeletal Structures from Mouse Embryo Mince in the Peritoneum of Adult Mice

In the course of attempts, as yet unsuccessful, to produce a non-malignant ascites growth of undifferentiated cells in peritoneal exudate, virgin female mice of two genotypes were injected intraperitoneally with homologous embryonic tissue mince, dissociated in a Waring micro-blendor and capable of passage through a 22-gauge hypodermic needle. Embryos ranged from the 4½-mm. 13-day stage, at which condensations of mesenchyme appear at the location of the future skeletal axes, to 8 mm. in length. Each of ten hosts received an inoculum equivalent to three embryos.



Skeletal structures recovered from the peritoneum of mice three weeks after injection with mouse embryo mince.
(1) Talus; (2) abnormally regenerating rib; (3) distal portion of 9th or 10th rib; (4) head of humerus; (5) ascending ramus of pubis; (6) bone teratoma

The treated mice failed to produce ascitic fluid, such as obtained by Klein[1] with a representative variety of dissociated neoplasms. Three to five weeks after injection, all the hosts were found to contain various teratomata, islands of bone and cartilage attached to the surfaces of spleen, liver, diaphragm and mesentery, and numerous fully differentiated, anatomically defined bones, including whole ribs, phalanges, sesamoids and vertebræ, corresponding in size to the skeletal proportions of mice about one week after birth. The bony structures (see photograph) are of especial morphogenetic interest, in that they provide further evidence (similar to the *in vitro* results of Fell and Robinson[2] with chick femoral rudiments) that skeletal primordia surpass other tissues in their capacity to attain not only advanced histological differentiation, but also to continue their normal anatomical development in foreign sites. In a relevant experiment, Ephrussi[3] cultured portions of 10-day mouse embryos homozygous for the lethal brachyury gene and their normal sibs and obtained differentiation of cartilage, but no definitive bone. It remains to determine the earliest develo stage from which anatomically recognizable the skeleton may be grown *in vitro* or *in* the minimal size of fragment still permittin bone growth.

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Toxicity of Copper in Solution to t Stone-loach

In June 1951, stone-loach (*Nemacheilus ba* L.), which had been kept alive in an aquariu March 1951, died when it became necessary to repl the water supply, which came from a nearby re with lake-water from Windermere. Chemical a showed that the original water contained 0·15 copper (Cu++) whereas the lake-water had 0·28 copper, presumably derived from the inflow Stone-loach, when placed in water containing in solution from nil in steps of 0·05 to 0·30 copper, lived in concentrations less than 0·20 copper, but all except one fish died within twen hours at concentrations of 0·20 p.p.m. and It seems reasonably certain, therefore, that th died of copper poisoning. This note is pub because it may be of practical interest.

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An Improved Block for Spore-Formati in Yeast

V. Hartelius and E. Ditlevsen[1] recently [illegible] attention to the fact that gypsum blocks u spore-formation in yeast will not tolerate th heating necessary for adequate sterilization trials with various materials, they finally block cast of Portland cement and kieselguh after hardening in carbon dioxide is sufficient

Nearly sixty years ago, H. Elion[2] refe disadvantages of the use of gypsum block for th study of spore-formation in yeast. He stated tha he had been using for several years [illegible] size 2 cm. × 2 cm. × 2 cm., made to hi [illegible] of unglazed porcelain, and that these [illegible] could be obtained from laboratory s [illegible] can easily be cleaned, sterilized and use [illegible] Elion described the excellent results w obtained by using these porcelain blocks [illegible] of spore-formation in yeast, and during many thereafter he continued to use these blocks great satisfaction.

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Technical Representations, Inc.,
Washington, D.C.

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